United States Patent [19]

Heesemann

[11] **3,715,839**

[45] **Feb. 13, 1973**

[54] **GRINDING DEVICE FOR THE RADIUSED CHAMFERING OF AN EDGE OF A WORKPIECE**

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[22] Filed: **Sept. 14, 1971**

[21] Appl. No.: **180,356**

[30] **Foreign Application Priority Data**

Sept. 15, 1970 Austria 8361

[52] **U.S. Cl.** **51/58,** 51/62, 51/141

[51] **Int. Cl.** **B24b 21/16**

[58] **Field of Search**.....51/137, 359, 360, 361, 58, 51/62, 63, 141

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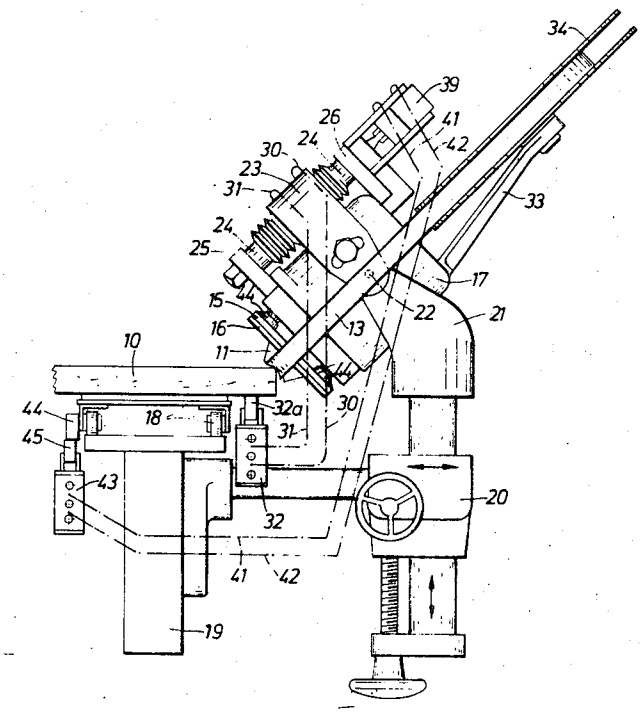
[57] **ABSTRACT**

A grinding device for the radiused chamfering of an edge of a workpiece. The grinding device is characterized by a grinding belt progressively drawn from a spool and passed around a pressing surface on a pressing shoe which has a trapezoidal channel profile. A motor, with apparatus which produces an orbital movement for the pressing shoe, is included.

7 Claims, 7 Drawing Figures



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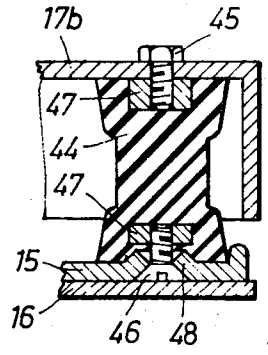

Fig.7

Fig.1

Fig.6

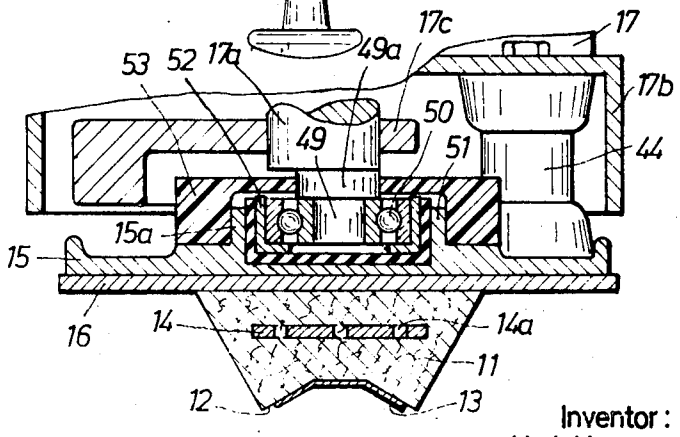

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Fig. 2

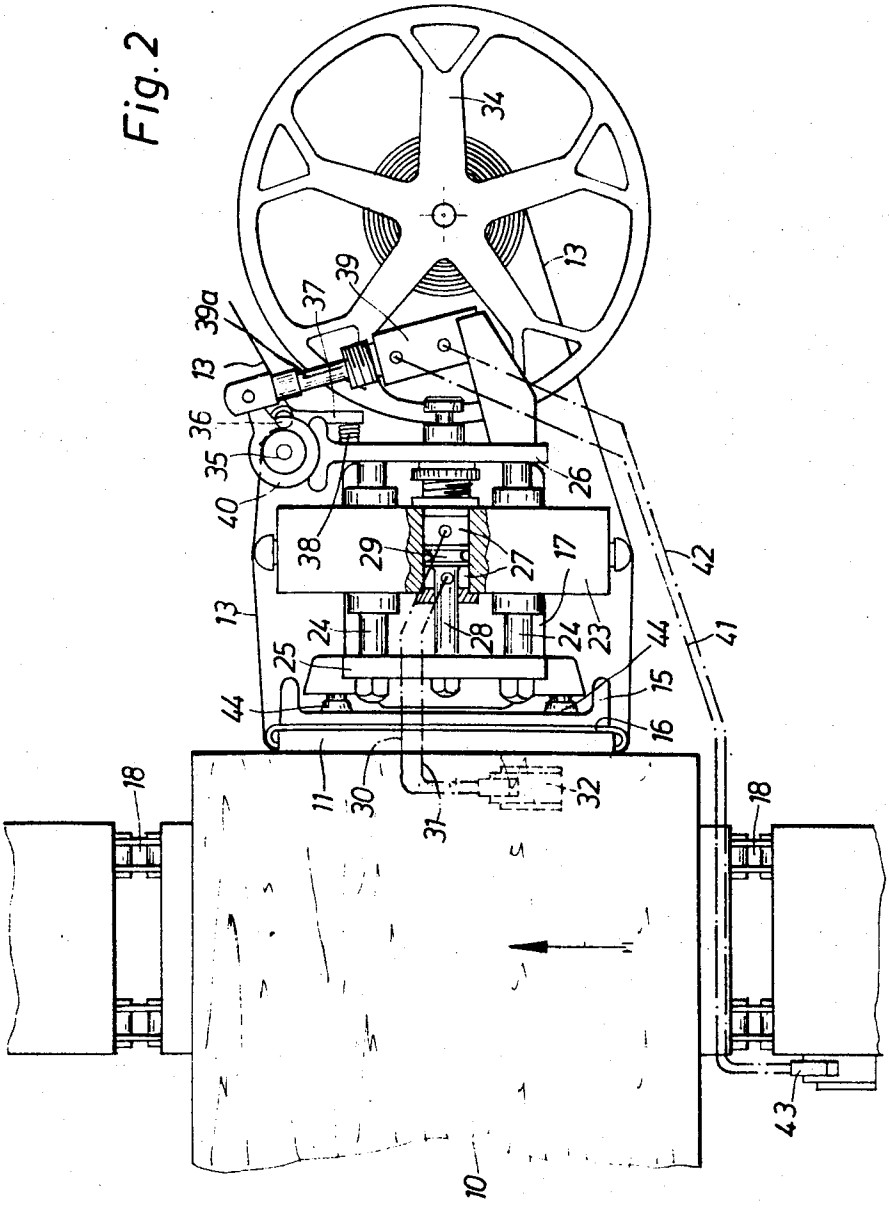

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Fig. 3

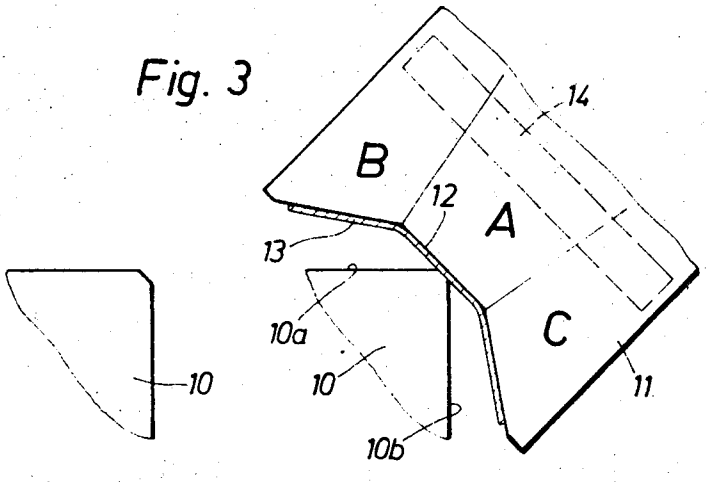


Fig. 4

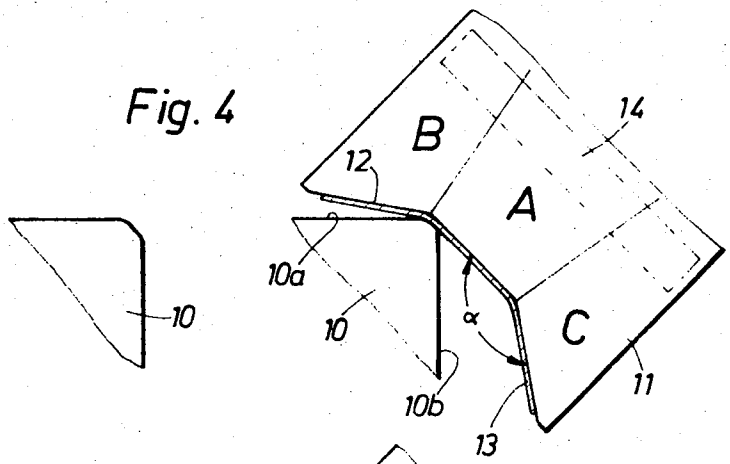
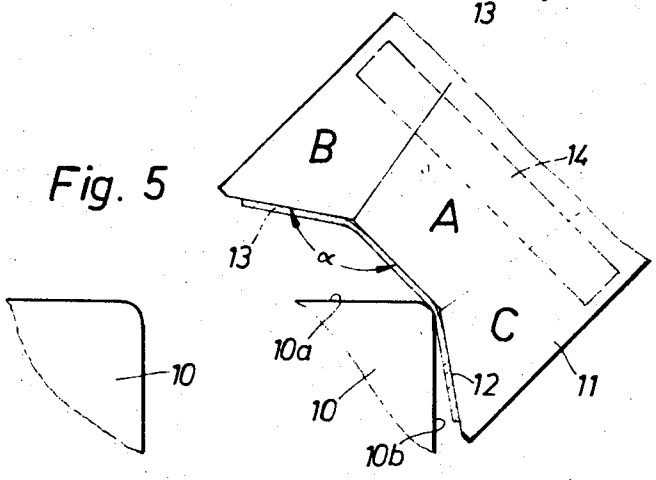


Fig. 5



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GRINDING DEVICE FOR THE RADIUSED CHAMFERING OF AN EDGE OF A WORKPIECE

The invention relates to an apparatus for radiused chamfering of wooden, plastics or other workpieces, which may be solid or coated with veneer plastics material sheet. This apparatus is provided with a pressing shoe providing a support for a progressively wooden, abrasive belt.

Various devices for chamfering wooden workpieces are known which operate with grinding plates, grinding wheels, grinding head comprising individual abrasive sheets, or with an endless rotating abrasive belt passed over a shaped part.

The main disadvantage of such devices is that it is not possible to chamfer a workpiece edge evenly and lightly over its whole length. In addition to this, when a veneer or a plastics material sheet is cemented with a thermoplastic bonding agent, the grinding means becomes rapidly clogged and thereby becomes ineffective.

A further disadvantage is that the effective width of abrasive belt is only that of the material width to be processed. If a sharp edge is to be chamfered, this width is only about 1mm, and since the abrasive belt, to be stably guided, must have a width of between 10 and 15 mm, only about 10 percent of the abrasive belt is used.

It is an object of the present invention, whilst avoiding such known deficiencies, to provide a grinding device which effects a satisfactory, even chamfering (radiused of edges) of workpieces, the abrasive belt area which becomes useless due to the bonding agent and/or grinding dust being continuously removed and automatically replaced by a new section of abrasive belt. A high percentage of abrasive surface is used.

In accordance with the invention a grinding device of the kind referred to above is characterized by the feature that the pressing shoe is provided with a pressing surface of different shape from the profile (radius) to be ground, and of larger groove-like cross-section which may be trapezoidal or arcuate. The belt is automatically removed slowly from a spool thereof, and besides a feed movement in the direction of the workpiece edge to be chamfered, is also given a rotary movement by means of the pressing shoe.

The pressing shoe with abrasive belt is given the rotary movement, whilst maintaining its longitudinal direction relative to the workpiece edge, by an eccentric drive and this movement together with passage of the workpiece past the shoe causes the workpiece edge to be radiused.

The channel-like pressing surface of the pressing shoe has a cross-section which shows three surface regions subtending obtuse angles relative to each other. The central surface region is at right angles to the angle-bisecting line of the workpiece edge to be chamfered, and this central pressing surface region with the two outer pressing surface regions enclose an angle of more than 136.

During the rotating movement the abrasive belt conforms to the cross-sectional shape of the pressing surface, and the center section first forms a flat on the workpiece edge, whereafter the two outer pressing surface regions radius it.

A driving motor supporting the pressing shoe may be located on a rod which is adjustable laterally and vertically relative to a conveyor moving the workpiece, and

by means of a pressure medium cylinder controllable by the workpiece, may be moved towards and away from the workpiece.

A draw-off device located on the belt driving means automatically moves the used part of the abrasive belt out of the pressing shoe region and brings up unused abrasive belt material; the belt runs off a spool rotatably mounted on the motor, and is carried past the abrasion area by means of a conveyor roller co-operating with a pressure application roller which is rotated in timed sequence by means of a pressure medium cylinder.

The pressure medium cylinder for rotation of the conveyor roller is connected via pressure medium pipes with a control valve actuated by cams on the conveyor device, which valve is controlled by the displacement movement.

The surfaces of the pressing shoe press the abrasive belt in a deformed or curved cross-sectional form against the edge to be chamfered, and radiusing of edge occurs due to the circulatory movement of the driven pressing shoe; at first a flat chamfer is ground on the edge, and then the chamfer is rounded off. Thus, the abrasive belt is utilized over a relatively wide strip region of large area (substantially over the whole width).

The length of the grinding tool (pressing shoe with abrasive belt region) is so chosen that any grinding marks overlap and a smooth finish is obtained.

The automatic abrasive belt advancing movement constantly presents new (unused) abrasion material to the workpiece, so that a satisfactory operation is ensured. The abrasive belt, which may be 50 meters long has a long life, so that time lost in replacement is negligible.

The invention will be described with reference to the accompanying drawings, in which:

FIG. **1** is an end view of a device for chamfering workpieces passing continuously therethrough;

FIG. **2** is a plan view of the same apparatus;

FIGS. **3** to **5** show how the workpiece edge is processed in individual phases;

FIG. **6** is a cross-section through the pressing shoe guiding the abrasive belt; and

FIG. **7** is a longitudinal section through an elastic mounting for the pressing shoe.

The apparatus shown for chamfering (radiusing) the edge of a workpiece **10** has a pressing shoe **11** with a channel-shaped profiled pressing surface **12** receiving an endless abrasive belt **13** adapted to be moved automatically in the longitudinal direction of the edge of the workpiece to be chamfered. This pressing shoe **11** supports the grinding belt **13** during chamfering, and is provided both with a feed movement across the width of the pressing surface (transverse direction) and with one in the longitudinal direction of the pressing surface.

The channel-like pressing surface **12** of the pressing shoe **11** can be seen in cross-section to have three surface regions A, B and C (FIGS. **3** – **5**) subtending obtuse angles with each other, the central surface region A being at right angles to the line bisecting the angle of the edge to be chamfered, and this central surface region A subtends an angle α of more than 136° with each of the surface regions B and C.

With respect to a workpiece having two surfaces 10*a*, 10*b* extending at right angles to each other and forming the edge to be chamfered, the central surface region A of the pressing surface 12 extends at an angle of 45° relative to each of the two workpiece surfaces 10*a*, 10*b*, and the external pressing surface regions B and C subtend with the workpiece surface 10*a*, 10*b* adjacent thereto an angle of between 5° and 15°, preferably an angle of about 10°. The three surface regions A, B and C are preferably formed of equal size.

In place of the three surface regions A, B and C the surface 12 may be concave.

The pressing shoe 11 has a length which is greater than its width, and preferably has a basic rectangular shape.

During chamfering the pressing shoe 11 is given a circular or elliptical movement whilst its longitudinal dimension remains parallel to the longitudinal direction of the workpiece edge, this circulating or elliptical movement during passage of the shoe along the workpiece edge producing a satisfactory, uniform radiusing of the edge.

The pressing shoe 11 is made of felt or like material, having an inserted bracing plate 14 which can be provided with apertures 14*a* mounted on a carrier plate 15 by means of a steel guide plate 16, the end face of which is radiused for guiding the grinding belt 13. The pressing shoe 11 has rubber mounting members 44, a driving motor 17, and is driven over its circular or elliptical path by an eccentric 49 coupled to the driving shaft 17*a* of the motor 17.

The carrier plate 15 is connected at its center to the eccentric drive and is carried at its corners by means of four suspension members 44 in the form of (see FIGS. 1 and 2 and right hand side of FIG. 6) rubber or like columns fastened on the housing 17*b* of the driving motor 17 or on a member rigidly connected to the motor housing 17*b*.

A preferred embodiment of this elastic suspension is shown in FIG. 7. Each suspension member is attached to a support by means of a screw 45 or 46 and may be made of solid material, as shown, or may be a tube. The screws engage in threaded nuts 47 moulded into the suspension members 44. To obtain a lateral positional location of the suspension members 44 the carrier plate 15 and/or the housing 17*b* may be provided with centering projections 48.

To form the eccentric drive, the motor shaft 17*a* is provided at its free end outside a mounting rib 17*c* with an eccentric pin 49, with is connected by interposition of a ball bearing 50 to the carrier plate 15. A damping skin in the form of a rubber layer 51 is located between bearing 50 and carrier plate 15, the skin being mounted in a cylindrical recess of the carrier plate 15. The roller bearing 50 and the eccentric 49 are protected from grit or dirt by a cover 53. This cover has a central aperture which engages over an eccentric shoulder 49*a* between the motor shaft 17*a* and the eccentric pin 49 and is mounted on the carrier plate 15 by means of screws (not shown). To form the cylindrical recess for the ball bearing and for centering the cover the carrier plate is provided with a sleeve 15*a*, (FIG. 6). The eccentrics 49, 49*a* may be made integrally with the motor shaft 17*a*, or fabricated as additional parts and connected rigidly or detachably to the motor shaft 17*a*.

The workpiece 10 is carried on a conveyor device 18, supported on a frame 19, which moves the workpiece past the pressing shoe 11 and grinding belt 13. A rod 20 which is vertically and laterally adjustable relative to the conveyor device 18, has a bifurcated head 21 which receives a carriage 23 pivoted at 22.

Two guide struts 24 extending parallel to each other and inclined with respect to the workpiece 10, engage the carriage 23, and are interconnected at both their ends by straps 25, 26; these two straps carry the motor 17.

The driving motor 17 with pressing shoe 11 and grinding belt 13 are moved towards and away from the workpiece edge by a piston 29 axially displaceable in a cylinder 27 between two guides 24. The piston can be subjected to fluid pressure on either side, and its piston rod 28 is connected to strap 25. Two fluid pressure pipes 30, 31 are connected to the cylinder 27 from a control valve 32 located in the region of the conveyor device 18.

On actuation of the plunger 32*a* of the control valve 32 by the workpiece when moved in the direction of the arrow (FIG. 2) by the conveyor device 18, the pipe 30 and hence the rear surface of the piston 29 is supplied a pressure medium, preferably air, whilst the other pressure medium pipe 31 is opened to exhaust. The piston 29 moves the motor 17 along the guides 24 towards the workpiece edge and brings the grinding belt 13 as shown in FIG. 1 into engagement with the workpiece. When the workpiece 10 has received a chamfered edge and has passed through the machine, plunger 32*a* is released, the pipe 31 is supplied with pressure medium and the pipe 30 is exhausted. The motor 17 with the pressing shoe 11 and grinding belt 13 is moved back into a retracted position.

A spool 34 dispensing the grinding belt 13 is rotatably mounted on a carrier arm 33 connected to the motor 17; the grinding belt 13 is drawn from this spool 34 over the pressing shoe 11 by a draw-off device engaging the used part of the grinding belt. This device applies a timed draw-off movement to the belt so that from time to time a piece of the belt is drawn off and a new and unused section of belt arrives in the region of the pressing shoe 11.

The draw-off device is located on a bracket 26 and has a conveyor roller 35 and a pressing roller 36 associated therewith. The conveyor roller 35 is made of rubber and the pressure application roller 36 is rotatably mounted near one end of a double-armed lever 37 the other end urging the pressure application roller 36 against the conveyor roller 35 by means of spring 38.

A pressure medium cylinder 39 displaceably mounted on the bracket 26 engages a stepping mechanism with its piston rod 39*a*, the mechanism rotating the conveyor roller 35 step by step as the piston is extruded and retracted. Two pressure medium pipes 41, 42 convey the medium alternately to one side or the other of the piston. The pipes are connected to a control valve 43; this valve is located in the region of the conveyor device 18 and is provided with a plunger 45 actuatable by a cam 44 of the conveyor device 18. When the plunger 45 is so actuated by the switch cam 44, then pressure medium is supplied to pipe 41 and the pressure medium pipe 42 is exhausted. This moves the

piston into its rear (retracted) end position and its movement transmits a rotary movement to the conveyor roller **33** via the catch **40**. This moves the grinding belt **13** a step forward. When the switch cam **44** releases the plunger **45**, the pressure medium pipe **41** is exhausted and pressure applied to pipe **42**, so that the piston is moved outwards into its extruded position. During this movement no rotary movement of the conveyor roller **35** occurs, since the catch **40** is disengaged from the roller **35**. The number of switching cams **44** located on the conveyor device **18** depends upon the material to be ground, the feed speed, and the grinding belt wear resulting therefrom. The actuation of valve **43** unrolls the grinding belt **13** piece by piece at adjustable intervals (arrangement of the switch cam **44**), the belt being drawn into the region of the pressing shoe **11** to renew the grinding surface.

As the grinding belt **13** moves into the pressing surface region of the pressing shoe **11** it conforms to the pressing surface shape, so that it has three surface regions corresponding to pressing surface regions A, B and C. Since the pressing shoe **11** executes a rotary movement the central part of the belt on the pressing shoe first grinds a 45° chamfer on the edge of the workpiece (see FIG. **3**), which is converted into a radius as the grinding progresses (FIGS. **4** and **5**). Owing to the large number of circular movements (for example, 5700 per minute) and the relatively long tool (pressing shoe **11**) overlapping of the grinding traces and a good finish is obtained.

An edge can have a radius of between 0.2 and 1.5 mm applied to it. This size depends upon the pressure of the medium on the piston **29** to urge the pressing shoe **11** towards the workpiece edge. This pressure is adjustable and retains the pressing shoe **11** against the workpiece edge during a grinding operation, so that this edge is uniformly chamfered or radiused over the whole length of the workpiece.

The strap **23** holding the motor **17** and pressing shoe **11** is pivotally mounted on the head **21**, so that the angular position of the pressing shoe **11** can be adjusted to different workpieces **10**. Thus, if a workpiece has surfaces **10***a*, **10***b* with an unequal angle relative each other are to be chamfered, it is possible to set an equal angle between the workpiece surfaces **10***a*, **10***b* and the two pressing surface regions B and C.

The grinding belt **13** has been described as carried step by step past the pressing shoe **11** by the draw-off device, so that its face is constantly replaced. In an alternative embodiment the grinding belt movement is continuous; the drawing-off device is moved by gearing and continuously draws the grinding belt **13** from its spool.

The apparatus in accordance with the invention is adapted to be used as a separate unit for chamfering workpiece **10**. It may be mounted on grinding machines or other workpiece processing stations and used in continuous production lines.

This apparatus may be used for machining a variety of wooden, plastics, metal or other workpieces. The latter may be solid, or may be coated with veneer, or plastics material sheet.

I claim:

1. A grinding device for the radiused chamfering of an edge of a workpiece and including:

a. a grinding belt drawn from a spool and passed around a pressing surface on a pressing shoe to exert a grinding pressure;

b. said pressing shoe defines a channel-like pressure application surface extending in the longitudinal direction of said workpiece edge, the cross-section of which surface is different from the cross-sectional profile of the radius to be ground, said cross-section defining a central region for chamfering a flat on said workpiece, and two lateral regions for radiusing said pressure application surface forming a trapezoidal channel profile;

c. a driving motor and means driven thereby for producing circulating (orbital) movement for said pressing shoe, said means comprising an eccentric drive located between said motor shaft and said pressing shoe;

d. means for urging said pressing shoe with said grinding belt passed around it towards and away from said workpiece edge at an angle relative to said workpiece surface; and

e. means for automatic progressive displacement of said grinding belt along said shoe.

2. A grinding device as recited in claim **1**, wherein said channel-shaped pressing surface of the pressing shoe has three surface regions subtending obtuse angles to one another in cross-section, the central surface region being located in use at a right angle to the angle-bisecting line of the workpiece edge to be chamfered, said central pressing surface section subtending with each of said two outer surface regions, an angle of more than 136°.

3. A grinding device as recited in claim **2**, in which said three surface regions of the pressing shoe surface are of equal width.

4. A grinding device as recited in claim **1**, in which said motor and pressing shoe have a bearing and two supporting straps said straps being interconnected by means of guides extending in the axial direction of said motor, a pressure cylinder acting on said motor to displace said motor in a direction towards or away from said workpiece, means for mounting a bearing for said motor on a bifurcated head, a rod carrying said head, said rod being adjustable in two directions with respect to said workpiece, and a conveyor device adapted to convey said workpiece past said pressing shoe.

5. A grinding device as recited in claim **4**, wherein said pressure cylinder includes a piston axially displacable in said cylinder, two pipes connected so as to supply medium to either side of said piston alternately, and a control valve actuated by said workpiece, said valve being located in the region of said conveyor device and being connected to a source of pressure medium.

6. A grinding device as recited in claim **1**, wherein said pressing shoe is made of felt with an inserted bracing plate, and is mounted on a plate guiding said grinding belt, resilient suspension members supporting said bracing plate on a carrier plate carrying said motor, and an eccentric causing said orbital movement of said pressing shoe connected to the driving shaft of said motor.

7. A grinding device as recited in claim **1**, comprising means for drawing said grinding belt progressively from a spool in dependence upon movement of said conveyor device, said means including a conveyor roller

co-operating with a pressure application roller, said pressure application roller rotatably mounted on said carrier strap, said rollers acting to pass said grinding belt across said pressing shoe; a pressure medium cylinder and piston intermittently energized to act as a ratchet device for said belt, said piston rotating said conveyor roller in one direction of movement only.

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