An apparatus for grinding a planar work piece which is conveyed along a transport path defined by at least partly driven supporting rollers and pressure rollers, contains a revolving grinding element which extends into the transport path and which contacts the work piece circumferentially on its way along the transport path. A pressure device is provided which applies an elastic pressure force to the revolving grinding element in the direction of the work piece in such a way that the revolving grinding element is set flexibly against the planar work piece in such a way as to follow the contour of the latter.
APPARATUS FOR GRINDING WORKPIECES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority, under 35 U.S.C. §119, of German application DE 10 2007 048 544.3, filed Oct. 9, 2007; the prior application is herewith incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0002] The invention relates to an apparatus for grinding a work piece which is conveyed along a transport path defined by at least partly driven supporting rollers and pressure rollers. The apparatus contains a revolving grinding element which extends into the transport path and which contacts the work piece circumferentially on its way along the transport path.

[0003] It is known that grinding apparatuses with which, for example, steel work pieces are machined on their underside have grinding elements in the form of fixed grinding rolls or belt grinding units provided with abrasive cloth or abrasive paper. The belt grinding units have an endless grinding belt which is directed over a fixed contact roll, contacting the work piece, and two or more deflection rolls.

[0004] In the above-mentioned grinding apparatuses of the prior art, the work pieces run over driven rubberized supporting rollers which are disposed upstream of and downstream of the grinding rolls or grinding belts as viewed in the conveying direction of the work piece.

[0005] In order to drive the work piece more effectively, pressure rollers loaded by spring pressure as a rule are arranged above the supporting rollers on the side of the work piece opposite the grinding roll, the pressure rollers exerting pressure on the work piece, while the latter is moved via the grinding roll or the contact roll along the conveying path defined by the supporting rollers and pressure rollers.

[0006] The grinding elements are set as a function of the desired removing capacity, i.e. the quantity of material to be removed from the work piece per unit time, in such a way that the contact lines between the grinding elements and the work piece are accordingly higher than the contact lines between the work piece and the supporting rollers.

[0007] With the grinding apparatuses of the prior art described above, it is only possible, on account of the fixed arrangement of the rollers and grinding elements, to flat-grind the underside of planar work pieces.

[0008] On the other hand, if the above-described grinding apparatuses are used for removing burrs, as produced, for example, during the thermal cutting of steel parts, problems arise with regard to the machining of the work pieces, since the work pieces are often concavely or convexly deformed beyond the normal tolerances due to the thermal cutting.

SUMMARY OF THE INVENTION

[0009] It is accordingly an object of the invention to provide an apparatus for grinding work pieces which overcomes the above-mentioned disadvantages of the prior art of this general type, which makes possible the machining of work pieces deformed in particular by a thermal cutting operation.

[0010] With the foregoing and other objects in view there is provided, in accordance with the invention, an apparatus for grinding a planar work piece. The apparatus contains at least partly driven supporting rollers and pressure rollers. The pressure rollers and the at least partly driven supporting rollers define a transport path along which the work piece is conveyed. A revolving grinding element extends into the transport path and contacts the work piece circumferentially on its way along the transport path. A pressure device for applying an elastic pressure force to the revolving grinding element in a direction of the work piece such that the revolving grinding element is set flexibly against the work piece in such a way as to follow a contour of the work piece.

[0011] The invention results in the advantage that, without regard to the plane-parallelism tolerance effected by, for example, a thermal cutting operation, work pieces of essentially identical shape can be passed through the apparatus directly one after the other without having to set up the latter again every time for this purpose for the respective degree of deformation of a work piece.

[0012] In particular, the apparatus according to the invention enables grinding to be carried out across the main surfaces of an essentially planar work piece irrespective of the respective tolerance in order to completely deburr the work piece, e.g. in the region of its underside.

[0013] A further advantage of the apparatus according to the invention consists in the fact that, even in the case of otherwise plane-parallel work pieces which are greatly deformed due to the preceding machining operation, damage to the preferably elastomeric lateral surface of the grinding roll or contact roll does not occur.

[0014] According to the invention, an apparatus for grinding a planar work piece which is conveyed along a transport path defined by at least partly driven supporting rollers and pressure rollers comprises a revolving grinding element which extends into the transport path and which contacts the work piece circumferentially on its way along the transport path. Furthermore, the apparatus contains, according to the invention, pressure means which apply an elastic pressure force to the revolving grinding element in the direction of the work piece in such a way that the revolving grinding element is set flexibly against the planar work piece in such a way as to follow the contour of the latter.

[0015] Although the pressure means may also have linear guides, the pressure means preferably contain a first and a second pivoted lever or oscillating lever, rotatably accommodating the revolving grinding element, and an actuator, in particular a pneumatic cylinder, acting on the pivoted lever or oscillating lever.

[0016] In order to operate the actuator, an electronic control device is provided in the preferred embodiment of the invention, the control device regulating the pressure force which is applied to the revolving grinding element by the actuator and/or regulating the position of the latter.

[0017] The apparatus according to the invention preferably has a workpiece-width detection device which is connected to the electronic control device and which is arranged upstream of the revolving grinding element as viewed in the work piece conveying direction, and from which the electronic control device receives signals which correspond to the instantaneously measured width of the work piece in the region of the workpiece-width detection device.

[0018] According to a further idea underlying the invention, the electronic control device varies the force of the actuator as a function of the signals from the workpiece-width detection device in such a way that the ratio of pressure force...
and workpiece width corresponds to an essentially constant specified value, which can be input by the operator, for example, before the machining of a certain type of work piece. This results in the advantage that the contact pressure—and thus the removing capacity—does not depend upon the instantaneous width of a work piece in the region of the revolving abrasive agent, as a result of which the loading of the abrasive agent in the case of narrow work pieces is reduced compared with grinding apparatuses in which the pressure force is constant, and the specific material removal is made more uniform.

Furthermore, provision may be made for the electronic control device to control the actuator as a function of signals from the workpiece-width detection device in such a way that the revolving grinding element is moved out of its position outside the transport path into the latter when the work piece front edge is located in the region of the grinding element. In a corresponding manner, the revolving grinding element is moved out of the transport path after the work piece rear edge has passed the revolving grinding element.

According to a further embodiment of the invention, the supporting rollers and/or the pressure rollers are driven at an essentially constant rotary speed, for example via a revolving chain. In this case, provision may advantageously be made for the pressure force which the actuator applies to the revolving grinding element to be varied by the electronic control device in a straight-line-controlled manner as a function of the work piece width detected by the workpiece-width detection device. For the straight-line-controlled detection, it is preferred here to arrange a rotary angle encoder on one of the supporting rollers and/or pressure rollers, said rotary angle encoder detecting the angular degree position of the roller, the angular degree position being temporarily stored, for example, in the electronic control device together with the associated instantaneous work piece width determined by the workpiece-width detection device. Once the rotary angle value has increased by a predetermined rotary angle magnitude which corresponds to the distance between the workpiece-width detection device and the contact line between the work piece and the revolving grinding element, the setting pressure of the grinding element is correspondingly reduced or increased by the electronic control device in accordance with the associated value for the workpiece width.

According to a further idea underlying the invention, there is assigned to the revolving grinding element a counter-pressure roller which is displaceable in the direction of the work piece, is arranged on the opposite side of the transport path and is set against the work piece with an elastic counterforce via further pressure means.

In this case, the further pressure means preferably have a further actuator, in particular a pneumatic cylinder, the pressure force of which is varied by the electronic control device as a function of the elastic pressure force with which the revolving grinding element is set against the work piece in order to prevent the work piece from giving way in the direction of the counter-pressure roller. In the process, the adjustment of the setting pressure of the further actuator is preferably effected automatically during the entire operation of passing the work piece through the apparatus.

The invention is described below with reference to the drawings and a preferred embodiment in which the grinding element is formed by a grinding roll arranged on the underside of the transport path.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in an apparatus for grinding work pieces, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWING

Fig. 1 is a diagrammatic, side view of a grinding apparatus according to the invention; and

Fig. 2 is a diagrammatic, cross-sectional view of the grinding apparatus according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the figures of the drawing in detail and first, particularly, to FIGS. 1 and 2 thereof, there is shown a grinding apparatus according to the invention that contains a machine column which consists of two cheeks or side parts 1, four cross members 2 and two cross members 3. A supporting frame 5 which contains two inner cheeks or side parts 5a and two further cross members 6 is accommodated on four screw spindles 4 which are mounted in the cross members 3. The cross members 6 are preferably provided with an internal thread for accommodating the screw spindles 4. The screw spindles 4 are driven via a geared motor 7, a chain 8 and chain wheels 9 in order to be able to set the work piece thickness.

Rubberized pressure rollers 11 preferably loaded by springs 10 are accommodated on the supporting frame 5, the pressure rollers 11 each being mounted on oscillating levers 12 which can pivot about an associated pin 13.

Additionally attached to the supporting frame 5 is a counter-pressure roller 14 which is rotatably mounted on an oscillating lever 15 which is arranged on both sides and is accommodated on the inner cheeks 5a preferably in such a way as to be likewise pivotable about a pin 16. By an actuator attached on both sides of the working width in the form of a compressed-air cylinder 16a, an elastic pressure force can be applied to the oscillating levers 15 in order to set the counter-pressure roller 14 against the work piece.

Preferably rubberized supporting rollers 18 are rotatably accommodated opposite the pressure rollers 11 on the two cheeks 1 and are driven by a motor, preferably a geared motor 19, via chain wheels 21 and a chain 22 jointed directed over all the chain wheels 21. The supporting rollers 18 together with the pressure rollers 11 form a transport path 100 for the entering work piece 33.

A grinding element in the form of a grinding roll 23 or also of a contact roll (not shown), over which an endless grinding belt is directed, is driven by an electric motor (not shown in any more detail), e.g. via V-belt pulleys and V-belts.

The grinding roll 23 is covered with a rubber lining 24, the abrasive agent 25—e.g. abrasive paper or abrasive cloth—being fastened to and clamped on the circumferential surface of the rubber lining 24.
[0035] The grinding roll 23 is preferably mounted in two bearing bushes 26, which each rest on an associated guide roller 27.

[0036] Each guide roller 27 is preferably mounted on two oscillating levers 28 which are connected to one another via a connecting element 29 and are pivotable via pins 30.

[0037] As shown in FIG. 2, pins 30 are supported on the cheeks 1 of the machine column via two angles 30a. As a result, the entire unit consisting of the two oscillating levers or pivotable levers 28 and a connecting element 29 is mounted on the pin 30 in a pivotable manner.

[0038] This unit, which is attached on the left and the right of the working width, is supported on a respective actuator, which is preferably configured as a pneumatic cylinder 31.

[0039] The unit consisting of the two oscillating levers 28, the connecting element 29, the pin 30, the angle 30a and the pneumatic cylinder 31 is also designated below as pressure means for the sake of simplicity.

[0040] Attached at the inlet of the machine is a workpiece-width detection device in the form of a light curtain 32 which can consist, for example, of a multiplicity of light sources and associated light sensors (not shown in more detail) which detect the instantaneous width of the work piece 33 when passing through the transport path 100 and also the front and rear edges of the work piece 33 when entering the transport path 100.

[0041] Functioning:

[0042] The work piece 33 entering in the conveying direction indicated by arrow 102 crosses the light curtain 32, which detects the front edge of the work piece 33 and after that scans the width of the work piece 33 until the rear edge of the work piece 33 has passed the light curtain 32. A non-illustrated electronic control device which is connected to the light curtain 32 and also to a non-illustrated solenoid valve assigned to each pneumatic cylinder 31, controls the solenoid valves in such a way that the grinding roll 23 is set against the underside of the work piece when the front edge of the work piece 33 is located perpendicularly above the grinding roll 23.

[0043] As a result of the elastic pressure force produced by the pneumatic cylinders 31, the grinding roll 23 always bears flexibly against the work piece 33 even in the case of a convoluted or concavely deformed work piece 33, as indicated in FIG. 1, the bearing force produced by the pneumatic cylinders 31 being varied as a function of the respective width of the work piece 33 which was determined beforehand by the light curtain 32.

[0044] When the rear edge of the work piece has reached the perpendicular above the grinding roll 23, the pneumatic cylinders 31—controlled by the electronic control device—are relieved, such that the grinding roll 23, on account of its own weight, moves back into the initial position, in which the circumferential surface of the grinding roll 23 is located outside the transport path 100. Above the grinding roll 23, the supporting roller 14 is pressed onto the work piece 33 in accordance with the grinding pressure by the further pneumatic cylinder 16a in order to produce an elastic counterforce which counters the pressure force produced by the pneumatic cylinder 31. In the process, the pressure rollers 11 are likewise loaded with an essentially constant force of the springs 10, whereas the supporting rollers 18 are mounted in a fixed manner in the machine column.

[0045] The work piece thickness desired in each case is set via the motor 7, the chain wheels 9, the chain 18 and the screw spindles 4 and screw nuts 6 before the machining of a series of work pieces.

1. An apparatus for grinding a planar work piece, the apparatus comprising:
   - at least partly driven supporting rollers;
   - pressure rollers, said pressure rollers and said at least partly driven supporting rollers defining a transport path along which the work piece is conveyed;
   - a revolving grinding element extending into the transport path and contacting the work piece circumferentially on its way along the transport path; and
   - a pressure device for applying an elastic pressure force to said revolving grinding element in a direction of the work piece such that said revolving grinding element is set flexibly against the work piece in such a way as to follow a contour of the work piece.

2. The grinding apparatus according to claim 1, wherein said pressure device has a first and a second oscillating lever, rotatably accommodating said revolving grinding element, and an actuator, acting on at least one of said first and second oscillating levers.

3. The grinding apparatus according to claim 2, further comprising an electronic control device controlling the pressure force applied to said revolving grinding element by said actuator.

4. The grinding apparatus according to claim 3, further comprising a workpiece-width detection device disposed upstream of said revolving grinding element as viewed in a work piece conveying direction.

5. The grinding apparatus according to claim 4, wherein said electronic control device controls said actuator in dependence on signals from said workpiece-width detection device such that a ratio of the pressure force and a workpiece width corresponds to an essentially constant specified value.

6. The grinding apparatus according to claim 4, wherein said electronic control device controls said actuator in dependence on signals from said workpiece-width detection device such that said revolving grinding element is moved out of its position outside the transport path into the transport path when a work piece front edge is located in a region of said revolving grinding element and said revolving grinding element is moved out of the transport path after a work piece rear edge has passed said revolving grinding element.

7. The grinding apparatus according to claim 4, wherein at least one of said supporting rollers and said pressure rollers are driven at an essentially constant rotary speed, and in that the pressure force which said actuator applies to said revolving grinding element is varied by said electronic control device in a straight-line-controlled manner in dependence on a work piece width detected by said workpiece-width detection device.

8. The grinding apparatus according to claim 1, further comprising:
   - a further pressure device; and
   - a counter-pressure roller assigned to said revolving grinding element, said counter-pressure roller being displaceable in a direction of the work piece and is disposed on an opposite side of the transport path and is set against
the work piece with an elastic counterforce via said further pressure device.

9. The grinding apparatus according to claim 8, wherein said further pressure device contains a further actuator, and a pressure force with which said further actuator sets said counter-pressure roller against the work piece is varied by said electronic control device in dependence on an elastic pressure force with which said revolving grinding element is set against the work piece.

10. The grinding apparatus according to claim 2, wherein said actuator is a pneumatic cylinder.

11. The grinding apparatus according to claim 9, wherein said further actuator is a pneumatic cylinder.

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