The invention relates to machining of surfaces of substantially flat workpieces by means of machining tools which can be driven in rotation, whereby the workpieces and tools are movable relative to one another. In order that a corresponding machining apparatus can be used with relatively low apparatus costs and with optimal machining results for very varied types of surface machining, the workpiece surfaces are machined in the same machining apparatus as required by means of a first tool unit containing a machining roller or (in exchange therefor) by means of a second tool unit containing a group of disc-type machining tools, whereby the machining roller can be positioned approximately in the radial direction and the disc-type machining tools can be positioned approximately in their axial direction against the workpiece surfaces.
METHOD AND APPARATUS FOR MACHINING WORKPIECE SURFACES

[0001] The invention relates to a method and to apparatus for machining surfaces of substantially flat workpieces according to the preamble to claim 1 or the preamble to claim 12 respectively.

[0002] Such methods and apparatus are used not only for relatively large workpieces but also for relatively small workpieces, for example for cleaning, grinding and polishing of the surfaces themselves and also for deburring of outer and inner edges of flat workpieces which are cut out or stamped out in any way whatsoever and may be produced for example from metal sheet, wood products, plastics and the like.

[0003] For the aforementioned purposes it is already known in the art for corresponding workpiece surfaces to be machined with machining tools which can be driven in rotation, whereby the workpieces can generally be transported along the tools and the tools can be positioned against the workpiece surfaces. Depending upon the desired type of machining, either at least one brush roller or at least one circulating abrasive belt is provided as machining tool in the machining apparatus. Especially when brush rollers and abrasive belts are used, particularly when machining relatively large workpiece surfaces, unwanted stripes are frequently formed, and for this reason these machining rollers and abrasive belts also have in addition to their circulating motion an oscillating motion aligned approximately transversely with respect to the workpiece transport direction, but this frequency leads to equally unwanted undulating stripes.

[0004] Furthermore U.S. Pat. No. 5,105,583 and EP-A-919 331 disclose apparatus in which a number of disc-type machining tools or brushes rotating about vertical axes are provided, which in addition to their autorotation can also carry out approximately planetary rotating movements about at least one further common axis of rotation. The consequence of these various rotating movements of the disc-type machining tools is that with simultaneous advancing movement of the workpiece a number of different relative movements take place, as a result of which surface machining operations which inevitably vary in intensity are carried out in different surface regions of the workpieces. Apart from this, a disadvantage is that these known constructions can only be used for a limited type of surface machining because of their machining tools which basically rotate about vertical axes.

[0005] The object of the invention is to design a method according to the preamble to claim 1 as well as apparatus according to the preamble to claim 12 so that the machining apparatus can be used extremely reliably for very varied types of surface machining with relatively low apparatus costs and with optimal machining results.

[0006] This object is achieved in terms of the method by the characterising features of claim 1 and in terms of the apparatus by the characterising features of claim 13.

[0007] Advantages embodiments and further developments of the invention are the subject matter of the subordinate claims.

[0008] A basic idea of the method according to the invention is seen in the fact that the workpiece surfaces are machined in at least one machining zone of the same machining apparatus as required by means of a first tool unit containing at least one machining roller or a second tool unit containing a group of disc-type machining tools, whereby the machining roller is positioned approximately in its radial direction and the disc-type machining tools are positioned approximately in their axial direction against the workpiece surfaces.

[0009] This method according to the invention is based upon the knowledge that different workpiece surfaces and different types of material can each only be optimally machined with appropriately adapted machining tools. In this case a relatively large group of types of surfaces and types of material can be machined particularly favourably with roller-type machining tools and a further large group of types of surface and types of material can be particularly favourably machined with disc-type machining tools, and the said groups may also overlap to some extent. Accordingly, if in at least one machining zone of one and the same machining apparatus the first tool unit containing at least one machining roller and the second tool unit containing a group of disc-type machining tools can be easily and relatively quickly exchanged for one another, then very varied types of surface processing (whether it be according to the size and shape of the surfaces or in relation to the type of material) can be carried out therein extremely reliably and with optimal machining results. This proves particularly advantageous above all when a user of such a machining apparatus is only machining relatively small quantities of workpieces with the respective specific types of surface machining or types of workpiece (with the most suitable machining tools in each case) and thus this machining apparatus would be quite inadequately utilised if it were equipped only with machining tools in the form of rollers or only with machining tools in the form of discs.

[0010] With this method according to the invention it is particularly advantageous if for each tool unit a tool mounting frame is used with at least in part the same external shape and each tool mounting frame can be installed so as to be quickly replaceable in the same receiving part-frame of a main apparatus housing or can be installed and removed.

[0011] According to a particularly preferred embodiment of the method according to the invention a brush roller is used in the first tool unit and circular brushes which can be positioned against the front face of the workpiece surface as disc-type machining tools are used in the second tool unit. Brush-type machining tools have proved particularly versatile in practical use, and it should also be noted that on the one hand the brush rollers and the circular brushes for each are suitable for entirely different machining actions and that on the other hand the possibility also exists of using specifically adapted bristle material (bristle set) both in the case of brush rollers and in the case of circular brushes in order to be able to produce more or less intensive machining actions.

[0012] Furthermore, varied possibilities advantageously exist for influencing the rotary movements and the positioning possibilities both of the brush rollers and of the circular brushes, which will become clear from the later description of various embodiments.

[0013] The apparatus constructed according to the invention is distinguished by a first tool unit containing a machin-
ing roller and a second tool unit containing at least one group of disc-type machining tools are provided for at least one machining zone of this apparatus, and these tool units can be operated as required for machining the workpiece surfaces, whereby the machining roller can be positioned with its outer circumferential surface approximately in the radial direction and the disc-type machining tools can be positioned with their outer end faces approximately in the axial direction against the workpiece surfaces.

[0014] According to a particularly advantageous embodiment of this apparatus each tool unit has its own tool mounting frame for the arrangement and retention of the machining tools, and a quick-change device is provided for reciprocal exchange of the various tool units as required, each tool mounting frame being of similar design as regards its shape and its external dimensions so that it can be installed with a precise fit in the same receiving part-frame of the main apparatus housing so that it is fixed but replaceable. Thus due to this construction, if necessary very varied or different types of machining can be carried out, optionally in quick succession, each with optimum results, since in each case a tool unit which is optimally adapted to the desired machining result and the particular types of workpiece can be used—because of the possibility of quick replacement or changing of the tool units.

[0015] Especially with this construction with a quick-change device a further embodiment of the invention has proved very advantageous in which in the operating state each tool unit is firmly screwed via its tool mounting frame to the receiving part-frame and in the released installation and removal state is supported and guided on slide rails of this receiving part-frame in such a way that it can be quickly installed and removed from one long side of the apparatus and thus quick changing of the tool units can be undertaken.

[0016] The invention will be explained in greater detail below with reference to several embodiments which are illustrated in the drawings. In these drawings:

[0017] FIG. 1 shows a simplified side view of the machining apparatus according to the invention with an installed first tool unit (with brush roller);

[0018] FIG. 2 shows a front view of the machining apparatus according to FIG. 1;

[0019] FIG. 3 shows a top view of the machining apparatus according to FIG. 1;

[0020] FIG. 4 shows a side view of the first tool unit with a brush roller;

[0021] FIG. 5 shows a front view of the first tool unit according to FIG. 4;

[0022] FIG. 6 shows a top view of the first tool unit according to FIG. 4;

[0023] FIGS. 7, 8 and 9 show a side view, a front view and a top view of a second tool unit with a plurality of circular brushes, according to a first embodiment in which all circular brushes are driven by belt drives;

[0024] FIG. 10 shows an enlarged cross-sectional view along the line X-X in FIG. 9;

[0025] FIG. 11 shows a purely schematic partial plan view of the second tool unit in order to explain the co-ordination of the circular brushes,

[0026] FIG. 12 shows a similar top view of the second tool unit to FIG. 9, but in order to explain a second embodiment in which the circular brushes are connected to one another for drive purposes by gear wheels ( spur gears);

[0027] FIGS. 13, 14 and 15 show a side view, a front view and a top view of the second tool unit according to a third embodiment in which the circular brushes are provided with separate individual drive motors;

[0028] FIG. 16 shows a cross-sectional view according to the line XVI-XVI in FIG. 15.

[0029] The overall construction of the machining apparatus 1 according to the invention will be explained first of all with reference to FIGS. 1 to 3, and it should be added that essentially only the apparatus parts which are regarded as necessary for explanation of the invention are illustrated in these drawings—partially in simplified form.

[0030] This machining device 1 serves for machining surfaces 2a of any substantially flat workpieces 2 (e.g. made from metal sheet, wood materials, plastics and the like) which during their machining are transported along on a suitable transport arrangement, for example a conveyor belt 3 which is only indicated in FIG. 1, in the direction of the arrow 4 (FIG. 2) beneath one or more machining tools of a respective installed tool unit.

[0031] In the representation in FIGS. 1 to 3 it may be assumed that a first tool unit 5, in which a brush roller 6 is disposed so that it can be driven in rotation as a machining roller or roller-type machining tool, is installed in the machining device 1. As will be explained in greater detail later, the brush roller 6—as is known per se in principle—can be positioned with its outer circumferential surface in an approximately radial direction against the workpiece surface 2a or can be lifted off therefrom, i.e. the brush roller 6 is adjustable precisely and to a sufficient extent with the entire first tool unit 5 in the direction of the double arrow 7, that is to say in the vertical direction.

[0032] The machining apparatus 1 contains a main apparatus housing 8 in which a main frame 9 is movable with the aid of two adjusting gears (e.g. worm gears) 10 and appertaining adjusting spindles 11 in the vertical direction and thus is adjustable in height in order to be able to ensure the vertical adjustability or the positioning of the respective tools (e.g. brush roller 6) according to the double arrow 7 relative to the workpiece surfaces 2a. In this case the adjusting spindles 11 can for instance be mounted in hollow shafts of the adjusting gear 11 so as to be axially adjustable. This axial adjustment (and with it the adjustability in height of the main frame 9 with the apparatus parts disposed thereon) can be made by any suitable drive arrangement; in this embodiment compressed air cylinders 12 are provided for this purpose. Furthermore, the axial adjustment path can be limited by suitable and preferably adjustable stops 13 (FIG. 2).

[0033] The axial adjustment explained above can be carried out to a certain extent as a double height adjustment in the direction of the double arrow in such a way that the machining tools (brush roller 6 or the circular brushes 25 which will be explained later) installed in each case in the main apparatus frame 8 can be adjusted on at least two adjustment paths vertically with respect to the tool surfaces 2a, of which the first adjustment path forms the general
positioning or adjusting facility and the second adjustment path forms a predeterminable stroke distance by which the machining tools are lifted off from the workpiece surfaces to an inactive or engaged position. The latter may for example be sensible and necessary when workpieces 2 to be machined during a reciprocating relative movement between the machining tools and the workpiece surfaces and the machining tools are not to carry out any machining of the workpiece surfaces as they travel back into a starting position or the like, that is to say they should be inactive. In this inactive or disengaged position it is generally sufficient if the tools are removed or lifted off from the workpiece surfaces by only a few millimeters (e.g. 3 mm). This raising of the machining tools can take place automatically with the reversal of the relative movements (e.g. for travelling back).

Independently of this raising of the machining tools by the stroke distance which can be predetermined or preset, with the aid of the adjusting gear 10 and the appertaining adjusting spindles 11 the machining tools can be generally positioned or adjusted in any way over the first adjustment path with sufficiently great adjustment distances if this is necessary (e.g. in the case of differing workpiece thicknesses, after wear of the bristle set on the machining tools, etc.).

[0034] A swing frame 14 is also disposed in the main frame 9 and at its front ends is mounted by longitudinal guide lugs 15 or the like in stationary guide bushes 16 in the direction of the broken double arrow 17 for a reciprocating movement running approximately transversely with respect to the workpiece 2 or to its transport direction according to the arrow 4, i.e. this swing frame 14 can carry out a corresponding transverse reciprocating relative movement between the workpieces 2 and the tools (e.g. roller 6). For this purpose a suitable oscillating drive 18, which can comprise inter alia a drive motor 18a, a miter gear 18b and a crank drive 18c, is associated with the swing frame 14 on the main frame 9. Naturally, other suitable oscillating drives could also be provided, such as for example a pneumatic cylinder or an electric cylinder.

[0035] For further explanation reference will first of all be made to FIGS. 4 to 6, in which only the first tool unit 5 is illustrated in various views. Here it can be seen that this first tool unit 5—in fact like every tool unit of the machining apparatus 1—has its own tool mounting frame 19 for the arrangement, retention and rotary mounting of the appertaining machining tool, that is to say in this case the brush roller 6. In this tool mounting frame 19 the brush roller 6 is rotatably mounted by way of its shaft ends 6a, 6b in two bearings 20 which are fixed so that they hang downwards on the ends of this bearing frame 19. One shaft end 6b of the brush roller 6 is extended beyond the bearing 20 and has a driving wheel mounted non-rotatably thereon which is preferably constructed in the form of a belt pulley or V-belt pulley 21. If reference is again made to the overall representation of the machining apparatus according to FIGS. 1 to 3, bearing in mind the foregoing explanations relating to FIGS. 4 to 6, then first of all it may be pointed out that an important feature of this machining apparatus 1 is a quick-change device for reciprocal changing of the various tool units as required. This consists on the one hand basically of the tool mounting frame of each tool unit of the machining apparatus 1, the tool mounting frames of all tool units being of similar construction as regards their shape and their external dimensions, and on the other hand of a receiving part-frame of the main apparatus housing 8, this receiving part-frame being constructed so that each tool mounting frame of the various tool units of the machining apparatus 1 can be installed in it with a precise fit so that it is fixed but replaceable.

[0036] This tool mounting frame 19 itself has substantially the shape of an elongated regular rectangle of sufficient length.

[0037] Thus if the entire machining apparatus 1 is considered again in the aforementioned sense, then it will be recognized particularly in FIG. 2 first of all that the tool mounting frame 19 explained with reference to FIGS. 4 to 6 is received in the receiving part-frame which has already been mentioned and which is preferably formed (according to this embodiment) by the swing frame 14 explained above. In the operating state of the machining apparatus 1 illustrated in FIGS. 1 and 2 it can be seen that the first tool unit 5 is securely installed or screwed via its tool mounting frame 19 to the swing frame (receiving part-frame) 14 with the aid of screws 22. In this way the first tool unit 5 (and also every other tool unit which can be installed) is connected during the machining operation on the one hand directly or firmly to the swing frame 14 and on the other hand also—via this swing frame 14—firmly connected to the main frame 9, so that this tool unit 5—and every other tool unit firmly connected thereto—also carries out not only the oscillating movements (double arrow 17) of the swing frame 14 but also the vertical adjusting or positioning movements (double arrow 7) of the main frame 9.

[0038] As can also be seen in FIG. 2, the lower ends of the swing frame 14 are bent inwards—towards one another—in the form of angles 14a so that they engage under the longitudinal supports 19a of the tool mounting frame 19, these angles 14a being constructed on their upwardly directed faces in the form of slide rails (optionally or advantageously with sliding material bearing surfaces). If the screws 22 are unscrewed from the tool mounting frame 19 and the latter or the appertaining tool unit 5 is in the released state, then this tool mounting frame 19 is supported by way of its longitudinal supports 19a correspondingly on the angles or slide rails 14a. In this released installation or removal state the tool unit 5 or each tool unit—supported and guided on the slide rails 14a—can be quickly installed and removed from one long side (or one end) of the machining device 1 or each tool unit can be exchanged for another tool unit. A tool unit newly installed in this way is, after it has been pushed into the receiving part-frame or swing frame 14, supported first of all on the slide rails 14a and can then, when it is situated in its precise installation position, be attached firmly to the swing frame 14 again from below with the aid of the screws 22 so that it is then situated in its operating state in the machining device.

[0039] In the installed state (FIGS. 1 and 2) of this first tool unit 5 the V-belt pulley 21 of the brush roller 6 is located in the region of one end of the machining apparatus 1. Accordingly a drive arrangement 23 is mounted stationary in or on the main apparatus housing 8 in a suitable manner for driving this brush roller 6 in rotation, this drive arrangement being connected for drive purposes by a drive connection, preferably a belt drive or V-belt drive 24, to the driving wheel or the V-belt pulley 21 of this first tool unit 5 installed in the swing frame 14 (or of any other installed tool unit). The drive arrangement 23 or a corresponding drive motor
can generally be designed for an adapted driving speed of the brush roller 6; however, it may be particularly advantageous if this drive arrangement 23 is equipped with a speed control so that the various machining tools can be driven at the particular speeds which are regarded as optimal in each case (also in adaptation to various materials). In this case it may furthermore be particularly advantageous if the drive arrangement 23 is constructed so that the machining tools which are used in each case (whether they be one brush roller 6 or several, whether they be disc-type machining tools/circular brushes, as will be explained in greater detail) can be driven if need be with a reversible direction of rotation.

[0040] A particular feature of this machining apparatus 1 according to the invention is generally to be seen in the fact that one or each machining zone (in the case where there is a plurality of similar machine zones arranged done behind the other) of this apparatus 1 can be provided with a first tool unit 5 containing at least one machining roller or brush roller 6 and a second tool unit containing at least one group of disc-type machining tools and these tool units can be operated as required, i.e. exchangeable for one another for machining of the workpiece surfaces 2a in the apparatus 1.

[0041] Whereas the machining apparatus 1 has been explained previously with reference to FIGS. 1 to 6 in connection with a first tool unit 5 which contains a brush roller 6 and is or can be replaceably installed therein, with reference to the further Figures a description will be given below of the fact that and the way in which a second tool unit with disc-type machining tools in the form of circular brushes can be replaceably installed in the machining apparatus 1.

[0042] Before the various embodiments of this second tool unit are discussed it should first of all be stated in advance that in this second tool unit—irrespective of which of the various embodiments—a sufficient number of disc-type machining tools in the form of circular brushes 25 is provided which are all of the same construction, have substantially vertically disposed brush shafts 26 and accordingly are disposed so as to be rotatable about vertical axes of rotation, and—as can be seen in the various drawings—they have a suitable bristle set 25a at least on their outer end faces directed towards the workpieces surfaces to be machined, i.e. directed downwards. By contrast, an approximately radial bristle set 6c is mounted on the outer circumferential roller shell—as indicated in FIGS. 1, 2 and 4.

[0043] A first embodiment of the second tool unit 30 in which a number of circular brushes 25 is provided will now be explained in particular with reference to FIGS. 7 to 10. This second tool unit has first of all—as already explained to some extent above in connection with the first tool unit 1—its own tool mounting frame 19 for disposing and retaining the appertaining machining tools, that is to say the circular brushes 25. This tool mounting frame 19 again forms not only a part of the appertaining tool unit, that is to say of the second tool unit 30, but also forms a part of quick-change device of the machining apparatus 1 already described above, in order to facilitate reciprocal exchange as required of the various tool units. As can be clearly seen from a comparison of the representations of first tool unit 5 in FIGS. 4 to 5 on the one hand and the second tool unit in FIGS. 7 to 9 on the other hand, this tool mounting frame 19 of the second tool unit 30 also has the shape of an elongated regular rectangle, whereby not only its shape but also its external dimensions are the same or the same size as those of the tool mounting frame 19 of the first tool unit 5. In this case this tool mounting frame 19—as FIGS. 8 and 10 in particular make clear—has distinct longitudinal supports 19a under which it is possible to engage freely from the exterior, so that this tool mounting frame 19 can again be firmly but replaceably installed with a precise fit in the same receiving part-frame, that is to say the swing frame 14 of the main apparatus housing 8, in precisely the same way as has been explained in detail above in connection with the tool mounting frame 19 of the first tool unit 5 (particularly with reference to FIG. 2), to which reference is made in order to avoid repetitions.

[0044] In the first embodiment of the second tool unit 30 which is illustrated in FIGS. 7 to 10, it is provided that the circular brushes 25 are mounted individually in the tool mounting frame 19 by way of their rotary shafts constructed as brush shafts 26, for example with the aid of antifriction bearings 27, in the manner shown in FIG. 10. In this case each pair of brush shafts 26 which are adjacent to one another are connected to one another for drive purposes at their shaft ends 26a opposite the circular brushes 25 by a drive connection which in this first embodiment of the second tool unit 30 is formed by a belt drive, preferably a toothed belt drive 31. For this purpose—as shown in particular by FIGS. 7 and 10—each pair of corresponding toothed belt pulleys 31 are generally mounted axially directly one above the other on the upper shaft ends 26a of the brush shafts 26 or a corresponding double pulley is non-rotatably mounted thereon.

[0045] In order for the circular brushes 25 of this second tool unit 30 to be driven by the same drive arrangement 23 as the brush roller 6 of the first tool unit 5, if this second tool unit 30 is installed for operation in the swing frame 14, a similar driving wheel or a similar V-belt pulley 21 is again rotatably mounted on the appertaining tool mounting frame 19 at the same end as in the tool mounting frame 19 of the first tool unit 5, and the said driving wheel or V-belt pulley is connected for drive purposes on the one hand via the belt drive (V-belt drive) 24 to the drive arrangement 23 (cf. FIG. 2) and on the other hand via a miter gear 32 to the toothed belt drives 31 for the circular brushes 25. Thus this miter gear 32 is disposed—as shown in particular by FIG. 7—between the appertaining V-belt pulley 21 and the corresponding first tool drive connection, that is to say the adjacent toothed belt drive 31, a further toothed belt drive 32a being provided on this connection (FIGS. 7 and 9).

[0046] The co-ordination of the circular brushes 25 will be discussed briefly with reference to the purely schematic partial plan view of the second tool unit 30. This FIG. 11 shows that the circular brushes 25 co-ordinated in at least one group and at least two transverse rows—when considered in plan view—are disposed staggered with respect to one another and that they overlap one another at least with respect to the workpiece transport direction (arrow 4), but preferably also, as shown, in the transverse direction thereto. Due to this uniformly overlapping co-ordination of the circular brushes 25 the workpiece 2 which is transported through beneath them in each case can be optimally machined on its surface 2a by the circular brushes 25 or their bristle set 25a. This co-ordination of the circular brushes
also applies basically to the further embodiments of the second tool unit which are described below.

[0047] Of the second embodiment of the second tool unit 30 only a top view similar to that of FIG. 9 is shown in FIG. 12. The essential difference between the first embodiment explained with reference to FIGS. 7 to 10 and this second embodiment of the second tool unit 30 resides in the fact that in this second embodiment the drive connections between each pair of brush shafts 26 which are adjacent to one another are formed in each case by a toothed-wheel gear 33 which comprises spur wheels 33a fixed in each case on two brush shafts 26 which are adjacent to one another and at least one reversing spur wheel 33b disposed therebetween. Otherwise in this second embodiment of the second tool unit 30 all toothed-wheel gears 33 are also again jointly driven by the V-belt pulley 21 and the miter gear 32 which are disposed in the same way at in FIGS. 7 and 9 on one end of the appertaining tool mounting frame 19, whereby a similar adapted toothed-wheel gear 33 can be provided between the latter gear 32 and the adjacent toothed-wheel gear 33. The tool mounting frame 19 here is constructed in precisely the same way as is explained with reference to FIGS. 7 to 9.

[0048] Whereas two typical embodiments have been explained previously with reference to FIGS. 7 to 10 and 12 showing how in the second tool unit 30 all circular brushes 25 can be jointly driven via their brush shafts 26, in FIGS. 13 to 16 a third embodiment is shown in which a separate drive motor 34 is coordinated with each circular brush 25, and preferably each drive motor 34 is equipped with a separate speed control. In this case the individual circular brushes 25 can be non-rotatably mounted on the downwardly projecting ends of the motor drive shafts 34a so that the circular brushes 25 can then again be driven in rotation about vertical axes of rotation. Also in this third embodiment the circular brushes 25 with their individual drive motors 34 are received and retained in their own tool mounting frame 19 which in shape and external dimensions corresponds to the tool mounting frame 19 described above with reference for instance to FIGS. 7 to 10.

[0049] This use of individual drive motors 34 for the circular brushes 25 results in varied possibilities for variations in the machining of different workpieces. Thus the circular brushes 25 can all be driven in rotation at the same speeds or they can be driven individually or in groups at different speeds. Furthermore it may be advantageous in this case if these circular brushes 25 are then driven in rotation at infinitely adjustable speeds, in which case moreover it may also be advantageous if these circular brushes 25 can be driven as required in one or the other direction of rotation, and in fact all circular brushes 25 are directed against one another in each case in one or the other direction of rotation or individually or in groups. Furthermore, the possibility also exists of controlling and driving all machining tools individually or in groups, for example in adaptation to the particular workpiece width or to a plurality of workpieces disposed adjacent to one another.

[0050] Particularly when individual drive motors 34 are used for the circular brushes 25, but optionally also when a common drive arrangement is used for all circular brushes 25, the possibility also exists of positioning the circular brushes 25 individually, in groups or jointly against the workpiece surface 2a. This is advantageous for example when the bristle set 25a of the circular brushes is worn down by certain amount, i.e. the possibility exists of adjusting the circular brushes 25 by an appropriate amount according to their respective wear.

[0051] Thus, to summarise, it may again be stated that by this construction according to the invention the surfaces 2a of workpieces 2 are machined in one and the same machining apparatus 1 as required by means of a first tool unit 5 comprising at least one machining roller, preferably a brush roller 6, or—in exchange therefor—by means of a second tool unit 30 comprising a group of disc-type machining tools, preferably circular brushes 25. In this case the brush roller 6 is positioned in an appropriate manner in each case approximately in its radial direction against the workpiece surfaces 2a, whereas the circular brushes 25 are positioned approximately in their axial direction against the workpiece surfaces 2a, in each case in accordance with the double arrow 7 in FIGS. 1 and 2. During the machining of their surfaces 2a the workpieces 2 are then transported along with the aid of the transport arrangement 3 in the longitudinal direction beneath the machining tools, that is to say the brush roller 6, or beneath the circular brushes 25. In this case the workpieces 2 are then placed sufficiently firmly or stationary on the transport arrangement 3, and with the aid of this transport arrangement 3 they are transported as required continuously, intermittently or reversibly relative to the machining tools.

1. Method of machining surfaces of substantially flat workpieces in a machining apparatus, in which during machining of the surfaces machining tools which can be driven in rotation are positioned against the surfaces of the workpieces to be machined and the workpieces and tools are moved relative to one another, characterised in that the workpiece surfaces (2a) are machined in at least one machining zone of the same machining apparatus (1) as required by means of a first tool unit (5) containing at least one machining roller (6) or a second tool unit (30) containing a group of disc-type machining tools (25), whereby the machining roller (6) is positioned approximately in its radial direction and the disc-type machining tools (25) are positioned approximately in their axial direction against the workpiece surfaces (2a).

2. Method as claimed in claim 1, characterised in that in each tool unit (5, 30) an oscillating movement (arrow 17) running substantially transversely with respect to the relative movement between workpieces (2) and tools (6, 25) is added as required to the rotating movement of the machining tools about their axes of rotation.

3. Method as claimed in claim 1, characterised in that the disc-type machining tools (25) are all driven in rotation at the same, preferably adjustable speeds.

4. Method as claimed in claim 1, characterised in that the disc-type machining tools (25) are at least in part driven in rotation at different, preferably infinitely adjustable speeds.

5. Method as claimed in in claim 1, characterised in that the machining tools (6, 25) can be driven as required in one or the other direction of rotation.

6. Method as claimed in claim 1, characterised in that all machining tools (6, 25) are driven by one common drive arrangement (23).
7. Method as claimed in claim 1, characterised in that all machining tools (25) are driven and controlled individually or in groups.

8. Method as claimed in claim 1, characterised in that for each tool unit (5, 30) a tool mounting frame (19, 19') is used with at least in part the same external shape and each tool mounting frame can be installed so as to be quickly replaceable in the same receiving part-frame (14) of a main apparatus housing (8) or can be installed and removed.

9. Method as claimed in claim 1, characterised in that during the machining of their surfaces (2a) the workpieces (2) are transported along beneath the machining tools (6, 25).

10. Method as claimed in claim 1, characterised in that a brush roller (6) is used in the first tool unit (5) and circular brushes (25) which can be positioned against the front face of the workpiece surface (2a) as disc-type machining tools are used in the second tool unit (30).

11. Method as claimed in claim 1, characterised in that the disc-type machining tools (25) are positioned individually, in groups or jointly against the workpiece surface (2a).

12. Method as claimed in claim 1, characterised in that the machining tools (6, 25) installed in each case in the main apparatus frame (8) can be adjusted on at least two adjustment paths vertically with respect to the workpiece surfaces (2a), of which the first adjustment path forms the general positioning or adjusting facility and the second adjustment path forms a predetermined stroke distance by which the machining tools are lifted off from the workpiece surfaces into an inactive disengaged position.

13. Apparatus for machining surfaces (2a) of substantially flat workpieces (2), with machining tools (6, 25) which can be driven in rotation and are disposed in a main apparatus housing (8) and can be positioned against the surfaces (2a) of the workpieces (2) to be machined, the workpieces and tools being movable relative to one another, characterised in that a first tool unit (5) containing at least one machining roller (6) and a second tool unit (30) containing at least one group of disc-type machining tools (25) are provided for at least one machining zone of this apparatus (1), and these tool units (5, 30) can be operated as required for machining the workpiece surfaces (2a), whereby the machining roller (6) can be positioned with its outer circumferential surface approximately in the radial direction (7) and the disc-type machining tools (25) can be positioned with their outer end faces approximately in the axial direction (7) against the workpiece surfaces (2a).

14. Apparatus as claimed in claim 13, characterised in that each tool unit (5, 30) has its own tool mounting frame (19, 19') for the arrangement and rotation of the machining tools (6, 25), and that a quick-change device is provided for reciprocal exchange of the various tool units (5, 30) as required, each tool mounting frame (19, 19') being of similar design as regards its shape and its external dimensions so that it can be installed with a precise fit in the same receiving part-frame (14) of the main apparatus housing (8) so that it is fixed but replaceable.

15. Apparatus as claimed in claim 14, characterised in that the receiving part-frame which firmly receives a tool mounting frame (19, 19') is constructed in the form of a swing frame (14) with which an oscillating drive (18) is associated for reciprocating relative movement (17) between workpieces and tools in an approximately transverse direction with respect to the workpiece.

16. Apparatus as claimed in claim 14, characterised in that in the operating state each tool unit (5, 30) is firmly screwed via its tool mounting frame (19, 19') to the receiving part-frame (swing frame 14) and in the released installation and removal state is supported and guided on slide rails (14a) of this receiving part-frame in such a way that it can be quickly installed and removed from one long side of the apparatus (1).

17. Apparatus as claimed in claim 16, characterised in that for driving the machining roller (6) of the first tool unit (5) in rotation and for driving the disc-type machining tools (25) of the second tool unit (30) in rotation a drive arrangement (23) is mounted stationary in the main apparatus housing (8), being the same drive arrangement which is connected for drive purposes by a drive connection, preferably a belt drive (24), to a similar driving wheel (21) of the respective tool unit installed in the receiving part-frame 14.

18. Apparatus as claimed in claim 13, characterised in that a separate drive motor (34) is co-ordinated with each disc-type machining tool (25) or each group of disc-type machining tools, and preferably each drive motor is equipped with a separate speed control.

19. Apparatus as claimed in claim 17, characterised in that all machining tools (6, 25) can be driven at a variable speed and preferably with a reversible direction of rotation.

20. Apparatus as claimed in claim 17, characterised in that the disc-type machining tools (25) are rotatably mounted via their rotary shafts (26) individually in the appertaining tool mounting frame (19') and each pair of rotary shafts (26) which are adjacent to one another are connected to one another for drive purposes at their shaft ends (26a) opposite the machining tools by a drive connection (31, 33), a miter gear (32) being disposed in the tool mounting frame (19') between the appertaining driving wheel (21) and a first tool drive connection.

21. Apparatus as claimed in claim 20, characterised in that each drive connection is formed by a belt drive, preferably a toothed belt drive (31).

22. Apparatus as claimed in claim 20, characterised in that each drive connection is formed by a toothed-wheel gear (33) with spur wheels (33a) fixed in each case on two tool shafts (26) which are adjacent to one another and at least one reversing spur wheel (33b) disposed therebetween.

23. Apparatus as claimed in claim 15, characterised in that for driving the machining roller (6) of the first tool unit (5) in rotation and for driving the disc-type machining tools (25) of the second tool unit (30) in rotation in each case a driving belt pulley (21), preferably a V-belt pulley, is disposed in the same structural arrangement in the appertaining tool mounting frame (19', 19').

24. Apparatus as claimed in claim 15, characterised in that the swing frame (14) together with the respective installed tool mounting frame (19', 19') is disposed in the main apparatus housing (8) so as to be adjustable—preferably infinitely adjustable—in the vertical direction (7).

25. Apparatus as claimed in claim 13, characterised in that during the surface machining the workpieces (2) are placed sufficiently stationary on a transport arrangement (3), and with this transport arrangement (3) they can be transported...
along continuously, intermittently or reversibly relative to the machining tools (6, 25) and beneath these tools.

26. Apparatus as claimed in claim 13, characterised in that the machining roller of the first tool unit (5) is constructed in the form of a brush roller (6) with a bristle stock (6c) mounted at least on its outer circumferential shell, whilst the disc-type machining tools of the second tool unit (30) are constructed in the form of circular brushes (25) which have a bristle stock (25a) at least on their outer end faces directed against the workpiece surfaces (2a) to be machined.

27. Apparatus as claimed in claim 13, characterised in that the circular brushes (25) combined in at least one group—when considered in plan view—are disposed staggered with respect to one another and that they overlap one another at least with respect to the workpiece transport direction (4).

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