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(54) **APPARATUS FOR DOUBLE-SIDED GRINDING**

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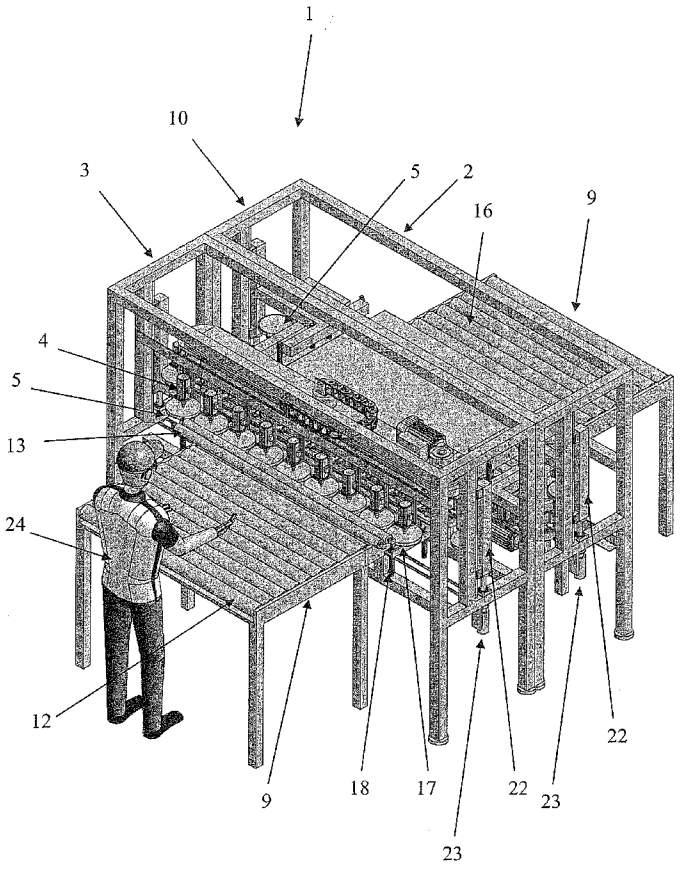
(57) **ABSTRACT**

A grinding apparatus for machining a workpiece (**6**), including an apparatus frame (**2**) supporting a grinding station (**3**) with a number of grinding heads (**4**) with associated grinding elements (**5**) arranged such that the grinding elements (**5**) are in contact with one surface (**7**) of the workpiece at the passage of the workpiece through the grinding apparatus (**1**), and an endless conveying means (**8**) for the grinding heads (**4**), and a roller table (**9**) for supporting the workpiece (**6**), where the grinding apparatus (**1**) includes a further grinding station (**10**) with grinding heads (**4**) arranged such that the grinding elements (**5**) are in contact with the opposite surface (**11**) of the workpiece at the passage of the workpiece across the roller table (**9**), where the roller table includes a first (**12**) and a second set of rollers (**13**), and where there is an interspace (**14**) between two set of rollers (**12**, **13**), allowing passage of the workpiece between the two set of rollers (**12**, **13**), wherein spacing (**15**) between individual rollers (**16**) in each of the two sets of rollers (**12**, **13**) is arranged such that a plurality of the rollers (**16**) from each of the two sets of rollers (**12**, **13**) are simultaneously in contact with the opposing surfaces (**7**, **11**), where a first grinding station (**3**) is provided between two succeeding rollers in the first set (**12**) and a second grinding station (**10**) is provided between two succeeding rollers in the second set (**13**).



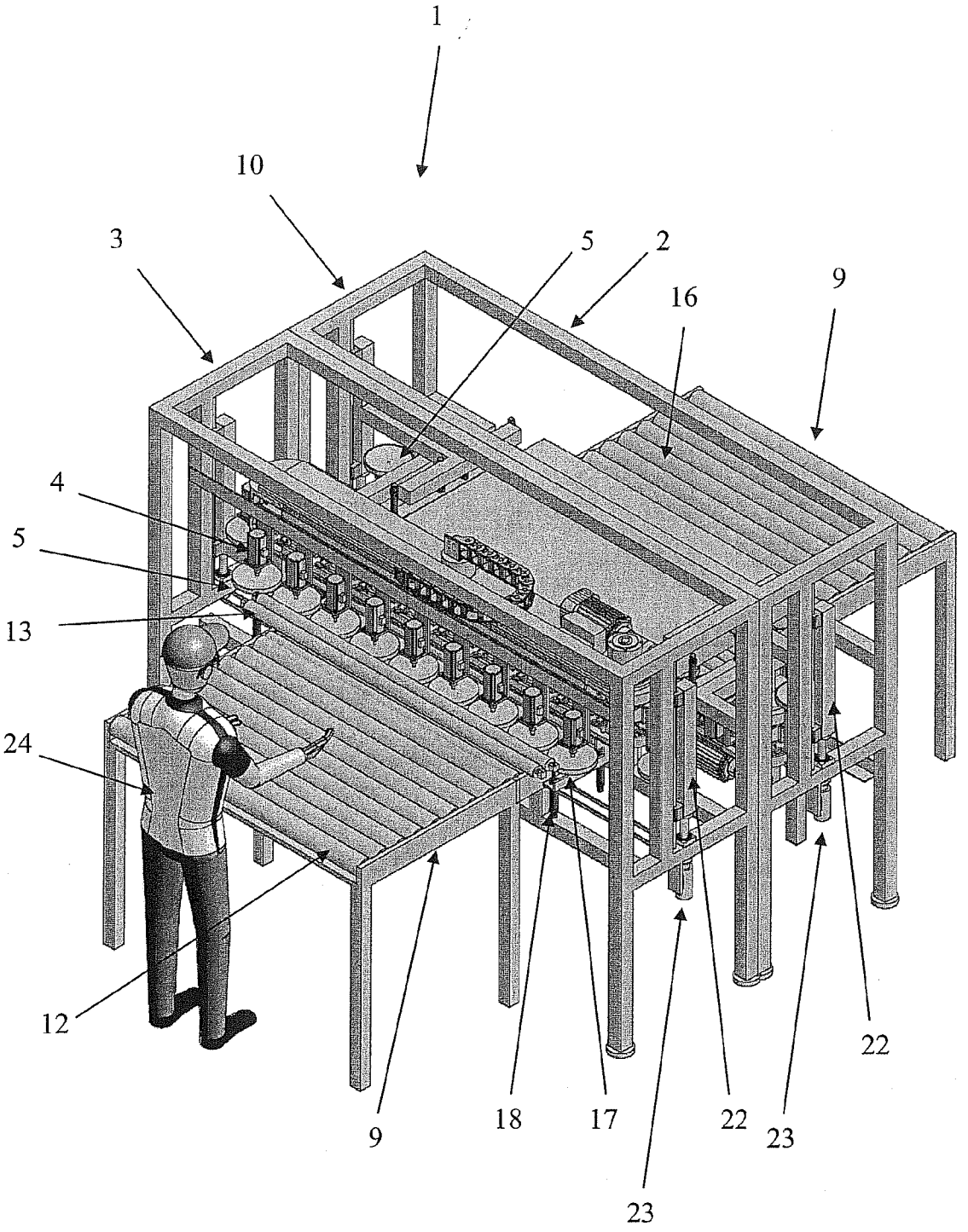


Fig. 1

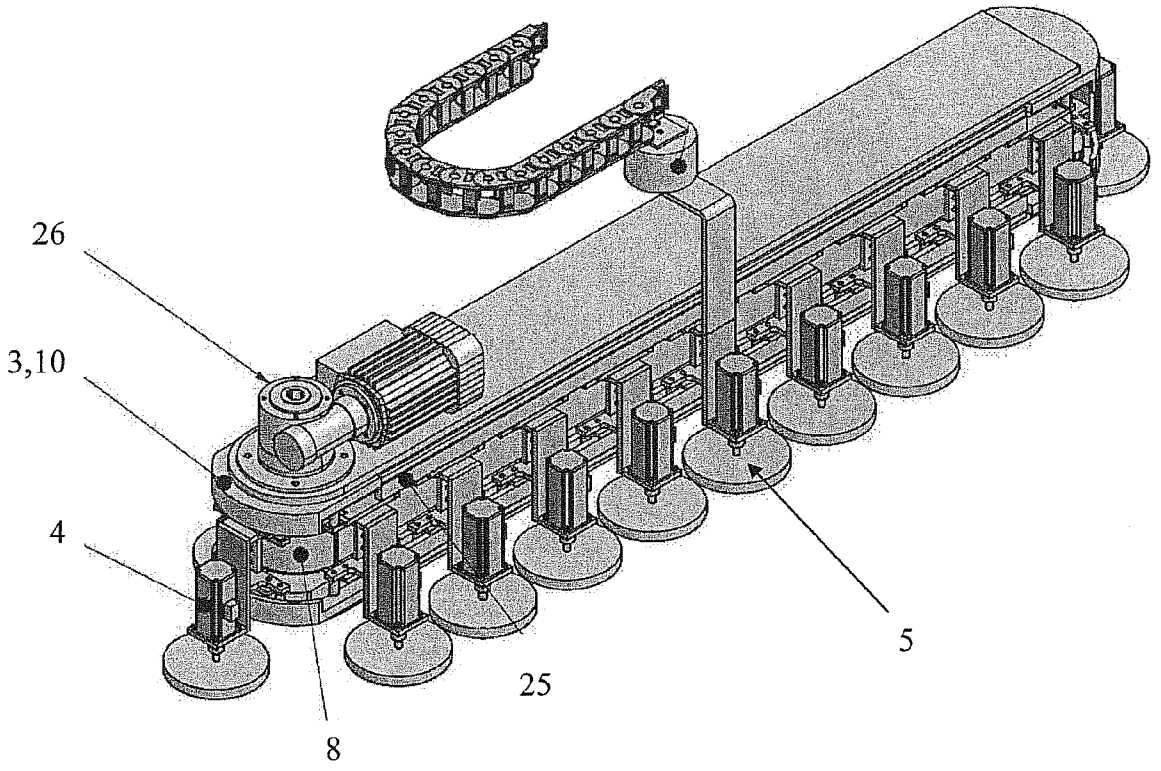


Fig. 2

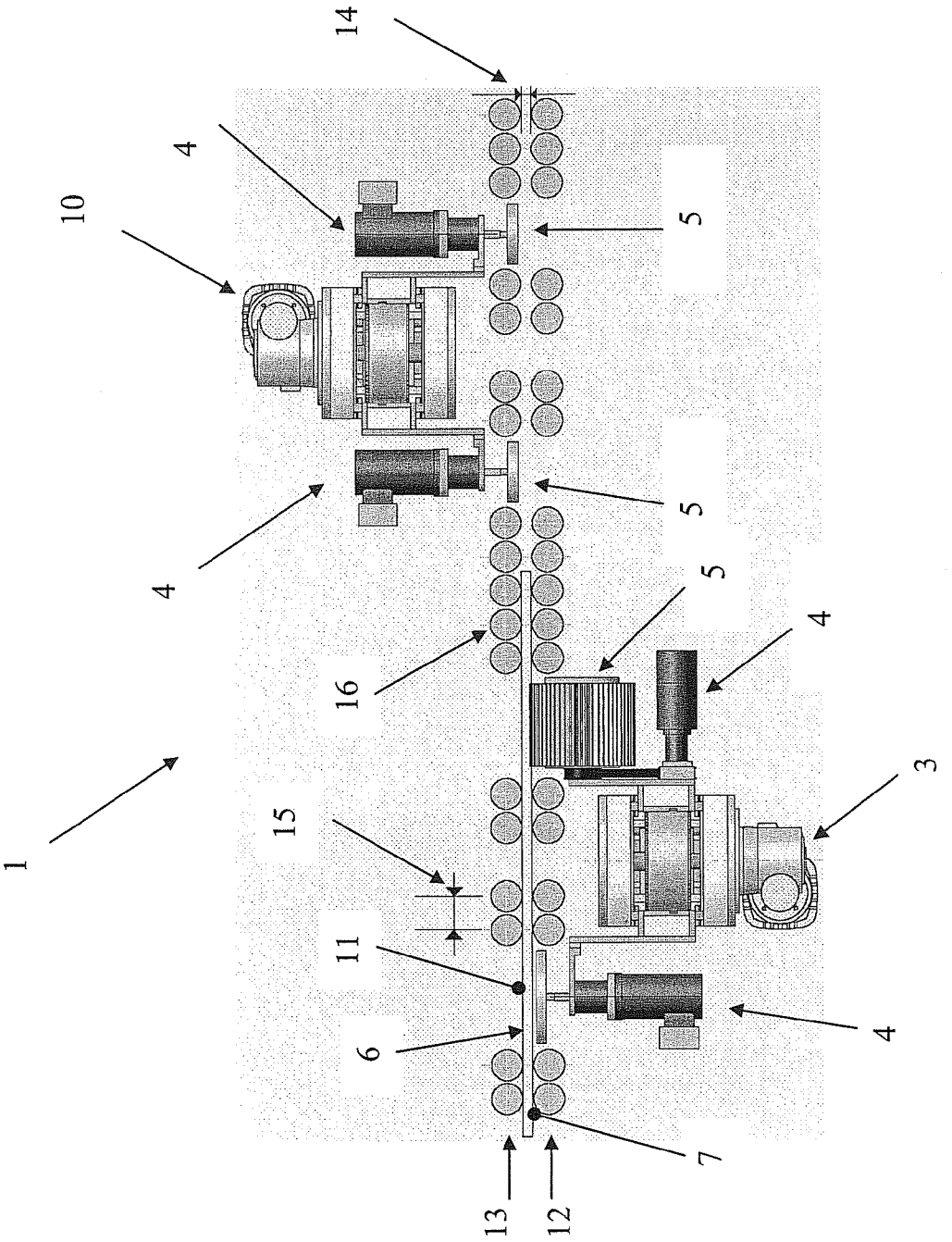


Fig. 3

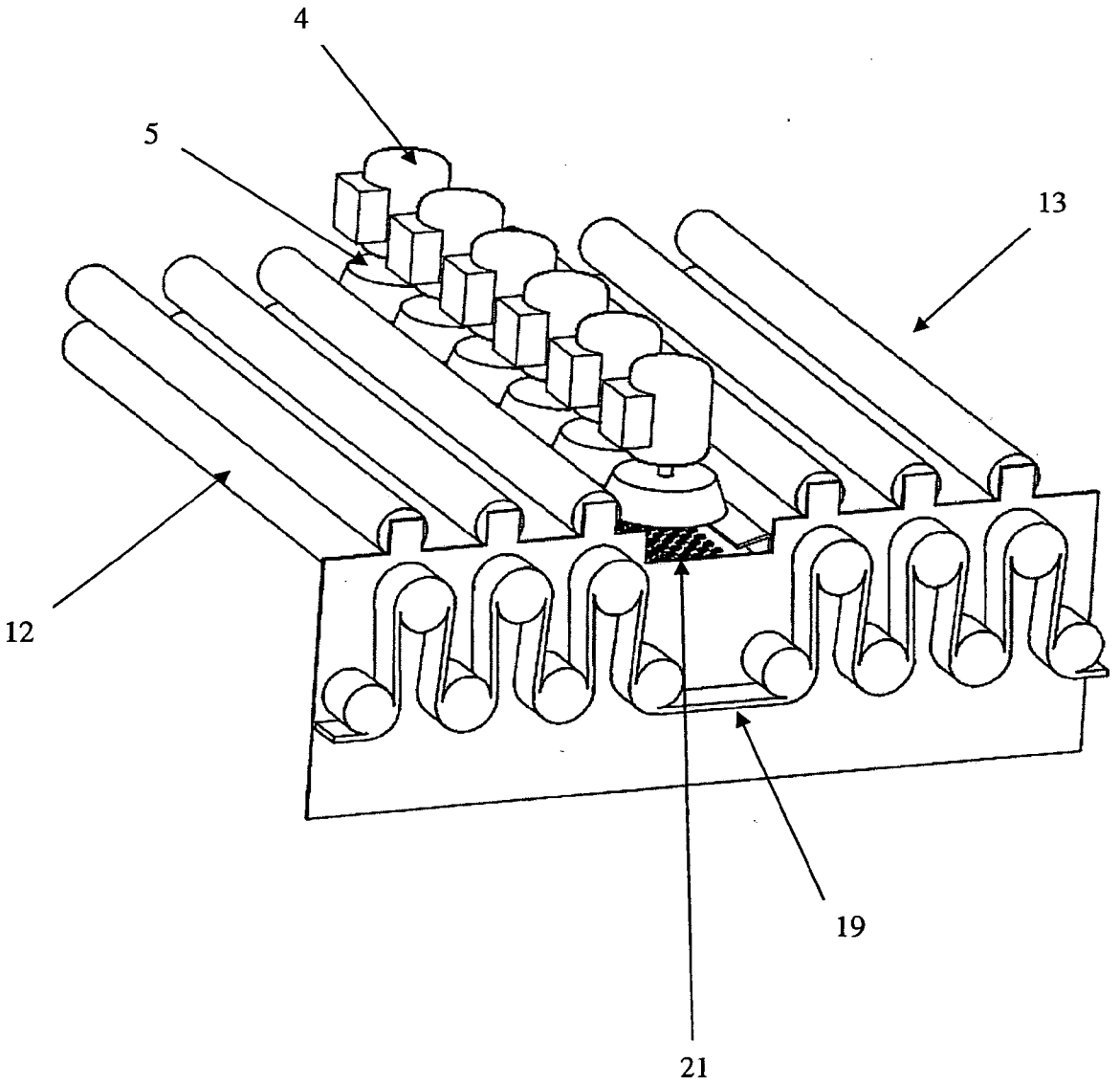


Fig. 4

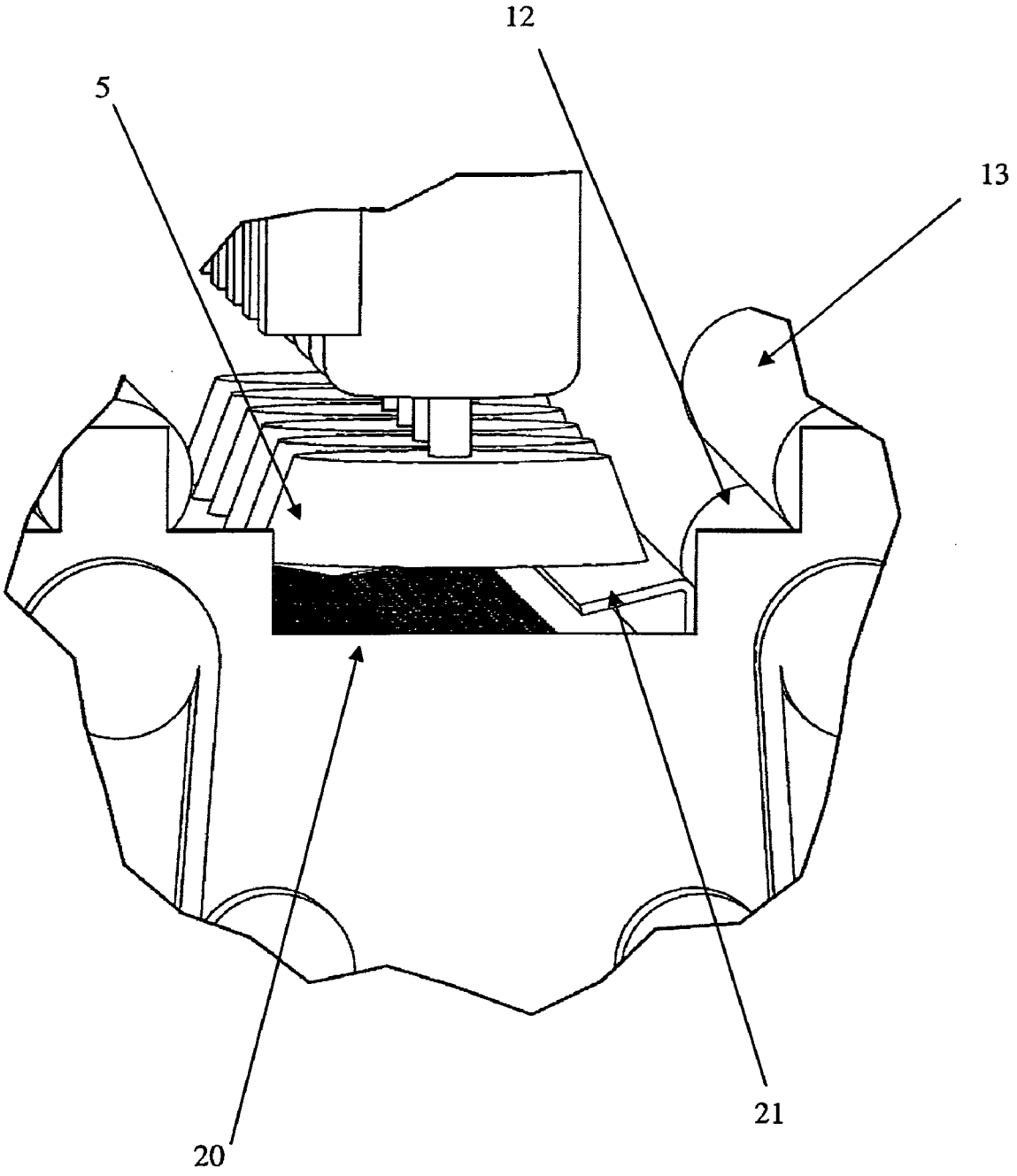


Fig. 5

APPARATUS FOR DOUBLE-SIDED GRINDING

FIELD OF THE INVENTION

[0001] The present invention concerns a grinding apparatus for machining a workpiece, including an apparatus frame supporting a grinding station with a number of grinding heads with associated grinding elements arranged such that the grinding elements are in contact with one surface of the workpiece at the passage of the workpiece through the grinding apparatus, and an endless conveying means for the grinding heads, and a roller table for supporting the workpiece, where the grinding apparatus includes a further grinding station with grinding heads arranged such that the grinding elements are in contact with the opposite surface of the workpiece at the passage of the workpiece across the roller table, where the roller table includes a first and a second set of rollers, and where there is an interspace between two set of rollers, allowing passage of the workpiece between the two set of rollers.

BACKGROUND OF THE INVENTION

[0002] By industrial grinding or sanding of workpieces that include edges, roundings and surfaces, e.g. table tops or doors or other items with limited length, and where these edges, roundings and faces are disposed on opposite sides of the workpiece, this will require grinding/sanding of both sides of the workpiece. On conventional grinding apparatuses, this requires two runs through the grinding apparatus in that it is necessary first to perform grinding of one side of the workpiece, after which the workpiece is turned and the grinding is repeated on the other side of the workpiece.

[0003] The drawback of this is reduced machine capacity and need for increased handling of workpieces that require double-sided machining, compared with workpieces that only require one-sided machining.

[0004] Apparatuses for polishing flat glass plates that are conveyed continuously from a production apparatus for glass production are known. Examples of such are known from GB 469951, U.S. Pat. No. 3,036,410, U.S. Pat. No. 3,177,625 and DE 670343. A disadvantage of these apparatuses is that they are not suited in connection with grinding workpieces with limited length as the workpiece is not sufficiently supported in order to avoid substantial deflection during the run until the leading edge of the workpiece has passed a grinding station.

OBJECT OF THE INVENTION

[0005] It is the object of the present invention to indicate a grinding apparatus that enables grinding of both sides of a workpiece requiring double-sided treatment, and which has a limited length such that grinding and/or deburring of the workpiece may be completed in one run.

DESCRIPTION OF THE INVENTION

[0006] This is achieved by means of a grinding apparatus of the type mentioned in the introduction, which is peculiar in that spacing between individual rollers in each of the two sets of rollers is arranged such that a plurality of the rollers from each of the two sets of rollers are simultaneously in contact with the opposing surfaces, where a first grinding station is provided between two succeeding rollers in the first set and a second grinding station is provided between two succeeding rollers in the second set.

[0007] The grinding apparatus is provided with two grinding stations disposed such that one grinding station machines one side of the workpiece and that the other grinding station machines the other, opposite side of the workpiece. The grinding stations are arranged in series such that the workpiece is treated by both grinding stations during the passage of the workpiece through the grinding apparatus. Treatment of both sides of the workpiece is hereby achieved in one run.

[0008] The grinding elements apply a force to the workpiece that necessitates support of the workpiece. The roller table functions as this support, but since the grinding elements from the two grinding stations act on the workpiece with oppositely directed forces, it is necessary with two sets of rollers, one above the other, such that the workpiece is supported in both directions when disposed in the interspace between the two sets of rollers. The grinding stations are each disposed between rollers on the inlet and outlet sides, respectively, of the workpiece. This ensures effective retention of the workpiece during the entire run. One grinding station is provided between rollers in the first set with a height of the grinding elements such that they are approximately flush with a plane tangent to the rollers, and which coincides with the side of the workpiece facing the grinding elements and thereby worked by the grinding station. In a corresponding way, the other grinding station is disposed between rollers in the other set for machining the other side of the workpiece. The height of the grinding stations in relation to the machined side of the workpiece is significant to the power of the grinding action, as this determines how strongly the grinding elements are to press on the workpiece.

[0009] It is particularly advantageous to dispose at least two successive rollers opposite each other in each of the two sets of rollers at the inlet side before a grinding element and at least two successive rollers opposite each other in each of the two sets of rollers at the outlet side after a grinding element. Consequently, in total at least four rollers at each their side of a grinding element.

[0010] Hereby is achieved that the workpiece is securely supported during insertion in the grinding station. When grinding is commenced from the leading edge of the workpiece during a run, the two rollers in each of the two sets opposite each other ensure that the workpiece is securely supported, even though it projects from its clamping between the two rollers in each set. Strong deflection of the workpiece and consequent reduction of the grinding capability is thereby obviated. The leading edge of the workpiece will, after passage of the grinding element, engage between at least two rollers in each set opposite each other at the outlet side of the grinding element. Finally, when the trailing edge of the workpiece loses its engagement with the two rollers in each set on the inlet side of the grinding element, it will still be securely supported, even though it projects from its clamping between the two rollers in each set at the outlet side of the grinding element.

[0011] Such a grinding apparatus may machine workpieces with a limited length. The length of the smallest workpiece to be processed by the grinding apparatus is determined in that the workpiece simultaneously is to engage two rollers from each set opposite each other on at one side of the grinding element, and two rollers opposite each other at the other side of the grinding element, where the last-mentioned rollers are two single rollers opposite each other.

[0012] Rollers in each of the two sets may be disposed within the grinding station.

[0013] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the two rollers in the two set of rollers are resilient for establishing a squeezing action on the workpiece. Hereby it becomes possible to retain the workpiece during the run. Another result is that there is still contact between roller and workpiece, even by workpieces with variations in thickness. The resilient properties of the rollers have to be adapted to the variations in thickness that are expected for the workpiece.

[0014] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the two set of rollers are disposed in approximately parallel, horizontal planes. This is necessary for the workpiece to pass through the grinding apparatus without being jammed or changing its direction.

[0015] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the rollers in the two set of rollers are disposed opposite each other. Hereby it becomes easier for an operator to insert the workpiece. Besides, deflection of the workpiece during passage of the individual rollers is avoided.

[0016] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the two set of rollers are provided in an arrangement that enables adjustment of the height of the interspace between the two set of rollers. If the grinding apparatus is to be used for different workpieces, it is suitable to have this adjustment possibility as workpieces with different thickness may occur.

[0017] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the height of the interspace between the two set of rollers is adjusted by means of actuators. By using actuators for height adjustment of the interspace, limitations caused by the operators lifting capacity are avoided. If it is necessary with many daily readjustments of the grinding apparatus to various workpieces, this may occur easily and rapidly by means of actuators. These actuators may be pneumatic, hydraulic or electric.

[0018] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the rollers are provided with a drive means for advancing the workpiece, the drive means optionally being a belt, a toothed belt, a chain or a toothed wheel. The advantage of providing the rollers with a drive means is that the operator is not to ensure manual advancing of the workpiece during a run through the grinding apparatus. This makes the grinding apparatus more safe in use and reduces the need for intervention by operators.

[0019] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that a unit for sucking grinding dust is provided in connection with each grinding station and at each area where the grinding elements are in contact with the workpiece. During use of grinding apparatuses of the described type, large amounts of grinding dust are released. With consideration to the working environment, this puts limitations to staying in the vicinity of the grinding machine. Therefore, it is expedient to remove as much as possible of this dust. The disposition of the unit for suction of grinding dust provides that most possible dust is removed as it is placed closest to the area in the grinding apparatus where the dust is generated.

[0020] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that a guide rail for the workpiece is provided on each suction unit. When the workpiece passes a grinding area where also a suction unit is provided, there is no possibility of supporting the workpiece. Thus a risk of deflection of the workpiece is present. The deflection becomes greater the closer the workpiece comes to the rollers at the outlet side of the grinding station. A guide rail is provided before the rollers at the outlet side of the grinding station in order to avoid jamming of the workpiece and to ensure engagement with the rollers. The guide rail counteracts possible deflection of the workpiece and disposes it opposite the interspace between the two sets of rollers.

[0021] According to a further embodiment, the grinding apparatus according to the invention is peculiar in that the grinding stations are provided in an arrangement that enables adjustment of the height of the grinding elements in relation to the surface of the workpiece, manually or by actuators. Hereby it becomes possible to adjust the grinding effect. This may be particularly advantageous in connection with shifting between coarse and fine grinding and with changing between different materials.

[0022] The grinding apparatus may be used for various types of work pieces, such as tabletops, closet doors or similar, and grinding or sanding of different types of materials such as wood, metal, glass, plastic, composite or similar.

[0023] The grinding heads may advantageously be arranged such that the direction of rotation of two grinding heads in succession is clockwise and counterclockwise, respectively. Hereby is achieved a very uniform polishing/deburring. As the grinding heads have separate electric motors, the direction of rotation may easily be changed for individual grinding heads.

DESCRIPTION OF THE DRAWING

[0024] The invention is explained more closely in the following with reference to the drawings, where:

[0025] FIG. **1** shows a perspective view of a grinding apparatus according to the invention;

[0026] FIG. **2** shows a perspective view of a grinding station;

[0027] FIG. **3** shows a side view of the grinding apparatus;

[0028] FIG. **4** shows an elementary sketch of the drive system for the rollers; and

[0029] FIG. **5** shows a draft of the suction and the guide rail.

DETAILED DESCRIPTION OF THE INVENTION

[0030] FIG. **1** shows a grinding apparatus **1** with an apparatus frame **2** which includes a roller table **9** in the entire length of the grinding apparatus, a first grinding station **3** and a second grinding station **10**. Each grinding station contains a number of grinding heads **4** with associated grinding elements **5**. The grinding stations are more closely described in connection with the description of FIG. **2**.

[0031] The workpiece is placed on the roller table **9** for inserting in the grinding apparatus **1** by an operator **24**. The workpiece is supported by a first set of rollers **12**. A second set of rollers **13** retain the workpiece in interaction with the first set of rollers during the run of the workpiece through the grinding apparatus. The rollers **16** can be provided in an arrangement **17** that enables adjusting the height of the interspace between the two sets of rollers **12**, **13**. The height can be adjusted manually or by a number of actuators **18**. These actuators may e.g. be pneumatic, hydraulic or electric.

[0032] The grinding stations **3**, **10** are provided in an arrangement **22** that allow vertical adjustment of the grinding stations **3**, **10**, as thereby allowance can be made for workpieces with different thickness and different requirements to grinding action. The height may be adjusted manually by an operator, or by means of actuators **23** which are preferred due to the weight of the grinding stations. These actuators may also be pneumatic, hydraulic or electric.

[0033] On FIG. **2** appears a grinding station **3**, **10** free from its apparatus frame. A number of grinding heads **4** with associated grinding elements **5** are provided in a roundabout **25** with an endless conveying means **8**. A moving motor with gear **26** drives the grinding heads **4** around the grinding station while at the same time the grinding elements rotate by means of the grinding heads, whereby an epicycloidal movement of the individual grinding elements **5** is established.

[0034] On FIG. **3** is shown a side view of the grinding apparatus **1** with a workpiece **6** during a run. The grinding apparatus includes a first grinding station **3** disposed between the rollers **16** in a first set of rollers **12** machining one surface **7** of the workpiece, and a second grinding station **10** disposed between a second set of rollers **13** machining the opposite surface **11** of the workpiece. The grinding heads **4** in each grinding station are provided with grinding elements **5** which are adapted to the grinding task. In the shown embodiment, the grinding elements **5** in the first grinding station **3** are of different combination. The height of the interspace **14** between the two sets of rollers **12**, **13** is adapted to the thickness of the workpiece. The spacing **15** between individual rollers in each set **12**, **13** is adapted such that several succeeding rollers **16** in each set **12**, **13** are in simultaneous contact with the opposing faces **7**, **11** of the workpiece.

[0035] FIG. **4** shows the drive mechanism **19** for the two sets of rollers **12**, **13**. In the shown embodiment, the first set of rollers **12** are driven by a belt. The second set of rollers **13** are freewheeling. The workpiece is driven forward as the second set of rollers **13** provide retention and ensure the required contact between workpiece and the first set of rollers **12** which rotate. The grinding heads **4** and the grinding elements **5** are disposed in an interspace between the one set of rollers **13**.

[0036] FIG. **5** shows a detail of the grinding apparatus in one of the areas where the grinding is performed. A suction unit **20** is provided between the rollers in the first set of rollers **12** and the grinding elements **5** are disposed opposite the suction unit **20** between the rollers in the second set of rollers **13**. A guide rail **21** ensuring engagement between the rollers after workpiece passage of a grinding area is provided at the outlet side of the suction unit **20**.

1. A grinding apparatus for machining a workpiece (**6**), including an apparatus frame (**2**) supporting a grinding station (**3**) with a number of grinding heads (**4**) with associated grinding elements (**5**), arranged such that the grinding elements (**5**) are in contact with one surface (**7**) of the workpiece at the passage of the workpiece through the grinding apparatus (**1**), and an endless conveying means (**8**) for the grinding heads (**4**), and a roller table (**9**) for supporting the workpiece (**6**), where the grinding apparatus (**1**) includes a further grinding station (**10**) with grinding heads (**4**) arranged such that the grinding elements (**5**) are in contact with the opposite surface (**11**) of the workpiece at the passage of the workpiece across the roller table (**9**), where the roller table includes a first (**12**) and a second set of rollers (**13**), and where there is an interspace (**14**) between the two set of rollers (**12**, **13**), allowing passage of the workpiece between the two set of rollers (**12** ,**13**), wherein spacing (**15**) between individual rollers (**16**) in each of the two sets of rollers (**12**, **13**) is arranged such that a plurality of the rollers (**16**) from each of the two sets of rollers (**12**, **13**) are simultaneously in contact with the opposing surfaces (**7**, **11**), that a first grinding station (**3**) is provided between two succeeding rollers in the first set (**12**) and a second grinding station (**10**) is provided between two succeeding rollers in the second set (**13**), that the two sets of rollers (**12**, **13**) are provided in an arrangement (**17**) enabling adaptation of the height of the interspace (**14**) between the two sets of rollers (**12**, **13**) and that the height of the interspace (**14**) between the two sets of rollers (**12**, **13**) is adjusted by means of actuators (**18**).

2. Grinding apparatus according to claim **1**, wherein the rollers (**16**) in the two sets of rollers (**12**, **13**) are resilient for establishing a squeezing action on the workpiece (**6**).

3. Grinding apparatus according to claim **1**, wherein the two sets of rollers (**12**, **13**) are disposed in approximately parallel horizontal planes.

4. Grinding apparatus according to claim **1**, wherein the rollers (**16**) in the two sets of rollers (**12**, **13**) are disposed opposite each other.

5. Grinding apparatus according to claim **1**, wherein the rollers (**16**) are provided with a drive means (**19**) for advancing the workpiece (**6**), the drive means optionally being a belt, a toothed belt, a chain or a toothed wheel.

6. Grinding apparatus according to claim **1**, wherein that a unit (**20**) for sucking grinding dust is provided in connection with each grinding station (**3**, **10**) and at each area where the grinding elements (**5**) are in contact with the workpiece (**6**).

7. Grinding apparatus according to claim **6**, wherein a guide rail (**21**) for the workpiece is provided on each suction unit (**20**).

8. Grinding apparatus according to claim **1**, wherein the grinding stations (**3**, **10**) are provided in an arrangement (**22**) that enables adjustment of the height of the grinding elements (**5**) in relation to the surface (**7**, **11**) of the workpiece, manually or by actuators (**23**).

9-10. (canceled)

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