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(54) Grinding machine for plates having an adjustable abrasive roller

(57) The grinding machine has rollers (1) adjustable through angle (A), non-zero and not a right angle, with respect to the direction (T) transverse to the direction (M) of movement of the plates or tiles (2) being machined. The cutting front is shorter than the length (L) of the roller: it is thereby possible to adjust the format of the machining to a width (P) of the material as required, even with unusual formats. The inclination of the roller is achieved (Fig. 2) by adjusting the support structure (7), rotating on the vertical axis (S) of the support column (8): means for locking the rotation (28) serve to stiffen the structure (Fig. 3); there is also means for rapid retraction (18, 23) with short stroke that distances the abrasive roller during the phases in which the production line on which the grinder is positioned is stopped.

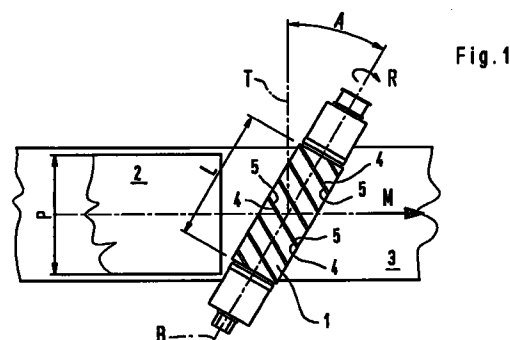


Fig. 1

## Description

The invention concerns: a thickness grinding machine for tiles or plates of granite, hard-fired ceramic or other hard materials or not, having a cutting front which is adjustable in width, that is, a machine that grinds the plates or tiles to a constant thickness, for the subsequent smoothing and polishing phase, having the possibility of varying the width of the machined strip at will.

Prior art comprises: the usual grinding machines with rollers whose axis is transverse or longitudinal to the direction of motion of the plates or tiles being machined; grinding machines with conical rollers rotating on a vertical axis head which also rotates; abrasive rollers with the most varied arrangements of the abrasive elements applied to the cylindrical or truncated cone surfaces: advantageously using those having diamond tipped abrasive elements arranged in a multi-start spirals on the cylindrical surface of the roller.

Finally, in the more general case of milling, also comprising: so-called modular rollers, consisting of elements that may be positioned side by side to form wider rollers; otherwise, rollers having abrasive elements mounted on an external sleeve of appropriate width, whereby when the format changes these are substituted with another of the desired width; or even, rollers whose abrasive elements are mounted in a removable manner.

Moreover, the grinding machine is often advantageously placed on a complete production line, that is, it is preceded and followed by machinery that perform other operations.

As is well known, the abrasive rollers of the grinding machine have to have a cutting width which is slightly shorter than the width of the material being machined, to avoid abnormal wearing of the abrasive elements or of the plate or tile being machined.

With prior art machines the variation of the format in the machines making up the production line is reasonably easy, except for the grinding machine. In fact, each of the methods indicated above require a considerable amount of time to vary the format: with modular rollers, as well as the time required to disassemble and reassemble the rollers, sets of modular elements of the most frequently used machining widths have to be kept in stock; it is not possible to simply eliminate or add one or more modules because of the different degrees of wearing these will have after use: the difference in wearing resulting in variations in thickness in the transverse direction on the machined material.

Analogously, with the interchangeable sleeve abrasive rollers, sets of sleeves of the desired lengths have to be provided for and kept in stock: the production line has to be stopped to carry out the substitution, though, whereas the time required is shorter than for modular rollers, it is not a quick operation in that the sleeves of all the rollers of the grinding machine have to be substituted. With the substitution of the abrasive elements,

one at a time on the surface of the roller, it is not possible to simply add or remove the minimum number of elements, the whole set of the desired length has to be substituted to avoid differentiated wearing of the abrasive elements and, therefore, leaving variations in the thickness in a transverse direction on the material.

The foregoing causes, with the type of machining with the most frequent changes in format, typically the machining of granite in small production lots, considerable costs in terms of setting up time with every change of format, with consequent loss of productivity, as well as the use of considerable sums of capital in keeping the various sets of tools in stock to carry out the required machining operations.

Such prior art may be subject to considerable improvements with a view to reducing the stop time of the production line to change the format, so as to increase productivity even with frequent changes of format.

From the foregoing emerges the need to resolve the technical problem of inventing a thickness grinding machine for tiles or plates of granite, hard-fired ceramic or similar hard materials that enables just a single set of tools to be employed to machine the various formats required, overcoming the limitations of prior art techniques.

The invention solves said technical problem by adopting: a thickness grinding machine for tiles or plates of granite, hard-fired ceramic or other hard materials or not, comprising one or more abrasive rollers of the cylindrical type, with diamond-tipped elements arranged on the external surface of the said rollers, adjustable in height to determine the thickness to grind to, characterised in that the said rollers are each supported on a structure that may be adjusted, with its rotation on a vertical axis positioned on the centre-line of the material being machined, at an angle which is not zero and not a right angle, with respect to the direction transverse to the direction of motion of the plates or tiles.

Also adopting: a column or hollow cylinder, supporting the adjustable structure, with a large diameter, on which act one or more locking or braking elements, for taking up the slack and carrying the thrust generated by the machining.

Also adopting: the locking elements acting on the external surface, consisting of at least two cylinders arranged so that they converge radially, with acute angle, on the said axis of rotation and vertically offset.

Also adopting: the said two single-acting locking cylinders, most advantageously hydraulic, subdivided in at least two pairs aligned vertically with the axis and converging radially on it, the extremities of the piston being curved to fit around the external cylindrical surface of the column.

Also adopting: a rapid retraction element, with short stroke, for detaching the abrasive roller from the material being machined, most advantageously positioned between the adjustable rotating structure and the

adjusting mechanism for the grinding thickness.

Also adopting: the said rapid retraction element consisting of a coaxial double-acting hydraulic cylinder, connected to the said adjustment mechanism for the grinding thickness and to the mobile part of the column and, therefore, to the rotating adjustable structure that carries the said abrasive roller; the piston or each foot-  
ing having mechanical limiter devices, that limit the stroke to just a few millimetres.

Also adopting: the said hydraulic cylinder for rapid adjustment having a piston with hollow stem, provided with a fixed lead screw coupled to the adjuster screw, for setting the grinding thickness, and the external sleeve of the cylinder coupled rigidly to the column of the adjustable structure; the piston and the lead screw being positioned angularly by means of devices that may slide axially and which have the function of preventing rotation.

Also adopting: the said anti-rotational devices, most advantageously, consisting of one or more studs or axial pins, sliding in the lead screw or in the piston or on an appendage rigidly attached to them.

Also adopting: the rotation of the adjustable structure and of the abrasive roller being controlled by means of transmission of motion between a worm screw and a worm wheel; the screw being driven by a motor reducer, whereas the worm wheel has a development that ensures at least 90 degrees of meshing with the said worm screw.

Finally, also adopting: a coupling with axial freedom of movement between the said worm wheel and the said column, advantageously achieved with a key fixed to the wheel and the slot in the column.

The advantages offered by the present invention are: the operator may use a single set of rollers to machine the most varied formats, even those that are unusual in the building trade; very wide abrasive rollers may be used, reducing the cutting front to the desired width, even machining more than one plate, strips or tiles that fit together longitudinally; the time interval that the production line has to be stopped to change the format in the grinding machine is reduced to the time required to adjust the inclination of the abrasive rollers with respect to the direction of advancement; also, the inclination of the rollers prevents the formation of longitudinal lines on the plates or tiles, caused by the repeated passage of the spaces, between the abrasive elements of the spiral of the roller, in the same point on the cutting front: in fact the inclined arrangement avoids the repetition in the same point of the spaces positioned on the same diametrical plane, preventing the contiguity of the ridge left by a single space with the subsequent ones on the same diametrical plane.

An embodiment of the invention is illustrated, purely by way of example, in the three tables of drawings attached in which Figure 1 is the plan view of the abrasive roller as described with an axis that is horizontal and angled with respect to the direction of advancement of the material being machined; Figure 2 is the trans-

verse section on a vertical plane of a head of the grinding machine with rollers that may be angled; Figure 3 is section III-III of Figure 2 showing just the section; Figure 4 is the vertical and transverse section of the said head of the grinding machine, enlarged and showing only the column and the movement and locking parts.

The figures show: 1, the cylindrical abrasive roller, with rotating motion R on horizontal axis B, inclined at an angle A with respect to direction T transverse to the direction M of advancement of the plates or tiles 2 being machined, transported on conveyor 3; 4, the abrasive elements attached to the roller using the known methods for attaching them to the surface of the roller and 5, the spaces, or discontinuities, between them in a metallic binding material; L, the width of the roller and P, the width of the plates or tiles being machined, even consisting of a plurality of plates or tiles positioned together longitudinally; D, Figure 2, a diametrical plane normal to the axis of the abrasive roller that contains the said spaces 5 of each start of the spiral, in a certain point of the generating line G of the cylindrical roller; 6, the supports of the roller 1, fixed to the adjustable structure 7, by means of column 8, coupled to the frame 9 of the grinding machine so that it is free to rotate on vertical axis S: the adjustment occurs around the centre line of the plates or tiles 2 being machined; 10, the drive belt between the electric motor 11 and the abrasive roller 1: the said motor and the transmission being fixed to the adjustable structure 7, and rotating with it.

The figures also show, still in Figure 2: 12, the longitudinal slot in the said column, in which slides the key 13, fixed to the sector of gearwheel 14 meshing with worm screw 15, in turn driven by motor reducer 16; 17, a flange inside the said column to which is attached a coaxial hydraulic cylinder 18, with extending stem with torque arm 19, in which a pair of pins 20 fixed to the adjustment head 21, may slide axially; 22, a adjustment screw coaxial with the hydraulic cylinder 18 and coupled within the piston 23, for the vertical adjustment of the roller 1; 24, the motor reducer for controlling the vertical adjustment and 25, the device for measuring the rotation of the screw 22 and consequently the vertical position of the roller 1; 26, tubes for supplying hydraulic fluid to the cylinder 18; 27, slots for the passage of the said tubes.

Finally, the figures show: 28, Figure 3, the hydraulic cylinders for locking the column 8, arranged in at least two vertical pairs with radial axes describing an acute angle between them; 29, Figure 4, the supply line of the said locking cylinders, having pistons 30 with curved extremities fitting around the external cylindrical surface 31 of the column 8; 32, the lead screw fixed to the said piston 23 and coupled to the screw 22 for vertical adjustment; 33, the upper chamber of the cylinder and 34, the lower chamber; 35, the annular shoulders of the piston within each chamber 33, 34 for limiting the stroke to a few millimetres.

Operation of the grinding machine is as follows: the operator, to adjust the rollers to the desired machining

format, unlocks the cylinders 28 hydraulically by releasing pressure from conduit 29 and simultaneously inverting the pressure in the upper chamber 33, connecting it to tank, and lower chamber 34, connecting it to the supply line of the operating hydraulic circuit. The column 8 with the adjustable structure 7 and the abrasive roller 1 are lifted through the short stroke allowed by the shoulders 35 of the said piston: motion commences only after the locking cylinder 28 releases. At this point, the abrasive roller being detached from the plates or tiles 2 being machined, it is possible to adjust the angle A of the roller 1 with respect to the material being machined: the greater the angle A, the smaller the projection of the generating line G of the abrasive roller 1 in the direction of advancement M. If the angle A is zero, operation is identical to known grinding machines having rollers with transverse axis, whereas, with a non-zero angle of inclination, the diametrical planes D, which contain the spaces 5 of the spiral starts, are inclined by a corresponding angle: the spaces 5, as they do not fall simultaneously in the same position over the width of the material being machined, do not leave longitudinal ridges in the direction of advancement M.

Experimental results show that the angle of inclination A may be varied within ample limits using normal abrasive rollers with multi-start spirals, that generally have an angle of inclination of the spiral of 30-50 degrees with respect to the diametrical plane D, consequently without causing damage to or abnormal wearing of the abrasive roller. Having completed the adjustment of the cutting front, the roller 1 can be positioned up against the material being machined, by operating the control for the chamber 33 and 34 of the cylinder 18: the lower chamber 34 is connected to tank and the upper chamber is connected to the supply; the column 8 may be subsequently immediately locked by pressurising to the locking cylinders 28 by means of line 29: the clearance between the column and its seat, required to allow sliding, is eliminated by the particular arrangement of the locking cylinders 28 converging on axis S and offset vertically, thereby stiffening the column to enable it to stand up to the considerable thrust generated by the machining.

The adjustment of the thickness to which the plates or tiles 2 are machined may be easily achieved during the adjustment phase by activating the motor reducer 24 and controlling the displacement using the device for measuring rotation 25.

In practice the materials, dimensions and details of execution may be different from, but technically equivalent to those described without departing from the juridical domain of the present invention.

## Claims

1. Thickness grinding machine for tiles (2) or plates of granite, hard-fired ceramic or other hard materials or not, comprising one or more abrasive rollers (1)

of the cylindrical type, with diamond-tipped elements (4) arranged on the external surface of the said rollers, adjustable in height to determine the thickness to grind to, characterised in that of the said rollers are each supported on a structure (7) that may be adjusted, with its rotation on a vertical axis (S) positioned on the centre-line of the material (2) being machined, at an angle (A) which is not zero and not a right angle, with respect to the direction transverse (T) to the direction (M) of motion of the plates or tiles.

2. Thickness grinding machine, according to preceding claim, characterised in that of having a column or hollow cylinder (8), supporting the adjustable structure (7), with a large diameter, on which act one or more locking or braking elements (28), for taking up the slack and carrying the thrust generated by the machining.
3. Thickness grinding machine, according to preceding claim, characterised in that of having the locking elements (28) acting on the external surface (31), consisting of at least two cylinders arranged so that they converge radially, with acute angle, on the said axis (S) of rotation and vertically offset.
4. Thickness grinding machine, according to preceding claim, characterised in that of having the said two single-acting locking cylinders (28), most advantageously hydraulic, subdivided in at least two pairs aligned vertically with the axis (S) and converging radially on it, the extremities of the piston (30) being curved to fit around the external cylindrical surface (31) of the column (8).
5. Thickness grinding machine, according to preceding claim 1, characterised in that of having a rapid retraction element (18,23), with short stroke, for detaching the abrasive roller (1) from the material being machined (2), most advantageously positioned between the adjustable rotating structure (17) and the adjusting mechanism (22,32) for the grinding thickness.
6. Thickness grinding machine, according to preceding claim 5, characterised in that of having the said rapid retraction element consisting of a coaxial double-acting hydraulic cylinder (18), connected to the said adjustment mechanism for the grinding thickness and to the mobile part (18) of the column (8) and, therefore, to the rotating adjustable structure (7) that carries the said abrasive roller (1); the piston (23) or each footing having mechanical limiter devices (35), that limit the stroke to just a few millimetres.
7. Thickness grinding machine, according to preceding claim 6, characterised in that of having the said

hydraulic cylinder for rapid adjustment having a piston (23) with hollow stem, provided with a fixed lead screw (32) coupled to the adjuster screw (22), for setting the grinding thickness, and the external sleeve (18) of the cylinder coupled rigidly (17) to the column (8) of the adjustable structure (7); the piston (23) and the lead screw (32) being positioned angularly by means of devices that may slide axially (19,20) and which have the function of preventing rotation.

8. Thickness grinding machine, according to preceding claim 7, characterised in that of having the said anti-rotational devices, most advantageously, consisting of one or more studs (20) or axial pins, sliding in the lead screw (32) or in the piston (23) or on an appendage (19) rigidly attached to them.
9. Thickness grinding machine, according to preceding claim 1, characterised in that of having the rotation of the adjustable structure (7) and of the abrasive roller (1) being controlled by means of transmission of motion between a worm screw (15) and a worm wheel (14); the screw being driven by a motor reducer (16), whereas the worm wheel (14) has a development that ensures at least 90 degrees of meshing with the said worm screw.
10. Thickness grinding machine, according to preceding claim 9, characterised in that of having a coupling with axial freedom of movement between the said worm wheel (14) and the said column (8), advantageously achieved with a key fixed (13) to the wheel and the slot (12) in the column.

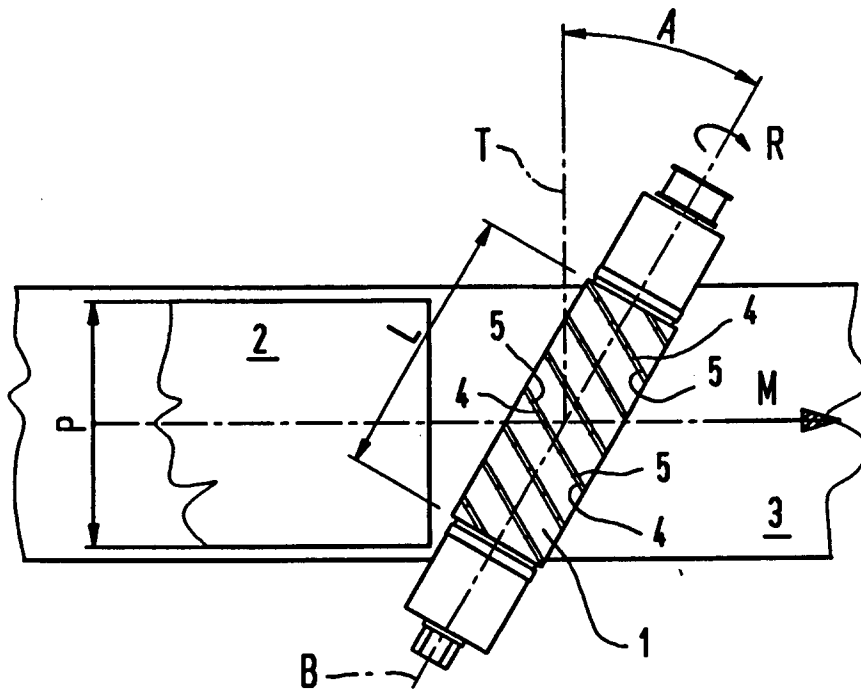


Fig. 1

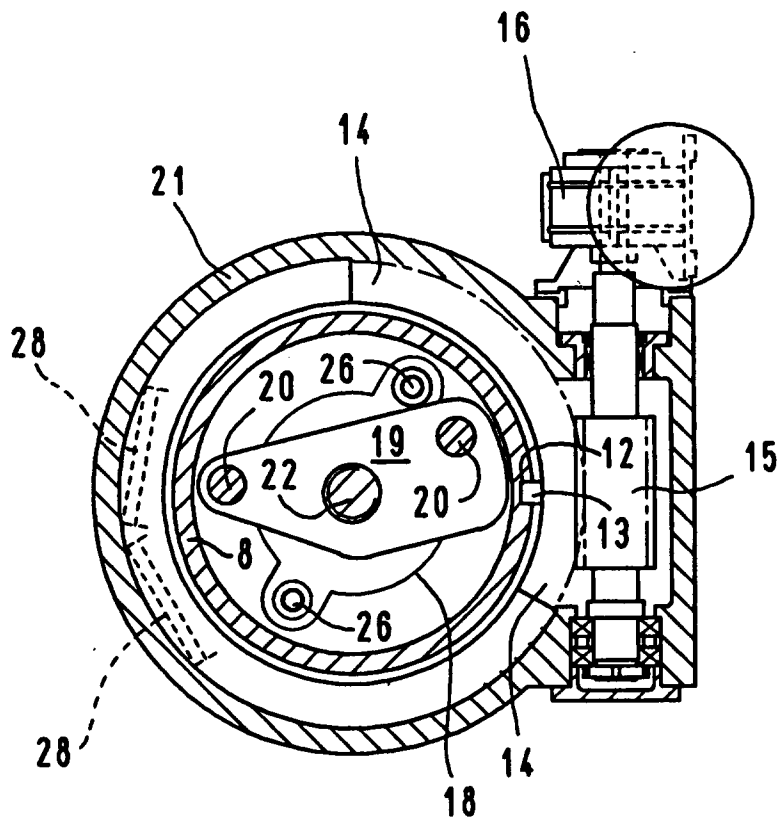


Fig. 3

Fig.2

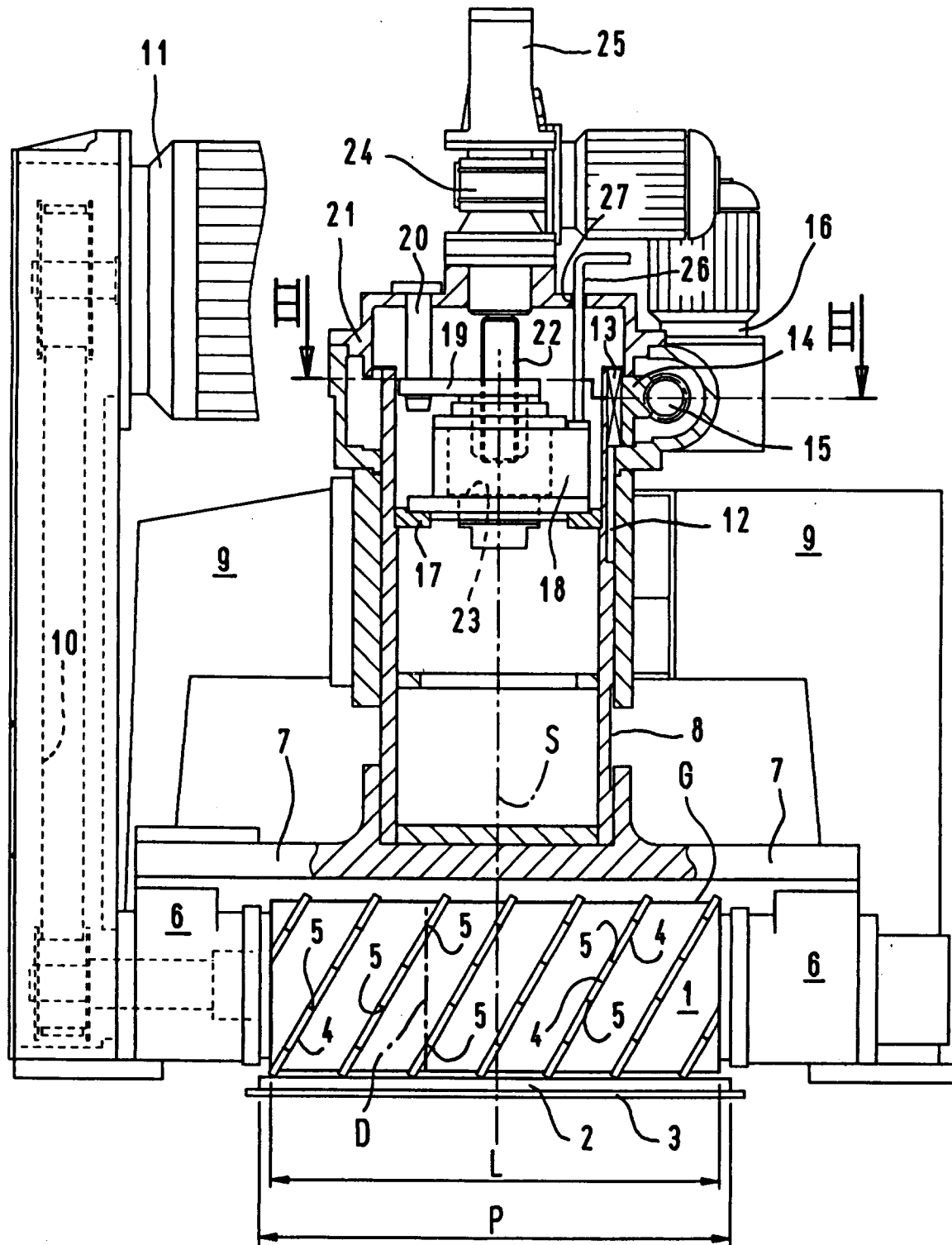
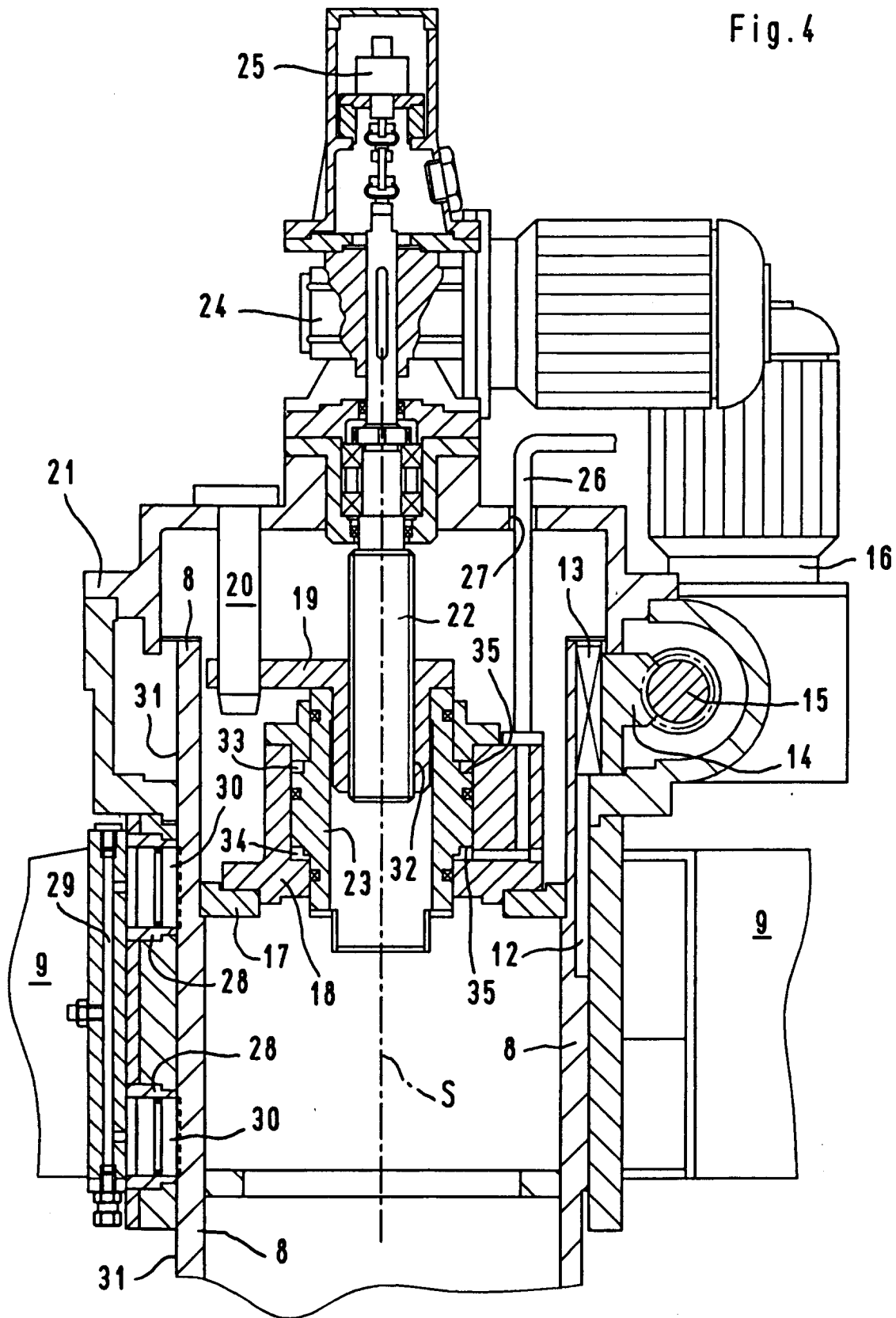


Fig. 4







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## EUROPEAN SEARCH REPORT

Application Number  
EP 96 11 6479

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                         |                                                     |                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                           | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE-A-28 11 894 (MICHAEL VOIT MASCHINENFABRIK ET AL) 4 October 1979<br>* page 4, line 16 - page 5, line 28;<br>figures * | 1,5,6,9                                             | B24B41/047<br>B24B7/22                       |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ---                                                                                                                     | 2                                                   |                                              |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US-A-4 720 940 (GREEN) 26 January 1988<br>* column 5, line 31 - line 53 *                                               | 2                                                   |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ---                                                                                                                     | 1                                                   |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US-A-2 771 713 (PECKETT)<br>* column 3, line 36 - column 4, line 17;<br>figure 4 *                                      | 1                                                   |                                              |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ---                                                                                                                     | 1                                                   |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | US-A-4 958 463 (HESS ARTHUR E ET AL) 25 September 1990<br>* abstract; figures *                                         |                                                     |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -----                                                                                                                   |                                                     |                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                         |                                                     | TECHNICAL FIELDS SEARCHED (Int.Cl.6)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                         |                                                     | B24B                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                         |                                                     |                                              |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                         | Date of completion of the search<br>28 January 1997 | Examiner<br>Garella, M                       |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                         |                                                     |                                              |

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