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(54) Polishing head, particularly for slabs of marble, granite, porcelainized gres, and other stone materials.

(57) A polishing head for marble, granite, porcelainized gres, and other stone materials, includes a main shaft (3) which is rotatably mounted on a stationary support (4) and is coupled to an external motor. A casing (2) which is keyed to the lower end of the main shaft (3) and a series of secondary shafts (5) which are arranged within the casing (2) and have external ends provided with abrasive tools (8). The head includes a cam-based movement means (13, 13'; 16, 16') which is connected to the secondary shafts (7) and a transmission means (18, 20) which is interposed between the stationary support (4) and the movement means (13, 13'; 16, 16') and is constituted by at least one worm screw/helical gear coupling (18, 20) wherein the worm screw (18) is fixed to the stationary support (4) and the helical gear is rotatably mounted on the casing (2). The cam-based movement means includes at least one intermediate shaft (14) on which a first cam (13) is keyed. The first cam (13) is suitable to cooperate with a roller which is mounted at the end of a radial arm (17) that is rigidly coupled to one of the secondary shafts (7).

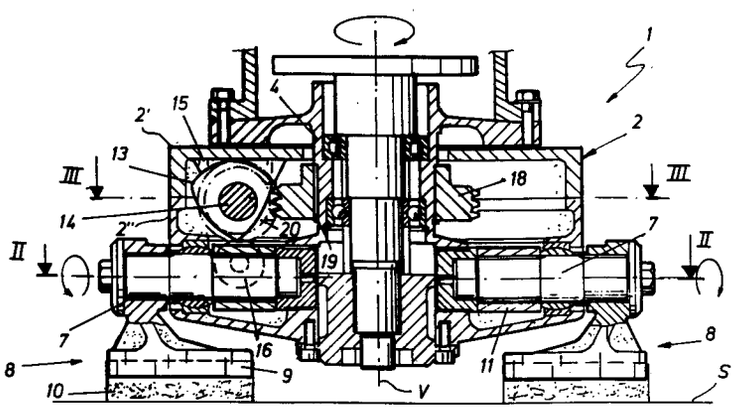

FIG. 1

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The present invention relates to a polishing head particularly for slabs of marble, granite, porcelainized gres, and other stone materials.

More particularly, the invention relates to a rotating head which is provided with multiple oscillating abrasive tools that act simultaneously on the surface to be polished. These heads are commonly mounted on movable fixtures which are placed above a conveyor belt or above a transport surface which is meant to move the slabs to be polished in a substantially horizontal direction.

European patent application no. 0 510 603 in the name of this same Applicant discloses a polishing head in which the oscillating tools are mounted on a rotating casing which is rotatably supported by a main shaft which has a vertical axis. The tools act tangentially with respect to the surface to be polished, with a motion that is the result of the composition of the combined rotation and translation of the casing and of the synchronized periodic oscillation of the respective secondary shafts. The active surface of the tools is, or becomes, slightly curved so as to have, with respect to the surface to be polished, a linear-type contact regardless of the relative position of the tools.

In this known head, as in other heads of the same type, the mechanism that controls the oscillation of the tools generally consists of a combined reduction and differential unit with spur gears that transfer motion from a gear that is rigidly coupled to the rotating casing to an idle gear which is coupled to a central cam with a profile having multiple lobes. End rollers act on the cam and are mounted on levers or arms which are rigidly coupled to the secondary shafts to make the secondary shafts oscillate periodically about their respective axes.

The frequency of these oscillations depends on the rotation rate of the head, on the transmission ratio of the combined reduction and differential unit, and on the number of lobes of the cam. For example, in a polishing head with six radial tools, if one uses a reduction unit with a 19:20 transmission ratio, and the casing rotates at approximately 400 rpm, the lobate wheel rotates at approximately 380 rpm. Accordingly, the differential rate of the lobate wheel with respect to the casing of the head is approximately 20 rpm. By using a lobate wheel with a profile having three lobes, the oscillation frequency of the tools is approximately 60 oscillations per minute.

Since the rotation rate of the gears of the reduction unit is high, these known polishing heads require abundant lubrication, which normally must be of the splash type with gears in an oil bath.

A drawback of these known polishing heads is indeed constituted by the excessive rotation rate of the gears of the reduction unit, which reduces the reliability and life of the entire head and can cause balancing problems.

In order to reduce the above described drawback it is necessary to limit the rotation rate of the gears of the reduction unit, but in this way one obtains an imperfect finish of the treated surfaces.

Another drawback of known heads is the high production and maintenance cost of the lubrication system of the reduction unit, which requires perfect tightness of the casing to avoid any leakage and dripping of the lubricant onto the marble being treated, which would consequently damage the marble.

Another drawback is the relative complexity of the reduction unit, which entails careful production and accurate assembly as well as frequent maintenance.

The aim of the present invention is to eliminate the drawbacks described above by providing a polishing head that is highly efficient, productive, reliable, has a longer life, and minimizes lubrication of its rotating parts.

A particular object is to reduce the rotation rate of the internal parts of the head so as to improve the reliability and life of the entire apparatus.

Another object is to conceive a head having a simplified structure that reduces the construction and maintenance requirements typical of conventional heads.

This aim, these objects, and others which will become apparent hereinafter are achieved by a polishing head, particularly for marble, granite, porcelainized gres, and other stone materials, comprising a main shaft which is rotatably mounted on a stationary support which is rigidly coupled to the outer skirt of the head and is coupled to an external motor means, a casing which is keyed to the lower end of the shaft, a series of secondary shafts which are rotatably arranged within the casing and have external ends provided with abrasive tools, characterized in that it includes a cam-based movement means which is connected to the secondary shafts and a transmission means which is interposed between the stationary support and the movement means to control the movement of the tools, wherein the transmission means consists of at least one worm screw/helical gear coupling wherein the worm screw is fixed to the stationary support and the helical gear is rotatably mounted on the casing.

The cam-based movement means can be constituted by at least one intermediate shaft on which a cam is keyed; the cam acts on an arm that is rigidly coupled to one of the secondary shafts.

The worm screw/helical gear coupling can include a gear with helical teeth which is keyed on each intermediate shaft and meshes with the worm screw.

By virtue of this particular arrangement, the internal gears rotate at considerably lower rates than in known heads of the past, significantly increasing the reliability and life of the head. As an alternative, if one maintains the same rotation rates for the internal parts it is possible to increase the rotation rate of the head, obtaining higher productivity and a better finish of the treated surfaces.

Further characteristics and advantages of the invention will become apparent from the detailed description of the following preferred, but not exclusive, embodiment of the polishing head according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a sectional front view of the polishing head according to the invention, taken along an axial vertical plane;

Figure 2 is a sectional plan view of the head of Figure 1, taken along the horizontal plane II-II;

Figure 3 is a sectional top view of the head of Figure 1, taken along the transverse plane III-III;

Figures 4a to 4c are enlarged front views of a detail of Figure 1, shown during three different operating steps during an oscillation of the tool.

With reference to the above figures, a polishing head according to the invention, generally designated by the reference numeral 1, can be installed, together with other heads of the same type, on multispindle polishing machines for treating slabs of marble, granite, porcelainized gres, and other stone materials. In these machines, the heads are generally fixed on a longitudinal beam which is moved so as to swing transversely with respect to a slab transport line.

The head 1 generally includes a casing 2 which is formed for example by two half-shells 2', 2'' which are coupled by stud bolts, not shown in the drawings, and in which the lower shell 2'' is fixed to the lower end of a main shaft 3 which has a substantially vertical axis V. The shaft 3 is arranged within a substantially cylindrical stationary support 4 in a coaxial position and with roller and ball bearings interposed. The support 4 is rigidly coupled to an upper skirt 5 of the head which accommodates an external motor means, for example an electric motor not shown in the drawings, which is connected to the shaft 3 by virtue of a flange 6.

Multiple secondary shafts 7 are rotatably supported on the casing 2 and have axes B_i which are angularly equidistant and arranged radially with respect to the vertical axis V. The shafts can be supported towards their ends and their external end protrudes from the casing 2. In the embodiment shown schematically in the drawings, there are six shafts which are accordingly angularly spaced by 60°, but it is evident that there may be a smaller or larger number of shafts without thereby abandoning the scope of the invention; the number must in any case be even for the reasons which will become apparent hereinafter.

Respective tools 8 of a known type are keyed at the external ends of the secondary shafts 7 and include a sliding block 9 which is provided, in a downward region, with a tenon-shaped seat for retaining pads of abrasive material 10. These pads are meant to interact with the surface S to be polished by virtue of a motion which is the result of the composition of the rotation of the head about its own vertical axis V and of the motion applied by the tool supporting shafts 7. The profile of the lower face of the pads is slightly curved, or assumes this shape after a short period of work, so that the region that makes contact with the surface S to be treated is approximately linear.

A sleeve 11 is keyed on each secondary shaft 7 and is provided with conical toothed sectors 12; the sleeve meshes with the adjacent ones to kinematically link the various shafts 7 and rotate them in alternating and synchronous directions.

The secondary shafts 7 are actuated by a cam-based actuation means which is in turn connected to a motion transmission means which is meant to take the rotary motion of the head with respect to the stationary support and transmit it to the tools 8.

In particular, the cam-based movement means includes at least one cam 13 which is keyed on an intermediate shaft 14 which is rotatably mounted on two supports 15 which are rigidly coupled to the upper half-shell 2' of the casing 2. The cam 13 cooperates with a roller 16 which is mounted at one end of a lever arm 17 that protrudes radially from the sleeve 11. In this manner, the continuous rotation of the cam 13 produces the alternating oscillation of the arm 17, which is rigidly coupled to the sleeve 11, and therefore of the shaft 7 on which the tool 8 is mounted.

In order to produce the complete oscillation of the shaft 7 there is a return means which acts on the secondary shaft. The return means can be constituted by a second cam 13' which is keyed on the same intermediate shaft 14 and in a position which is angularly offset by 180° with respect to the first cam; the second cam acts on a second roller 16' which is rotatably mounted at the end of a second arm 17' that protrudes radially from the sleeve 11 and is arranged opposite to the preceding arm 17.

The intermediate shaft 14 is preferably arranged at right angles to the main shaft 3 and to the secondary shaft 7 to which it is coupled.

The profiles of the cams 13, 13' are complementary and are calculated according to per se known algorithms so that during the rotation of the intermediate shaft 14 they are permanently in con-

tact with the respective rollers 16, 16', minimizing clearances in operation and smoothing the oscillations of the tools 8.

For balancing reasons, there are multiple movement assemblies, constituted by pairs of cams 13, 13' which cooperate with respective rollers 16, 16'; the assemblies are angularly equidistant and their number is equal to the number of secondary shafts or a submultiple thereof. For example, in the illustrated example there are three movement assemblies which are mounted on respective tool supporting shafts having axes B_1, B_3, B_5, whereas the remaining three tool supporting shafts are moved by the respective toothed sectors 12.

According to the invention, the transmission means is constituted by at least one worm screw/helical gear coupling in which the worm screw is fixed and the helical gear is rigidly coupled to the casing.

In particular, there is only one worm screw 18, which is fixed on the outside of the stationary support 4 by virtue of a key 19. At least one helical gear 20 meshes with the worm screw 18 and is keyed on one of the intermediate shafts 14 of the respective movement assemblies.

Preferably, there is a helical gear 20 for each intermediate shaft 14, that is to say, for each movement assembly. Accordingly, the helical gear 20 of each transmission assembly which is rotated by the casing 2 has a relative motion with respect to the worm screw 18.

A result of this relative motion is the transmission of motion with a transmission ratio N:Z, where N is the number of starts of the worm screw and Z is the number of teeth of the helical gear.

In a preferred embodiment, the number of starts N of the worm screw is three, whereas the number of teeth Z of the helical gear is between 15 and 27 and is preferably 21. This leads to a transmission ratio between 1:9 and 1:5, preferably 1:7.

In this last case, a full oscillation of the tools is achieved for every seven turns of the head. For example, if the head rotates at 500 rpm, the tools oscillate at the frequency of approximately 71 oscillations per minute.

The result of this mechanically determined arrangement is that the number of tools 8 is a multiple of the number of starts of the worm screw 18.

By virtue of the relatively low rotation rate of the helical gears 20 of the reduction units, it is possible to adopt higher head rotation rates, close to 1000 rpm, maintaining the same reliability and life as conventional heads with differential-based reduction units and improving the degree of finish of the treatments.

Furthermore, lubrication is less critical and can be permanent, by using self-lubricating or sealed bearings to support the intermediate shafts 14 and the tool-supporting secondary shafts 7, avoiding oil-bath lubrication and eliminating the risk of seepage of oil from the head.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Polishing head, particularly for marble, granite, porcelainized gres, and other stone materials, comprising a main shaft (3) which is rotatably mounted on a stationary support (4) which is rigidly coupled to the outer skirt of the head (5) and is coupled to an external motor means, a casing (2, 2', 2'') which is keyed to the lower end of said shaft (3), a series of secondary shafts (5) which are rotatably arranged within said casing (2) and have external ends provided with abrasive tools (8), characterized in that it comprises a cam-based movement means (13, 13'; 16, 16') which is connected to said secondary shafts (7) and a transmission means (18, 20) which is interposed between said stationary support (4) and said movement means (13, 13'; 16, 16') to control the movement of said tools (8), wherein said transmission means consists of at least one worm screw/helical gear coupling (18, 20) wherein the worm screw (18) is fixed to said stationary support (4) and the helical gear (20) is rotatably mounted on said casing (2).

2. Polishing head according to claim 1, wherein each worm screw/helical gear coupling (18, 20) comprises a gear (20) with helical teeth that is keyed on at least one intermediate shaft (14) which is rotatably mounted on said casing (2) and meshes with said worm screw (18).

3. Polishing head according to claim 1, wherein said worm screw/helical gear coupling has a transmission ratio between 1:9 and 1:5, preferably 1:7, and the number of starts of the worm screw (18) is preferably three.

4. Polishing head according to claim 2, wherein said cam-based movement means comprises at least one assembly which is composed of a first cam (13) that is mounted on said inter-

mediate shaft (14) and is suitable to cooperate on a roller (16) that is rotatably mounted at the end of a radial arm (17) which is rigidly coupled to one of said secondary shafts (7).

5. Polishing head according to claim 4, wherein each intermediate shaft (14) lies at right angles both to said main shaft (3) and to the secondary shaft (7) to which it is connected.

6. Polishing head according to claim 5, wherein said movement means furthermore comprises a return means that acts on the secondary shaft (7) to which said arm (17) is rigidly coupled.

7. Polishing head according to claim 6, wherein said return means comprises a second cam (13') which is mounted on the same intermediate shaft (14) and acts on a second arm (17') which is keyed on said secondary shaft (7) opposite to the first one (17).

8. Polishing head according to claim 7, wherein said first cam (13) and said second cam (13') are angularly offset by approximately 180° to give the respective arms (17, 17') an alternating periodic motion.

9. Polishing head according to claim 8, wherein said first cam (13) and said second cam (13') have complementary geometric profiles which are suitable to maintain said cams constantly in contact with the respective rollers (16, 16') during the rotation of the intermediate shaft (14) on which they are keyed.

10. Polishing head according to one or more of the preceding claims, wherein said secondary shafts (7) are substantially radial with respect to said main shaft (3).

11. Polishing head according to one or more of the preceding claims, wherein said secondary shafts (7) are kinematically connected to each other with a 1:1 transmission ratio.

12. Polishing head according to claim 1, wherein lubrication of the components located inside said container (2) is of the permanent and/or sealed type.

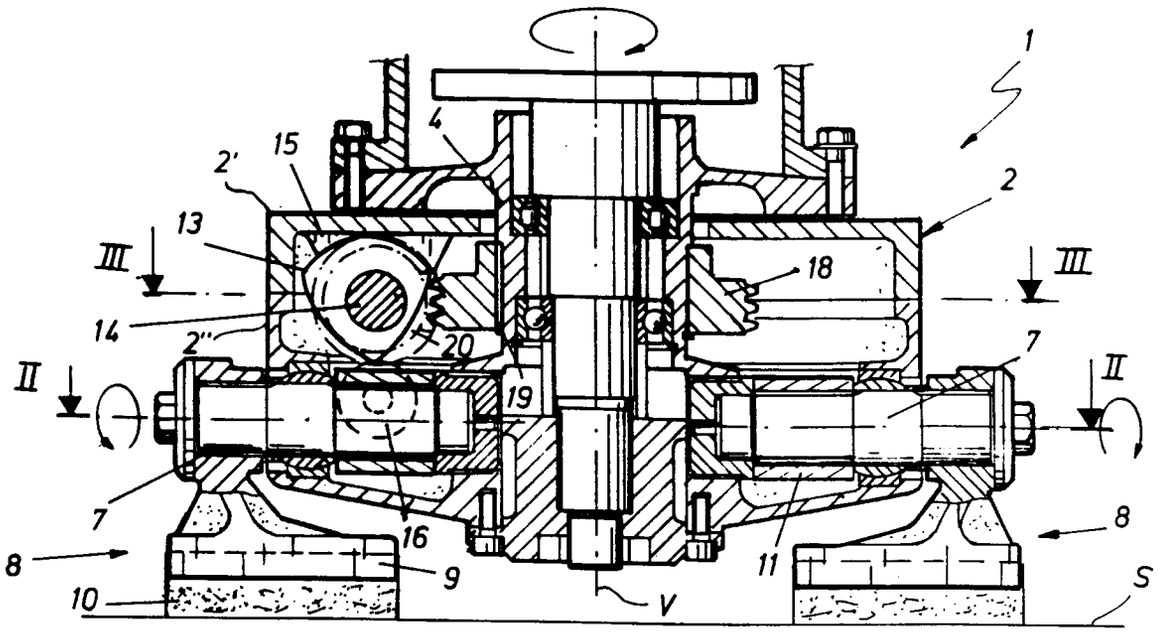
1
2
2'
2''
4
15
13
14
III
III
II
II
18
20
19
7
8
9
10
16
11
V
S

FIG. 1

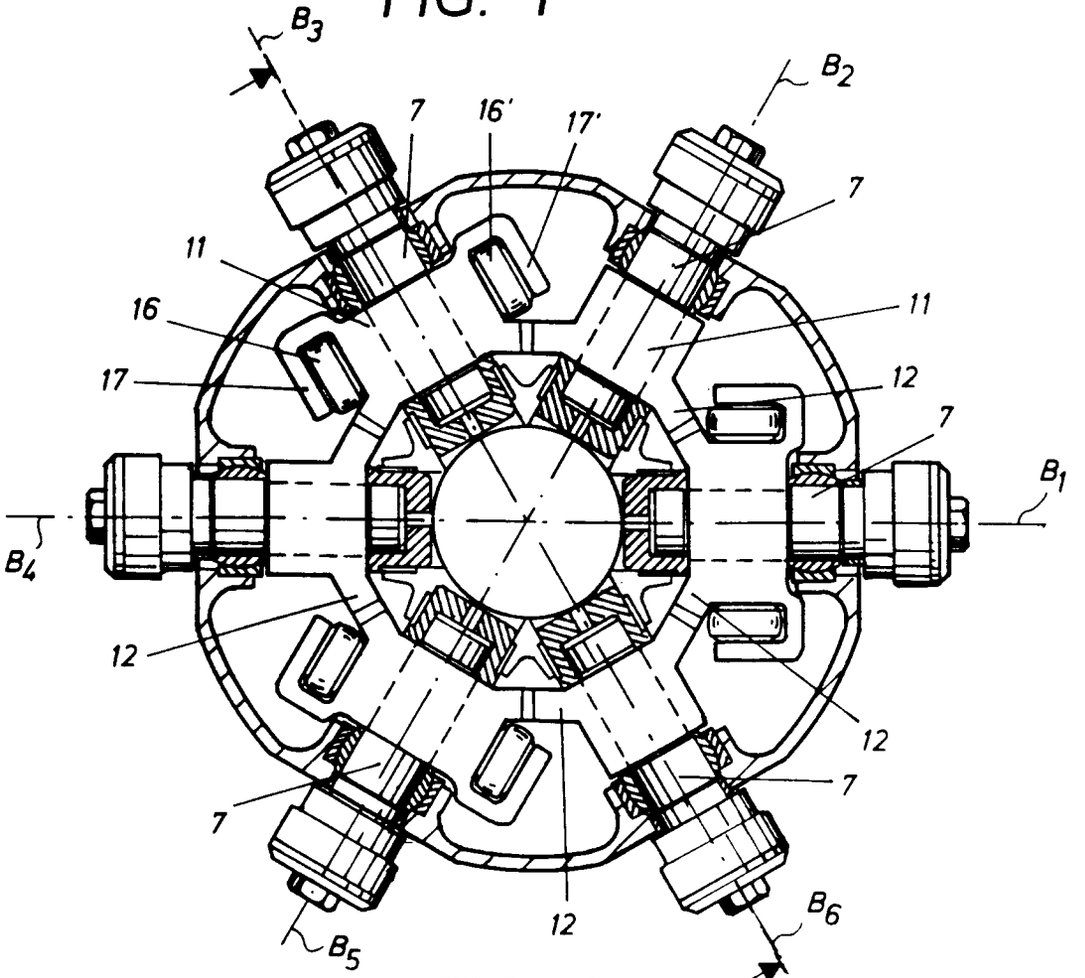
B3
B2
B1
B4
B5
B6
7
16'
17'
11
16
17
12

FIG. 2

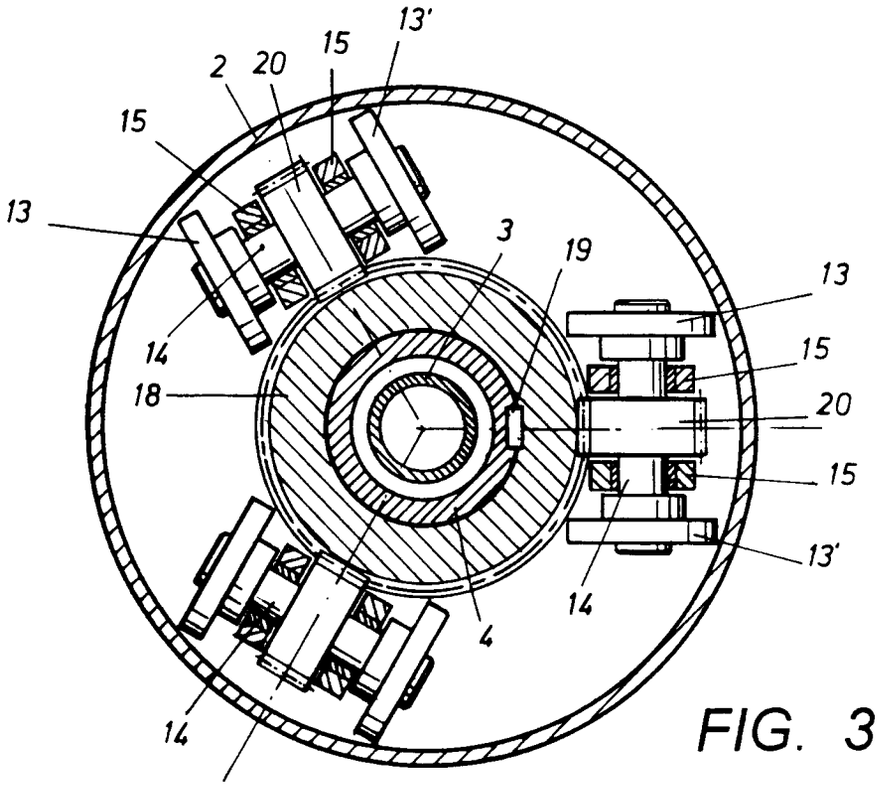

FIG. 3

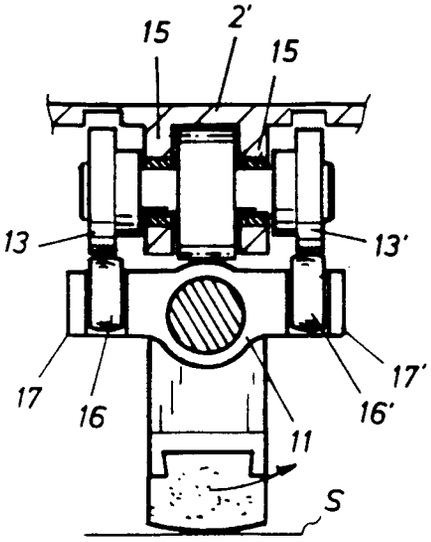

FIG. 4a

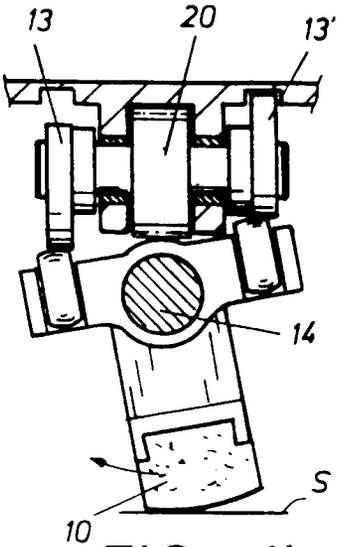

FIG. 4b

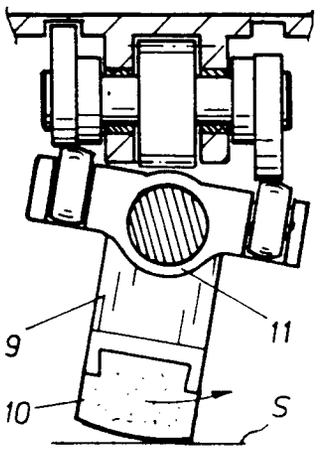

FIG. 4c

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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 0598

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	EP-A-0 448 847 (ZAMBON S.N.C.) * the whole document *	1-3	B24B41/047
X	EP-A-0 510 603 (SIMEC S.P.A.) Document cited in the application * column 2, line 27 - column 3, line 44; figures 4,5 *	4-6, 10-12	
A	FR-A-2 565 148 (BALENCIAGA EIZMENDI A.) * abstract; figures *	7-9	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24 May 1995	Eschbach, D

CATEGORY OF CITED DOCUMENTS

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