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(54) Grinding machine for spiral springs and related grinding method

(57) Grinding machine for spiral springs comprising a discoid spring-support table, in which there are arranged two distinct grinding stations, each one of which provided with respective pairs of grinding wheels arranged on two distinct planes extending parallel to said discoid table; said two grinding stations are capable of being operated independently of each other, in the sense that there may be operated just a single station or both stations at the same time. There are furthermore provided actuation and control means adapted to vary in a selectively independent manner: - the distance between the grinding wheels of each station, - the rate of variation of said distances, - the speed of rotation of said discoid table, - the speed of rotation of each single grinding wheel, - the direction of rotation of each single grinding wheel, - and the force acting upon the springs.

In an advantageous manner, there is provided at least a pressing station between said at least two grinding stations.

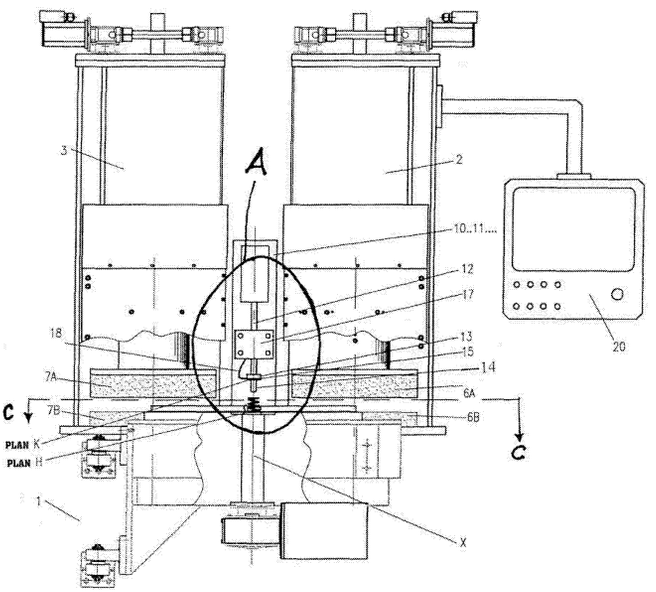

FIG. 1

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Description

[0001] The present invention refers to an improved kind of multiple-pass spring grinding machine, which is particularly efficient in its operation and has such features as indicated in the appended claim 1.

[0002] Spiral springs, and in particular the springs that are designed to work as compression springs, are generally submitted, during the manufacturing thereof, to a grinding operation at the extremities or end portions thereof, so that such end portions show, during use, respective planar surfaces, and these planar surfaces are parallel to each other and orthogonal to the axis of the spring spiral.

[0003] The machines used to perform this grinding operation on spiral springs in general, and compressively operating spiral springs in particular, are generally described in the patent publication EP 0722810 B1, which reference should therefore be conveniently made to. The grinding machines described in this publication are essentially characterized in that they are able to perform both single-pass grinding and multiple-pass grinding. As compared with prior-art machines, these grinders have an advantage in that they enable a single machine to be used, which, duly set-up with a few simple operations, is advantageously able of grinding both small-size springs, with a single-pass grinding operation, and springs of a bigger size, using a multiple-pass grinding operation in this case.

[0004] It has however been found that, in practical use, this machine, although reaching all of the aims as set forth and indicated in the above-cited patent publication, has nonetheless a well-known drawback that it typically shares with the generality of prior-art machines. In other words, this drawback lies in the fact that springs, including larger-sized ones, must exhibit an adequate ultimate finishing quality, and this implies that grinding wheels must be consistently fine. However, due to such larger-size springs having to undergo a correspondingly more powerful processing owing to their size, it ensues that this machine has to complete its grinding job through a multiple-pass operation in order to ensure an adequate finishing quality along with an appropriate grinding depth. As a result, this need for a multiple-pass grinding operation to be performed implies longer processing times and, therefore, higher costs.

[0005] On the other hand, if use is made of just a single pair of coarse-grained grinding wheels in view of improving productivity, this would quite obviously have detrimental effects on the finishing accuracy.

[0006] In a few words, therefore, it may be stated that the machine disclosed in the above-mentioned patent publication is effective in increasing the productivity of the grinding operation, but not the finishing accuracy thereof.

[0007] It would therefore be desirable, and it is actually a main purpose of the present invention, to provide a grinding machine for spiral springs, which is provided with means adapted to improve the flexibility of use thereof and, in particular, to adjust the distance between the grinding wheels during the use thereof, and which is furthermore adapted to improve the productivity of the machine by speeding up overall processing times, i.e. by working at faster rates.

[0008] Within this general object, it is another purpose of the present invention to reach these aims through the use of means and devices that are both reliable and low-cost, as well as readily available on the market.

[0009] According to the present invention, these aims as set forth above, along with further ones that will become apparent from the following description, are reached in a grinding machine made so as to incorporate the features and characteristics as recited in the appended claims.

[0010] Features and advantages of the present invention will anyway be more readily and clearly understood from the description that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a simplified front view of a grinding machine according to the present invention;
- Figure 2 illustrates a view along the section plane C-C of Figure 1, with the additional symbolical representation of the relative position of a pressing station (10...11..);
- Figure 3 is an enlarged view of the zone circled at A in Figure 1.

[0011] With reference to the above-listed Figures, a grinding machine according to the present invention substantially comprises:

- a common bed-plate 1,
- a first grinding station 2,
- a second grinding station 3,
- a first pair of grinding wheels 6A, 6B included in said first grinding station 2,
- a second pair of grinding wheels 7A, 7B included in said second grinding station 3.

[0012] Furthermore, the inventive grinding machine also comprises:

- a discoid turning table 4 arranged between said two grinding stations,
- a plurality of through-recesses 5 provided within said discoid turning table close to the periphery thereof.

[0013] The size and the relative positioning of the two grinding stations and said discoid turning table 4 with respect to each other are such that both the grinding wheels of the first grinding station 2 and the grinding

wheels of the second grinding station 3 are arranged on respective parallel planes on the two opposite sides of said discoid turning table, substantially as this is the case in the prior art.

[0014] In particular, the configuration of the entire machine is defined so as to enable said discoid table to turn in a controlled manner about a vertical axis X extending between said two grinding stations, so that all aforementioned through-recesses 5 are caused to successively pass between the grinding wheels 6A, 6B of the first grinding station 2, as well as the grinding wheels 7A, 7B of the second grinding station 3.

[0015] The two grinding stations may be set up and fitted with respective pairs of grinding wheels having differing characteristics; in particular, a grinding station may be provided with coarse-grained grinding wheels, for a first roughing-out grinding operation to be performed therewith, whereas the other grinding station may be provided with grinding wheels having a much finer grain for carrying out the ultimate finishing grinding operation.

[0016] All moving members of the inventive machine are provided with actuating and control means adapted to actuate them in a fully independent, selectively variable manner. In particular, following process parameters are capable of being pre-set in a selectively variable manner:

- the distance between the grinding wheels of each pair of grinding wheels,
- the variation rate or speed of said distances,
- the speed of rotation of said discoid turning table 4,
- the speed of rotation of each single grinding wheel,
- the direction of rotation of each single grinding wheel,
- the force or pressure exerted on the springs in said two grinding stations.

[0017] The means used to perform such controls and adjustments are neither shown in the Figures nor described here any further, since they are generally well-known to all those skilled in the art and, therefore, are of no relevance to the purposes of the present invention.

[0018] During its operation, the inventive machine can perform according to different operating dispositions and modes, depending on the actual production requirements. So, for example,

- in a first such operating disposition, there may be activated just a single grinding station, while the other grinding station is kept idle, in which case the machine would therefore be operating much like a prior-art grinding machine;

- in a second such operating disposition, both grinding stations are on the contrary operated, wherein the springs undergo a first roughening-out grinding at the first station they encounter, which is provided with coarse-grained grinding wheels rotating at a suitably pre-defined speed, and a second finishing grinding when, upon exiting the first grinding station, they enter the second grinding station that will be provided with grinding wheels featuring a much finer grain.

[0019] In an ideal manner, the wheels will exert a greater pressure upon the springs, so as to cut the processing time, whereas in the second station the wheels will rotate by exerting a lower pressure to enable high-precision finishing grinding, i.e. the length of the spring to be reduced in a very precise manner.

[0020] In addition, it will prove advantageous for the rotating speed of the grinding wheels of a single and same pair to be capable of being differentiated from each other so as to compensate for possible grinding differences on the terminal portions of the springs.

[0021] The advantages brought about by the present invention can at this point be fully appreciated: there is an increase in the actual contact time of the spring with the grinding wheels, thereby increasing the overall productivity of the machine, without however suffering any loss in grinding precision, owing to the final grinding phase taking place in the second grinding station that is set-up in an optimised manner so as to ensure the best finishing results.

[0022] Furthermore, even in the case of smaller springs, which are usually more delicate and require being processed with a much greater precision, the provision of two different grinding phases enables both the precision of the obtainable final spring length and the finishing quality to be increased to a really significant extent.

[0023] The grinding cycle therefore takes place again from the beginning, according to the above-described sequence and modalities.

[0024] A machine of the above-described kind allows anyway for further advantageous improvements. In this connection, it may be reminded that a compression spring must generally be "packed together", i.e. must be pressed tightly together so as to remove from it any internal stress that may have be introduced during the spring forming operation. The need for such pressing operation to be performed arises from the fact that it is effective in stabilizing the length of the spring, which in fact tends to change, i.e. to be different after such pressing operation from what it was prior to it. Anyway, this pressing technique is largely known to all those skilled in the art, so that it shall not be described here any further.

[0025] According to the prior art, this pressing operation, although necessary, is however not free of some inherent drawbacks: in fact, if such pressing takes place before the spring is submitted to grinding, an out-of-alignment condition tends to generally arise between the axis of the spring and the direction of the pressing force acting on the spring, so that the spring itself ulti-

mately suffers a deformation; if, on the other hand, pressing takes place after spring grinding, springs of differing heights tend generally to result (owing to the great variability in internal stresses that are present in the spring immediately after forming, and that are relieved by pressing), which thing is fully unacceptable in the great majority of applications.

[0026] Accordingly, an advantageous improvement of the present invention lies in providing one or more pressing stations 10, 11 to be inserted between said two grinding stations 2 and 3.

[0027] With reference to Figures 1 and 2, said pressing stations comprise:

- an actuating rod 12,
- a pressure pan 13,
- an alignment pin 14,
- a detector means 15 for detecting an electric contact condition between said pan 13 and the spring 16,
- a measuring means for measuring the displacement or lowering of said actuating rod.

[0028] Furthermore, said means 17 is controlled so as to only detect the position of the actuating rod 12 on the basis of an electric signal of an appropriate nature coming from said means 15 and indicating when the contact between said pan 13 and said spring 16 is actually established. Quite obviously, the pressure pan 13 may itself include in this case means adapted to provide the means 17 measuring the position of the actuating rod 12, via the connection 18, with the signal containing the information about the moment at which said pan 13 substantially separates from the spring being processed, so that said means 17 is immediately put in a position as to exactly know the position of the pan 13 and, ultimately, the height of the spring. It will be readily appreciated that other, fully equivalent solutions may of course be found and implemented for a correct detection of the height of the spring, these solutions being on the other hand fully within the capability of those skilled in the art, so that they shall not be explained in any closer detail here.

[0029] The operating sequence of the inventive machine can at this point take place according to two alternative operating modes:

- according to a first such mode of operation, the pressing station 10 performs a pressing operation according to a pre-set, unvarying procedure, at the end of which the spring is automatically transferred to the second grinding station without any further checks or operations being performed in the meanwhile;

- according to a second such mode of operation, upon conclusion of the above-described pressing operation, the afore-mentioned means 15 and 17, which are functionally coordinated with each other, measure the height of the spring 16 at the moment at which the contact between said pressure pan and the spring itself is broken, i.e. the pan separates from the spring, and compare this detected height with a pre-set value (the height of the spring can be easily gauged and assessed through a precalibration of the distance from the lower-side contact plane K of said pan, in a known reference position, to the resting plane H of the same spring).

[0030] If the result of said comparison turns out to be situated anywhere between two pre-defined values, the discoid table is allowed to turn further until it carries the spring below the second grinding station; if, on the contrary, the outcome of said comparison is a different one, then the discoid table is allowed to turn further until the through-recess holding the spring thus found as not complying with the specifications is positioned below the second pressing station 11, where the same spring undergoes a further pressing operation.

[0031] The kind of control and actuation means used to such purpose, the logical and functional connection thereof, and the integration thereof with the other members and parts of the machine for carrying out the above-described operating procedures in a controlled, coordinated manner are generally within the capabilities of those skilled in the art, so that they shall not be described here any further. Figure 1 alone can be noticed to illustrate in a fully symbolical manner a representation showing that a control means 20 of a fully general kind, such as for instance a computer controlling the operation of the entire machine, is adapted to receive an appropriate signal from said means 17 and, based on said signal, to control and adjust the operation of all other functional members and parts of the machine, and in particular of the second pressing station, the rotation of the discoid table 4 and the two grinding stations 2 and 3, accordingly.

Claims

1. Grinding machine for spiral springs, comprising:

- a discoid turning table (4) supporting the springs to be processed and provided with a plurality of through-recesses (5) adapted to receive and hold said springs, said table being rotating about a vertical axis (X),
- a first grinding station (2) provided with a first pair of grinding wheels (6A, 6B), which are arranged parallel to said discoid table on opposite sides thereof, and are adapted to grind said springs, **characterized in that** it is further provided with at least a second grinding station (3) that is in turn fitted with a second pair of respective grinding wheels (7A, 7B). which are ar-

ranged on two respective distinct planes extending parallel to said discoid turning table on opposite sides thereof, and are adapted to grind said springs when these are rotated by said discoid turning table so that said respective spring-holding through-recesses are positioned between said two other grinding wheels (7A, 7B) of said at least a second grinding station (3).

2. Grinding machine according to claim 1, **characterized in that** said two grinding stations (2, 3) are capable of being operated independently of each other, in the sense that the possibility exists for only one of them to be operated, while the other one is kept idle, or both of them can be operated at the same time.

3. Grinding machine according to claim 2, **characterized in that** there are provided control means adapted to vary in a selectively independent manner:

- the distance between the grinding wheels of each pair of grinding wheels,
- the rate of variation of said distances,
- the speed of rotation of said discoid table 4),
- the speed of rotation of each single grinding wheel (6A, 6B, 7A, 7B),
- the direction of rotation of each single grinding wheel, and
- the force acting upon the springs.

4. Grinding machine according to any of the preceding claims, **characterized in that** between said at least two grinding stations (2, 3) there is arranged at least a pressing station (10).

5. Grinding machine according to any of the preceding claims, **characterized in that** between said two grinding stations (2, 3) there are arranged at least two pressing stations (10, 11), and that a first one (10) of said pressing stations is provided with means for measuring the height of the spring upon the latter having been pressed, and for comparing the result of such measurement with a pre-set value.

6. Method for grinding compression springs, and carried out with a machine according to any of the preceding claims 1 to 5, **characterized in that** the springs to be processed are successively:

- inserted in said discoid turning table,
- automatically transferred to said first grinding station (2), within the grinding wheels (6A, 6B) of said first pair of grinding wheels,
- ground by said two first grinding wheels,
- transferred by said discoid table to said second grinding station (2), within the two grinding wheels (7A, 7B) of said second pair of grinding wheels,
- ground by said two second grinding wheels.

7. Method according to claim 6, **characterized in that,** after grinding in said first grinding station, and prior to grinding in said second grinding station, said machine successively performs following operations:

- the discoid table is stopped when a spring whatsoever comes to be positioned in said pressing station (10),
- a pressing member (13) is lowered to press, i. e. pack the spring,
- said pressing member is raised.

8. Method according to claim 7, **characterized in that**, upon said pressing member having been raised, said machine performs following additional operations:

- the length of the spring is measured,
- the measured length is compared with a pre-set reference value,
- if said comparison finds that the measured length of the spring exceeds said pre-set reference value, said discoid table is caused to rotate further to bring the spring being processed under a next pressing station (11),
- the spring is caused to undergo a second pressing carried out according to the preceding claim 7.

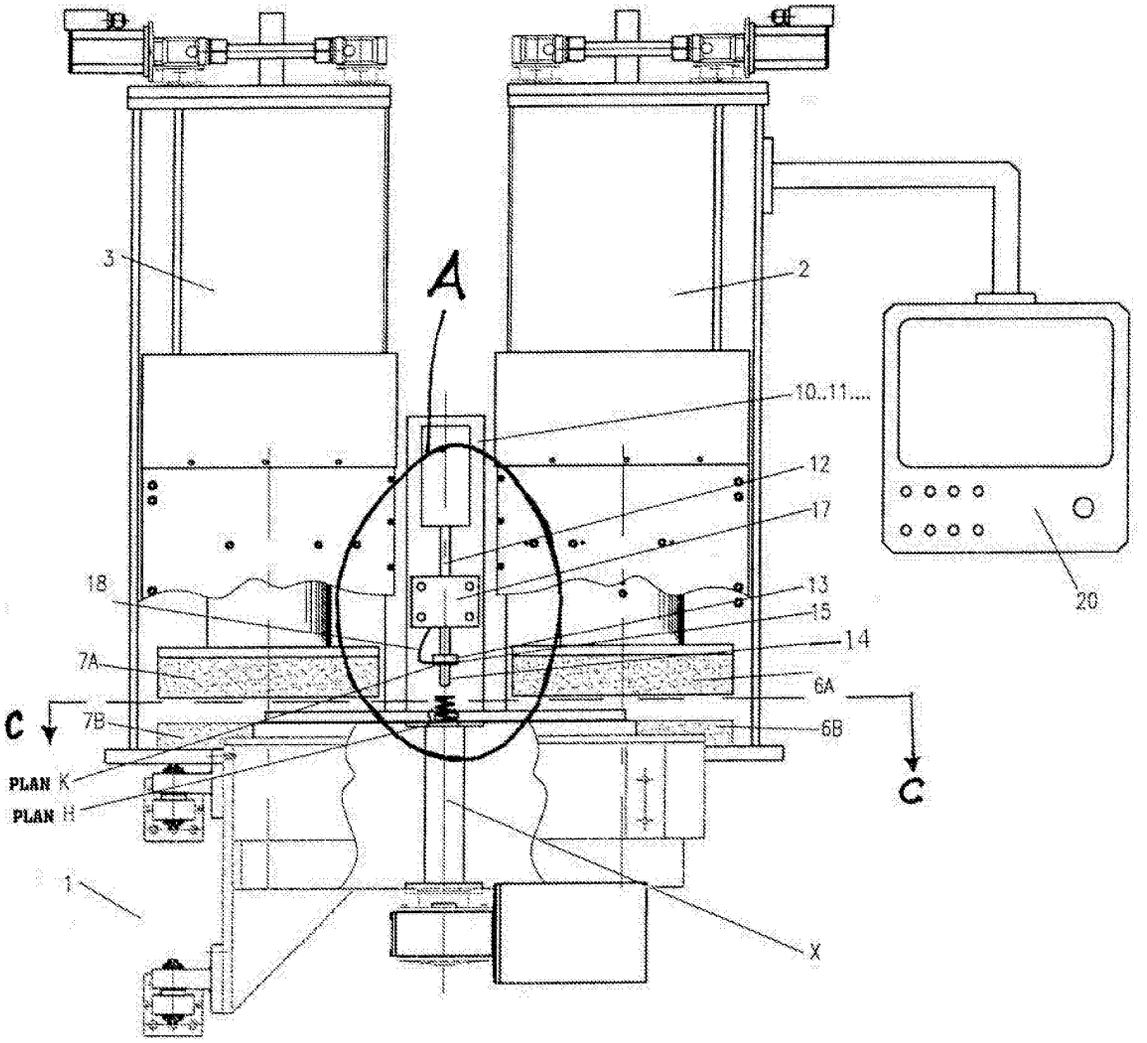

FIG. 1

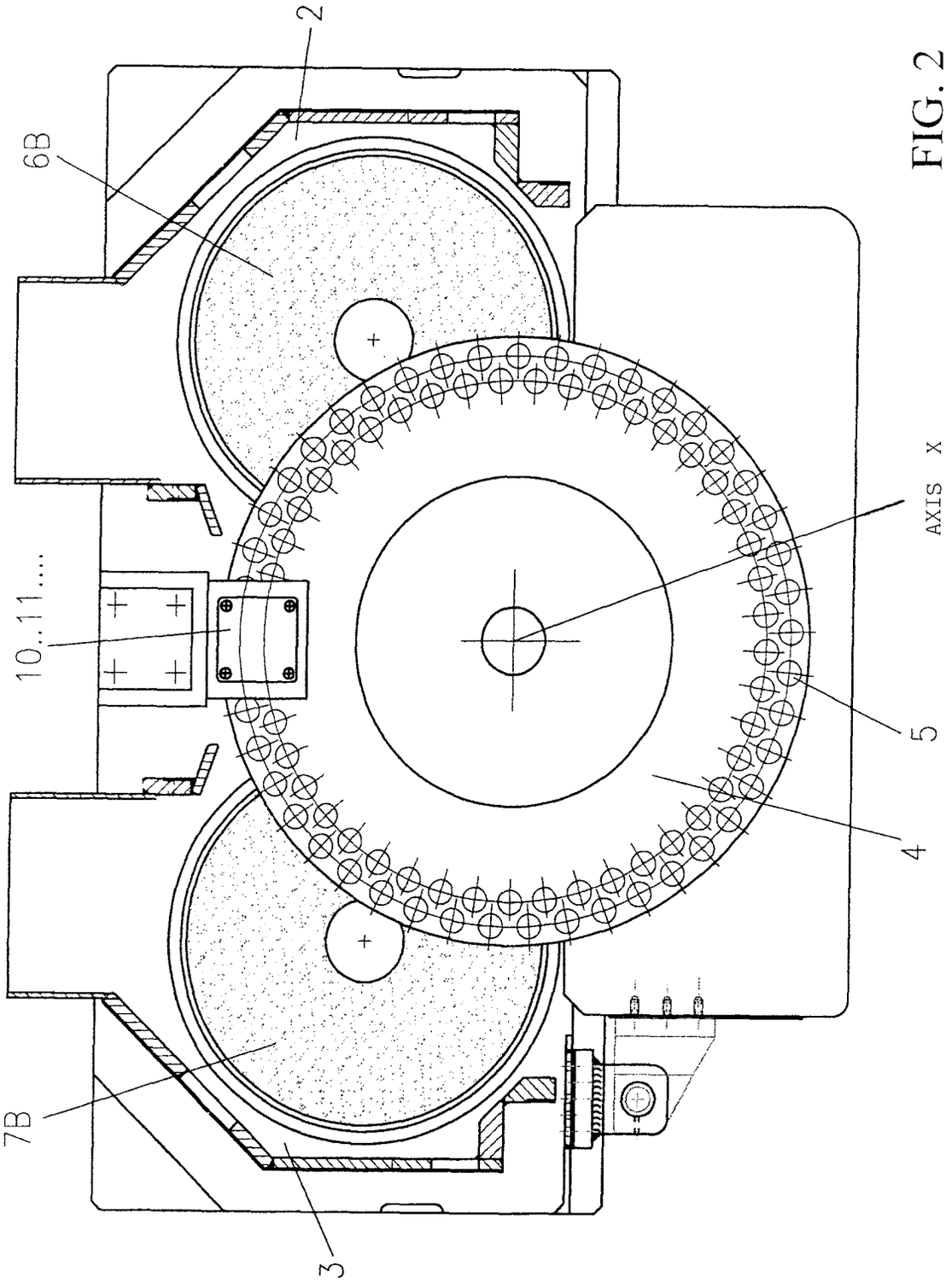

FIG. 2

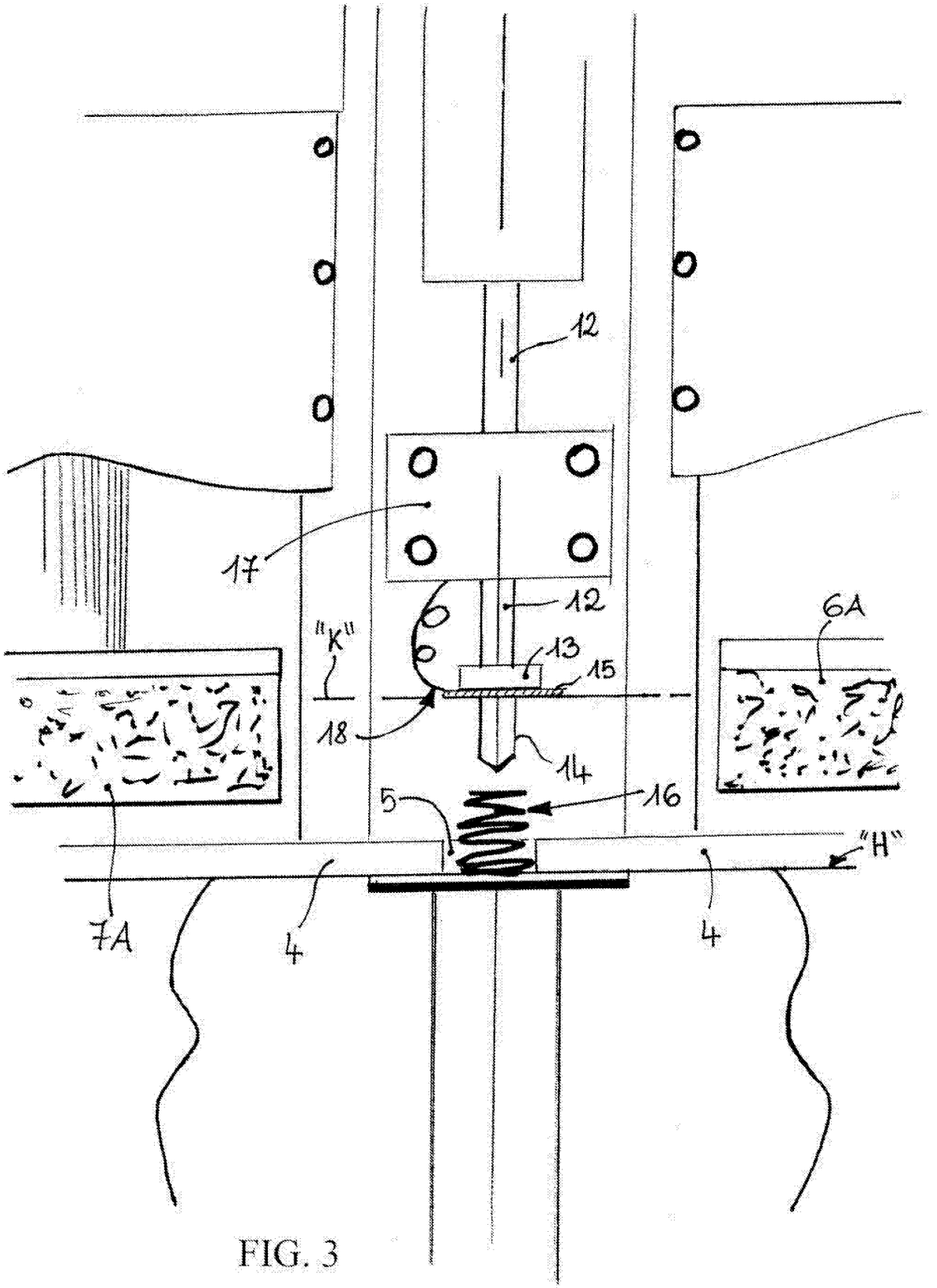

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 4361

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 November 2004	Koller, S

CATEGORY OF CITED DOCUMENTS

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