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(54) **Grinding device and use of same grinding device for rectifying cylindrical items, apparatus and method for rectifying cylindrical items**

Schleifgerät, dessen Anwendung zum Schleifen von zylindrischen Gegenständen , Vorrichtung und Verfahren zum Schleifen von zylindrischen Gegenständen

Dispositif de meulage, son utilisation pour meuler des objets cylindriques, machine et procédé pour meuler des objets cylindriques

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Description

[0001] The present invention relates to a method for grinding cylindrical items made of hard metal material.

[0002] The present invention falls within the industrial field concerned with surface working of cylindrical items such as cylindrical tools to be subsequently used in high speed machine tools, and it is in particular directed to the sector in which high-accuracy machining operations are carried out by material removal, such as grinding, lapping, and/or similar surface-finish working operations on cylindrical metal items.

[0003] It is known that grinding of cylindrical metal items like the above mentioned ones is generally carried out by means of grinding apparatus provided with suitable abrasive grinding devices capable of acting on a surface of the cylindrical item under working to remove a predetermined surface layer therefrom in order to reach a satisfactory finishing degree adapted for the cylindrical item itself.

[0004] In more detail, grinding apparatus normally used currently involve a working station at which a corresponding grinding device such as a grinding wheel suitably driven in rotation around a longitudinal axis thereof is brought into direct contact with the outer surface of the cylindrical item which too is movable in rotation around a respective longitudinal axis.

[0005] During working, the cylindrical item is axially translated relative to the grinding wheel in such a manner that the whole axial extension of the item itself is machined and the whole outer surface of said item is concerned.

[0006] In detail, the grinding wheel currently used for machining cylindrical metal items consists of a cylindrical support core covered with an outer layer of abrasive material. The outer layer of abrasive material is subjected to wear as the grinding wheel is used during surface machining of the cylindrical items. When the abrasive outer layer is worn out, the grinding wheel is readily replaced with another grinding wheel similar to the preceding one and unimpaired.

[0007] Obviously, due to the high angular speed to which both the grinding wheel and the cylindrical item under working are submitted and due to the persistent and prolonged friction between them, as required for achieving an optimal grinding quality, the grinding wheel and cylindrical item are subjected to too much heating. This tendency is however counteracted by a continuous supply of one or more cooling fluids constantly impinging on the parts in direct contact thereby maintaining them to a temperature suitable for the working operation being carried out.

[0008] While present grinding apparatus and devices enable surface finishing of cylindrical items with satisfactory qualitative results, the Applicant has found that the known art has some drawbacks and can be further improved under different points of view. In particular, the Applicant has found that the quality and finishing degree of the cylindrical items under working can be greatly improved by an excellent grinding of the outer surface of said workpieces.

[0009] In addition, it has been also found that cooling of the mutually-contacting parts of the rectifying device utilised and the cylindrical item under working can be optimised by increasing the efficiency of the cooling fluids used; at the same time too much waste of said fluids can be avoided, which use usually affects the overall production costs.

[0010] It is also known from document US 4341532 a laminated rotary grinder including a plurality of thin grinding stone discs laminated together in an axial direction wherein the thickness of each of the discs is in the range of 1 to 10 mm, the width of each space between each of the discs is within the range of 0,05 to 4 mm. The discs are wholly made of abrasive material and all present a central shaft opening. A method of using such a device is also shown in this document.

[0011] It is a main aim of the present invention to solve the problems found in the known art by proposing a high-quality grinding operation. It is a further aim of the invention to make available a grinding wheel that has an optimal sharpness (thus increasing the production rates) and does not give rise to overheating problems in the regions under working, while at the same time enabling optimisation of the cooling fluids and reduction of waste.

[0012] The foregoing and further aims that will become more apparent in the course of the following description are substantially achieved by a method of grinding cylindrical items of hard metal material, comprising the features set out in claim 1.

[0013] Further features and advantages will become more apparent from the detailed description of a preferred embodiment relating to a method of grinding a cylindrical item of hard metal material, in accordance with the present invention. This description will be set out hereinafter with reference to the accompanying drawings, in which:

- Fig. 1 diagrammatically shows a grinding device;
- Fig. 2 shows the device in Fig. 1 seen in section; and
- Fig. 3 diagrammatically shows a machine for grinding cylindrical items.

[0014] With reference to the drawings, generally denoted at 1 is a grinding device for cylindrical items 2 in particular made of metal and preferably hard metal material, such as cylindrical tools designed for use in high-speed machine tools and other similar apparatus. In particular, as shown in Figs. 1 and 2, the grinding device 1 comprises at least one first substantially-cylindrical abrasive body 4 having at least one respective abrasive surface 4a set to act, under operating conditions, on a surface of the cylindrical item 2 to remove a predetermined surface layer therefrom. Still with reference to Figs. 1 and 2, the grinding device 1 further comprises at least one second abrasive body 5, of substantially cylindrical shape

as well, having a respective circumferential abrasive surface 5a set to act, under operating conditions, on a surface of the cylindrical body 2 under working, to cooperate with the first cylindrical abrasive body 4 in removing the predetermined surface layer of the cylindrical item 2. Advantageously, the grinding device 1 also comprises at least one intermediate element 6 interposed between the first and second cylindrical abrasive bodies 4, 5 to axially space out said bodies a predetermined amount (δ) apart.

[0015] In detail, each cylindrical abrasive body 4, 5 has a support core 4b, 4c that is substantially cylindrical and preferably made of high tensile steel, and at least one outer layer 4c, 5c for material removal, made of abrasive material, preferably diamond material, such as industrial diamond and/or powder metal alloys. The cylindrical support core 4b, 5b of each cylindrical abrasive body 4, 5, depending on the construction requirements of the grinding apparatus 3, can have a central through opening 4d, 5d axially expending in such a manner that engagement on a possible rotating shaft 7 of apparatus 3 is allowed. The outer layer 4c, 5c for material removal, seen in cross section has a substantially ring- or crown-shaped conformation the outer peripheral region of which defines the abrasive circumferential surface 4a, 5a of the respective cylindrical abrasive body 4, 5, while the inner peripheral region gives rise to engagement of the outer removal layer 4c, 5c with the respective cylindrical support core 4b, 5b.

[0016] As shown in Figs. 1 and 2, the intermediate element 6, preferably of cylindrical conformation, has a smaller radial bulkiness than the maximum diameter of at least one of the provided cylindrical abrasive bodies 4, 5. In particular, the radial or diametrical bulkiness of the intermediate element 6 is smaller than the maximum diameter of the cylindrical support core 4b, 5b of the cylindrical abrasive bodies 4, 5 to such an extent that at least one undercut is defined, together with the respective cylindrical abrasive body 4, 5, also in a condition of full wear of the respective outer removal layer 4c, 5c. Preferably, the radial or diametrical bulkiness of the intermediate element 6 is smaller than the maximum diameter of the support core 4b, 5b of all the cylindrical abrasive bodies 4, 5 forming the grinding wheel. In this way, the intermediate element 6 together with the cylindrical abrasive bodies 4, 5, defines at least one circumferential cooling groove 6a such set that, under operating conditions, it faces the cylindrical item 2 to enable at least one cooling fluid to act between the cylindrical abrasive bodies 4, 5, intermediate element 6 and cylindrical item 2, so as to suitably cool them.

[0017] In the embodiment shown in Figs. 1 and 2, the grinding device 1 advantageously contemplates the presence of a plurality of cylindrical abrasive bodies 4, 5, 8 and a plurality of intermediate elements 6 aligned in coaxial relationship along a respective longitudinal common axis "X". The intermediate elements 6 are preferably alternated with the cylindrical abrasive bodies 4, 5, 8 to define a series of circumferential cooling grooves 6a such set that, under operating conditions, they face the cylindrical item under working. The size difference between the intermediate elements 6 and cylindrical abrasive bodies 4, 5, 8 gives the grinding device 1 an overall structure that, in longitudinal section, appears substantially indented. In this case each tooth is defined by the respective cylindrical abrasive body 4, 5, 8 while the space between adjacent teeth is defined by the circumferential cooling grooves 6a.

[0018] Still with reference to Figs. 1 and 2, the cylindrical abrasive bodies 4, 5, 8 are preferably identical and have the same axial and diametrical sizes. However, for particular applications or specific working operations on the cylindrical items 2, the cylindrical abrasive bodies 4, 5, 8 may also have different structural features. As shown in the accompanying figures, and for illustration convenience, the cylindrical abrasive bodies 8 too are provided with respective reference numerals 8a, 8b, 8c identifying the circumferential abrasive surfaces, cylindrical support cores and corresponding outer layers for material removal, respectively.

[0019] Preferably, the intermediate elements 6 too are substantially identical and consequently, together with the cylindrical abrasive bodies 4, 5, 8, they define a series of cooling grooves 6a that are substantially identical with each other.

[0020] Advantageously, the cylindrical bodies 4, 5, 8 and corresponding intermediate elements 6 are rigidly engaged to define a single structure 9 in the form of rings. In other words, the cylindrical abrasive bodies 4, 5, 8 and intermediate elements 6 are movable in rotation integral with each other, around the common longitudinal axis "X" and they all rotate at the same angular speed and in the same rotation direction.

[0021] Obviously, a structure like the one described offers a great number of advantages, such as possibility of assembling and disassembling the grinding device 1 depending on the features of the cylindrical item 2 under working, use of the components presently on the market without necessarily being obliged to fully plan and make an article of this kind, and also interchangeability of the different elements based both on production requirements and/or on wear of some parts.

[0022] As shown in Fig. 3, the grinding device 1 is mounted on said grinding apparatus 3 at a working station 10 of said apparatus suitably equipped with adapted supports for movably carrying both the grinding device 1 in use and the cylindrical item 2 to be ground and also equipped with suitable movement means to drive the grinding device 1 in rotation around the longitudinal axis "X" thereof and the cylindrical item 2 around a longitudinal axis "Y" thereof. The movement means is further able to relatively move the grinding device 1 and cylindrical item 2 between an operating condition at which the grinding device 1 acts on the surface of the cylindrical item 2, and a non-operating condition at which they keep substantially spaced apart, i.e. do not come into mutual contact.

[0023] In order to counteract temperature rising both

in the grinding device 1 and in the cylindrical item 2, the apparatus further comprises, in the working station 10, suitable cooling means 11 capable of delivering the above mentioned cooling fluid. The cooling fluid is preferably directly delivered onto the overheated parts by externally impinging on the latter and penetrating between the same by means of the circumferential cooling grooves 6a of the grinding device 1.

[0024] First of all, it is necessary to assemble and form the grinding device 1 so that it may be subsequently mounted on the respective apparatus 3 for grinding of cylindrical items 2. Assembling of the grinding device 1 takes place by arranging at least the first and second cylindrical abrasive bodies 4, 5 according to predetermined positions (generally there will be a plurality of cylindrical bodies) and subsequently spacing them apart through interposition of the respective intermediate element 6.

[0025] The first and second cylindrical abrasive bodies 4, 5 are consequently axially spaced out. The same operation is also carried out, by turns, on the other cylindrical abrasive bodies 8 and the other intermediate elements 6 that will be necessary to constitute the grinding device 1. Union of the cylindrical abrasive bodies 4, 5, 8 and the intermediate elements 6 is preferably carried out in such a manner that all components are rigidly fastened to each other.

[0026] At this point the grinding device 1 is mounted on apparatus 3 at the working station 10 of the latter and subsequently driven in rotation about its longitudinal axis "X". Simultaneously or subsequently, the cylindrical item 2 too is located in the working station 10 of apparatus 3 to be driver in rotation around its longitudinal axis "Y".

[0027] The grinding device 1 is finally disposed in the operating condition and subsequently axially translated relative to the cylindrical item 2 at a predetermined advancing speed capable of ensuring full grinding of the cylindrical surface of the cylindrical item itself.

[0028] The invention achieves important advantages.

[0029] First of all, the ring structure 9 of the grinding device enables an excellent finishing of the cylindrical surface of the cylindrical items under working, thereby achieving a high quality degree, higher than when grinding is carried out by use of a classic grinding wheel.

[0030] Sharpness of the grinding wheel being the object of the invention is greater than in known devices, so that high production rates are allowed.

[0031] It is also to be added that the presence of a plurality of circumferential cooling seats enables a greater heat exchange between the cooling fluid supplied during working and the elements that are subject to strong temperature rises, such as the grinding device itself and the cylindrical item under working. In particular, the cooling fluid can penetrate into the circumferential cooling seats partly surrounding the cylindrical item under working and operating on a wider surface of the grinding device.

[0032] It will be also recognised that cooling optimisation allows an important amount of the delivered cooling fluid to be saved, which will result in a reduction in the overall production costs as far as grinding of cylindrical items is concerned.

Claims

1. A method of grinding a cylindrical item of hard metal material with a grinding device comprising:

- at least one first and one second cylindrical abrasive bodies (4, 5) having respective circumferential abrasive surfaces (4a, 5a) set to act, under operating conditions, on a surface of a cylindrical item (2) driven in rotation about a longitudinal axis ("X") thereof;
- at least one intermediate element (6) interposed between said first and second cylindrical abrasive bodies (4, 5), said intermediate element (6) axially spacing apart said circumferential abrasive surfaces (4a, 5a) of said cylindrical abrasive bodies (4, 5), the intermediate element (6) having a maximum radial bulkiness smaller than said maximum diameter of at least one of said cylindrical abrasive bodies (4, 5), each cylindrical abrasive body (4, 5) comprising a substantially cylindrical support core (4b, 5b) and at least one outer layer (4c, 5c) for maternal removal, made of abrasive material and engaged on said cylindrical core (4b, 5b), said intermediate element (6) having a maximum radial bulkiness smaller than, or at most as large as, the maximum diameter of the cylindrical support core (4b, 5b) of at least one of said cylindrical abrasive bodies (4, 5), the outer layer (4c, 5c), seen in cross section, having a substantially ring-shaped conformation the outer peripherical region of which defines the.abrasive circumferential surface (4a, 5a) of the respective cylindrical abrasive bodies (4, 5), while the inner peripheral region gives rise to engagement of the outer removal layer (4c, 5c) with the respective cylindrical support core (4b, 5b), the method comprising:

  - driving at least one cylindrical item (2) in rotation around a longitudinal axis ("Y") thereof;
  - driving a grinding device (1) in rotation around a longitudinal axis thereof ("X");
  - positioning said grinding device (1) relative to said cylindrical item (2) to a position suitable for grinding;
  - axially translating said grinding device (1) relative to the cylindrical item (2) at a predetermined advancing speed capable of ensuring full grinding of the cylindrical surface

of the cylindrical item

Patentansprüche

1. Verfahren zum Schleifen eines zylindrischen Gegenstandes aus Hartmetall mit einem Schleifgerät umfassend:

   - mindestens einen ersten und einen zweiten zylindrischen Schleifkörper (4, 5), die entsprechende Umfangsschleifflächen (4a, 5a) aufweisen, die unter Arbeitsbedingungen bereitgestellt sind, an einer Oberfläche eines zylindrischen Gegenstandes (2) zu wirken, der um eine Längsachse ("X") dessen drehbewegt wird;
   - mindestens ein Zwischenteil (6), das zwischen den ersten und zweiten Schleifkörpern (4, 5) zwischengeschaltet ist, wobei das Zwischenteil (6) die Umfangsschleifflächen (4a, 5a) der zylindrischen Schleifkörper (4, 5) axial beabstandet, und wobei das Zwischenteil (6) eine radiale Höchstraumbeanspruchung aufweist, die kleiner ist als der Höchstdurchmesser mindestens eines der zylindrischen Schleifkörper (4, 5), wobei jeder zylindrische Schleifkörper (4, 5) einen im wesentlichen zylindrischen Tragkern (4b, 5b) und mindestens eine äußere Schicht (4c, 5c) zur Materialabtragung umfasst, die aus Schleifmaterial besteht und mit dem zylindrischen Kern (4b, 5b) in Eingriff steht, wobei das Zwischenteil (6) eine radiale Höchstraumbeanspruchung aufweist, die kleiner oder höchstens gleich dem Höchstdurchmesser des zylindrischen Tragkerns (4b, 5b) mindestens eines der zylindrischen Schleifkörper (4, 5) ist, und wobei die äußere Schicht (4c, 5c) im Querschnitt betrachtet eine im wesentlichen ringförmige Ausbildung aufweist, deren äußerer Umfangsbereich die Umfangsschleiffläche (4a, 5a) der entsprechenden zylindrischen Schleifkörper (4, 5) festlegt, während der innere Umfangsbereich den Eingriff der äußeren Abtragsschicht (4c, 5c) mit dem entsprechenden zylindrischen Tragkern (4b, 5b) erzeugt, wobei das Verfahren umfasst:

     - Drehbewegen mindestens eines zylindrischen Gegenstandes (2) um eine Längsachse ("Y") dessen;
     - Drehbewegen eines Schleifgerätes (1) um eine Längsachse ("X") dessen;
     - Positionieren des Schleifgerätes (1) relativ zum zylindrischen Gegenstand (2) in einer zum Schleifen geeigneten Position;
     - axiales Verschieben des Schleifgerätes (1) relativ zum zylindrischen Gegenstand (2) mit einer vorbestimmten Vorrückgeschwindigkeit, die geeignet ist, um vollständiges Schleifen der zylindrischen Oberfläche des zylindrischen Gegenstandes sicherzustellen.

Revendications

1. Procédé de meulage d'un article cylindrique constitué d'un matériau métallique dur avec un dispositif de meulage comprenant :

   - au moins des premier et second corps abrasifs cylindriques (4, 5) ayant des surfaces abrasives circonférentielles respectives (4a, 5a) réglés pour agir, dans des conditions de fonctionnement, sur une surface d'un article cylindrique (2) entraîné en rotation autour d'un axe longitudinal (« X ») de celui-ci ;
   - au moins un élément intermédiaire (6) interposé entre lesdits premier et second corps abrasifs cylindriques (4, 5), ledit élément intermédiaire (6) espaçant axialement lesdites surfaces abrasives circonférentielles (4a, 5a) desdits corps abrasifs cylindriques (4, 5), l'élément intermédiaire (6) ayant une grosseur radiale maximale inférieure audit diamètre maximal d'au moins un desdits corps abrasifs cylindriques (4, 5), chaque corps abrasif cylindrique (4, 5) comprenant un noyau de support sensiblement cylindrique (4b, 5b) et au moins une couche externe (4c, 5c) pour le retrait de matériau, constituée d'un matériau abrasif et en prise sur le noyau cylindrique (4b, 5b), ledit élément intermédiaire (6) ayant une grosseur radiale maximale inférieure, ou au moins égale, au diamètre maximal du noyau du support cylindrique (4b, 5b) d'au moins un desdits corps abrasifs cylindriques (4, 5), la couche externe (4c, 5c), vue en coupe, ayant une conformation sensiblement annulaire dont la région périphérique externe définit la surface circonférentielle abrasive (4a, 5a) des corps abrasifs cylindriques respectifs (4, 5), tandis que la région périphérique interne donne lieu à une mise en prise de la couche externe de retrait (4c, 5c) avec le noyau de support cylindrique respectif (4b, 5b), le procédé comprenant :

     - l'entraînement d'au moins un article cylindrique (2) en rotation autour d'un axe longitudinal (« Y ») de celui-ci ;
     - l'entraînement d'un dispositif de meulage (1) en rotation autour d'un axe longitudinal de celui-ci (« X ») ;
     - le positionnement dudit dispositif de meulage (1) par rapport audit article cylindrique (2) à une position appropriée pour le meulage ;
     - la translation axiale du dispositif de meu-

lage (1) par rapport à l'axe cylindrique (2) à une vitesse de progression prédéterminée capable de garantir un meulage total de la surface cylindrique de l'article cylindrique.

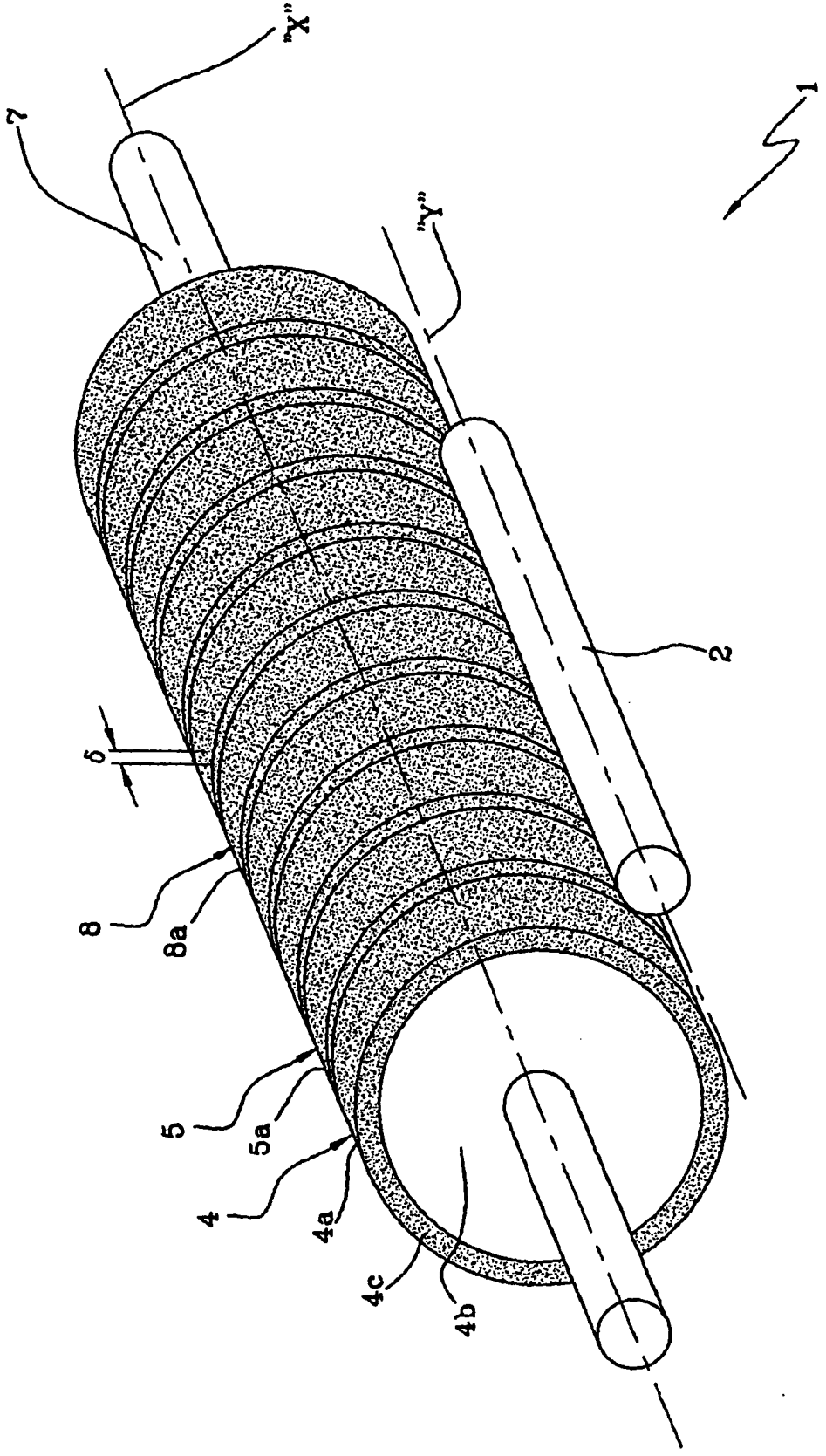

FIG 1

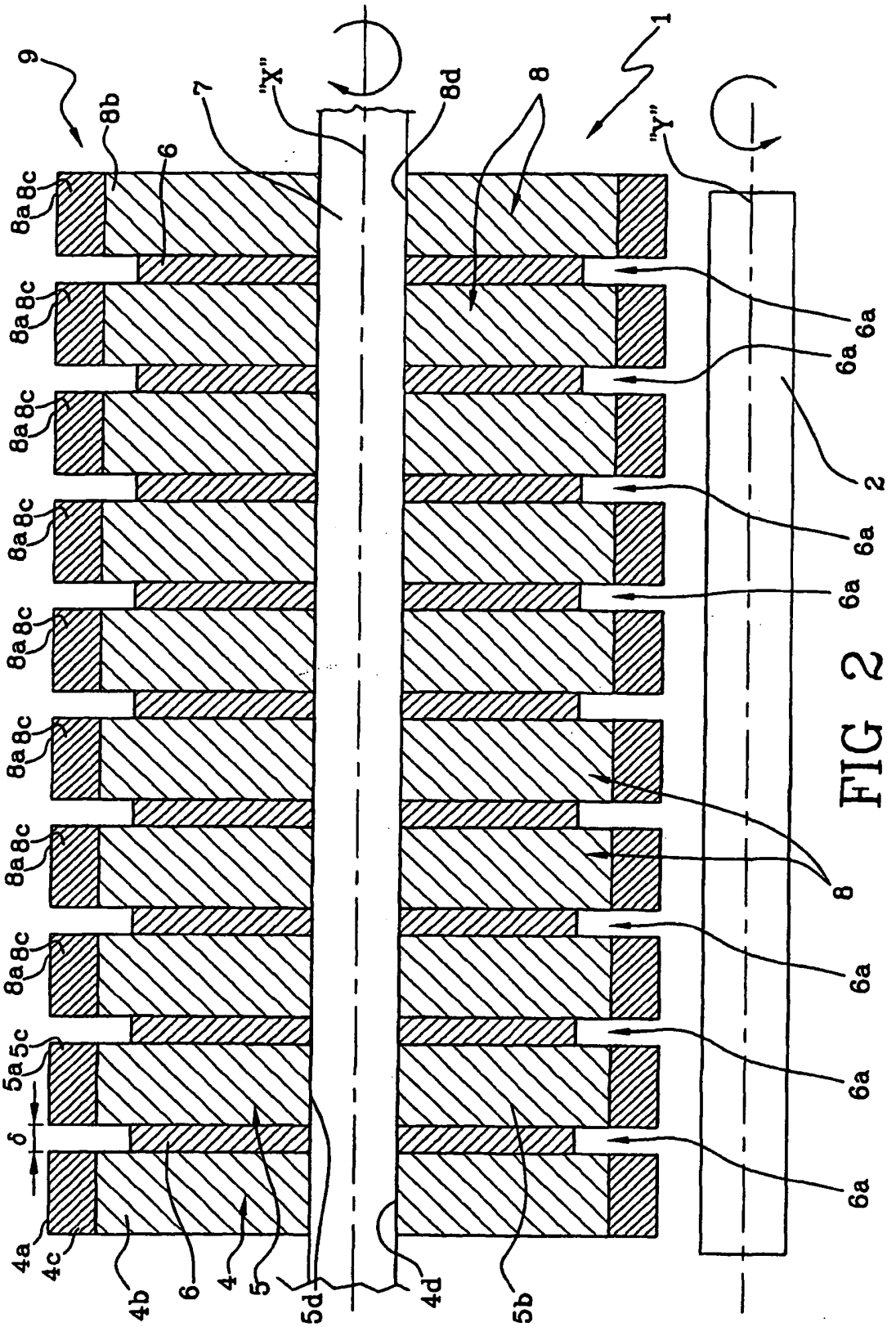

FIG 2

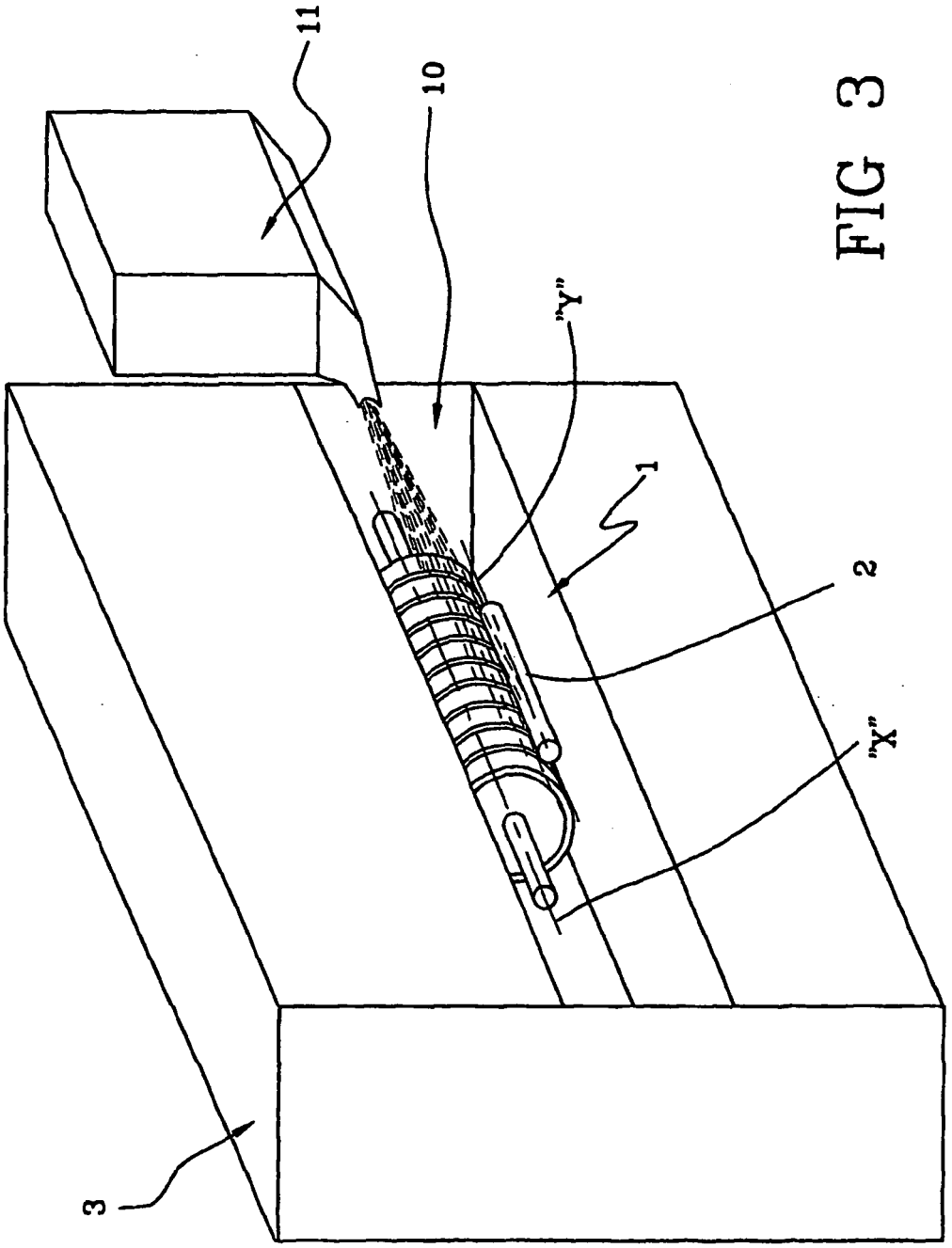

FIG 3

REFERENCES CITED IN THE DESCRIPTION

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