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(54) **Compacting Press**

Kompaktierpresse

Presse de compression

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(56) References cited:
**WO-A1-01/83135 US-A- 2 800 684
US-A- 2 867 844**

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Description

[0001] The present invention relates to a press for compacting metallic powders within a die of a particular shape, which is suitable to manufacture mechanical components.

[0002] The machining processes for which the compaction of metallic powders is used are casting (pressure die-casting) and sintering.

[0003] Casting requires the powders compacted inside the die to be brought to a temperature that is higher than their melting point for a time that is sufficient to ensure complete melting of the compacted mass.

[0004] Sintering is the operation by means of which metallic (or ceramic) powders are agglomerated, at temperatures lower than the melting point, by virtue of diffusion phenomena. It is performed by heating the powders (usually precompressed when cold) in furnaces that are generally of the tunnel type. During sintering, extremely low shrinkage is observed and the density of the resulting parts is always lower than the density that can be obtained by casting; with respect to casting, sintering has the advantage, which is substantial especially in the case of high-melting materials, of working at lower temperatures and of obtaining parts that have their finished dimensions.

[0005] Currently as shown in WO 01/83135, presses have a certain number of guiding bars, on which a containment rim supporting cross-member is fitted so that it can slide. Below the containment rim there is a lower plug, which is aligned with the lower opening of said containment rim, and an upper plug is arranged in an upper region.

[0006] Replacing the containment rim and the lower plug, for example to change the size of the mechanical part being made, entails extracting from the machine the entire die supporting assembly with the adapter that comprises the cross-member, the containment rim and a corresponding footing.

[0007] During reassembly of the assembly, it is almost impossible to provide perfect alignment between the containment rim and the upper plug, with the risk of friction between the surface of the containment rim and of the plug, with subsequent damage.

[0008] In order to obviate this drawback, a plurality of upper shafts have been used on which the plate to which the upper plug is coupled can slide, its end engaging slidably within respective cavities (without play) provided on the containment rim supporting cross-member. The presence of these shafts ensures the alignment of the upper plug with respect to the containment rim, but makes it awkward to access the machine for any operator who has to perform cleaning, maintenance or replacement of parts of the die.

[0009] The operations for assembling and disassembling the die supporting assembly are very complicated, due to the presence of the shafts, which must be fixed to the die supporting assembly so as to prevent it from

falling before it is possible to release said assembly from the press.

[0010] The vertical translational motion of the cross-member (and accordingly of the die) is allowed by way of the presence of a hydraulic piston or of another movement system arranged below the footing and centered with respect to it.

[0011] The presence of this piston entails a particularly complicated installation: it is necessary to prepare a special foundation, at the region where the press is installed, that is sufficient to accommodate the piston and the corresponding electrical and hydraulic circuits.

[0012] The aim of the present invention is to obviate the described drawbacks and to meet the mentioned requirements, by providing a compaction press in which the operations for removing and replacing the die supporting assembly (known as "adapter" in the jargon) are simplified and in which the alignment between the containment rim of the die and the upper plug is ensured at each assembly.

[0013] Within this aim, an object of the present invention is to provide a structure that is compact and does not require the provision of receptacles in the flooring or other foundation work.

[0014] Another object of the present invention is to provide a press that has a simple structure, is relatively easy to provide in practice, safe in use, effective in operation, and has a relatively low cost.

[0015] This aim and these and other objects that will become better apparent hereinafter are achieved by the present compacting press, of the type that comprises one or more pairs of upper and lower plugs, a die supporting assembly, constituted by a cross-member that can perform a translational motion along appropriately provided guides fixed to the structure of the press, a die supporting containment rim and a footing, and the corresponding movement means, characterized in that guiding columns are distributed substantially along the external perimeter of the press and are fixed to the same structure, said columns guiding both said cross-member and an upper plate for accommodating the upper plug, and in that said cross-member has a frustum-shaped receptacle, whose shape and dimensions are complementary to those of the die supporting containment rim, the containment rim and the receptacle being mutually associable, in coaxiality conditions imposed by the taper, by virtue of removable coupling elements when they are forced one inside the other.

[0016] Further characteristics and advantages of the present invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of a compaction press, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a front view, with some areas shown in cross-section, of a press according to the invention; Figure 2 is a side view of a press according to the

invention;

Figure 3 is a top view of a press according to the invention;

Figure 4 is a plan view of a cross-member of a press according to the invention;

Figure 5 is a partially sectional front view of a die supporting assembly of a press according to the invention.

[0017] With reference to the figures, the reference numeral 1 generally designates a compaction press.

[0018] The press 1 comprises a supporting structure 2, which rests (and is optionally also fixed) on the floor; a movable arm 3 for supporting a management and control unit 4 is associated with the structure 2.

[0019] In its central portion, the press 1 is provided with one or more pairs of plugs, an upper plug 5 and a lower plug 6, and a die supporting assembly 7 constituted by a cross-member 8, which can perform a translational motion along four guiding columns 9, which are fixed to the structure 1 and are distributed substantially along the external perimeter of the cross-member 8 proximate to the corners, by a containment rim supporting table 10, and by a footing 11.

[0020] A plate 12 for accommodating the upper plug 5 is also guided along the columns 9.

[0021] The cross-member 8 is provided with a frustum-shaped receptacle 13, whose shape and dimensions are complementary to the containment rim supporting table 10, said containment rim supporting table and said receptacle being mutually associable, in coaxial conditions imposed by the taper, by bolting when they are forced one inside to the other. The frustum-shaped receptacle 13 and the containment rim supporting table 10 have an angle comprised between two diametrically opposite generatrices that span substantially 30°.

[0022] The cross-member 8 can perform a vertical translational motion by means of two hydraulic pistons 14, which are arranged in diametrically opposite positions with respect to the receptacle 13 and have an upper movable end that is rigidly coupled to the lower face of the cross-member 8 and a lower end that is rigidly coupled to the supporting structure 2.

[0023] The pistons 14 are actuated simultaneously and are mutually controlled, in terms of position and speed, for the correct translational motion of the cross-member 8: any advancement of one with respect to the other would in fact entail the tilting of the cross-member, with consequent malfunction of the press 1 and misalignment between the containment rim 18 and the plugs 5 and 6.

[0024] The cross-member 8 is constituted by a metallic element, which has a substantially rectangular cross-section with four external arms 15, which protrude substantially from the corners along the directions of the diagonals, each arm 15 having an end hole 16 which accommodates, even indirectly, a respective column 9; each end hole can in fact accommodate stably a bush 17, which can slide on the respective column 9.

[0025] The plate 12 is shaped like the cross-member 9 and has respective arms with end holes with which the bushes are associated, said bushes being able to slide on the respective columns 9.

[0026] The provision of the cross-member 8 and of the plate 12 with arms that protrude diagonally is due to the need to maximize their mutual distance, so as to ensure that if a small mutual misalignment thereof occurs (due to the arrangement of one arm higher or lower than the others), this leads in the central region (which corresponds to the plugs 5 and 6 and to the containment rim 18) to the smallest coaxiality error in order to ensure the correct action of the plugs 5 and 6 on the containment rim 18.

[0027] The containment rim 18 is mounted on the containment rim supporting table 10 so that the upper end protrudes slightly from the upper face of the containment rim supporting table 10.

[0028] The cross-member 8 supports a fixed lamina 20, which is mounted on top, and a removable lamina 21, which is fixed above the upper end of the containment rim 18 and protrudes from the containment rim supporting table 10: the fixed lamina 20 and the movable lamina 21 have the same thickness.

[0029] A cup 22 for feeding the powders to the die receives the powders from a hopper 23 through a duct 24; the cup 22 can slide on the upper surface of the laminas 20 and 21, and in the inactive position rests exclusively on the fixed lamina 20 and can move by way of the action of a motor 25 from said inactive position to the position for releasing the powders that corresponds to its overlap on the upper opening of the containment rim 18. In a lower region, the cup 22 has scrapers, which ensure that in sliding on the surface of the laminas 20 and 21 it does not scatter metallic powders thereon; gliding of the cup 22 on the laminas 20 and 21 is ensured by the fact that the laminas have the same thickness and therefore there are no discontinuities in the transition from one to the other.

[0030] With this new machine architecture, if it is necessary to replace the containment rim 18, it is necessary to lift the cross-member 8 with respect to the upper end of the lower plug 6 in order to space it from said end by an extent that is greater than the height of the containment rim supporting table 10.

[0031] Once this workspace has been created, it is necessary to free the rim supporting table 10 from the cross-member 8, subsequently removing the die supporting assembly from the press 1.

[0032] In a convenient position, for example on a working surface that is adjacent to the installation area of the press 1, it is therefore possible to replace the containment rim 18 in the containment rim supporting table 10.

[0033] The die supporting assembly, with the new containment rim 18 mounted thereon, can then be arranged again below the cross-member 8, making the cross-member 8 descend until the seat 13 is forced onto the rim supporting table 10, so that their taper forces their

mutual alignment. At this point, it is possible to fix the containment rim supporting table 10 by bolting to the cross-member 8.

[0034] Since the cross-member 8 and the plate 12 are constantly guided on the fixed columns 9 and are therefore perfectly aligned, and by ensuring, by way of the conical coupling, a perfect alignment between the receptacle 13 and the rim supporting table 10, the containment rim 18 is perfectly aligned with the upper plug 5 and with the lower plug 6. This ensures that the pressing operations are performed with maximum efficiency, obtaining correctly formed products and avoiding the risk of damaging the mating parts due to incorrect alignments.

[0035] Throughout the operations, the cup for feeding the powders 22 to the containment rim 18 continues to rest on the fixed lamina 20 in the inactive position: advantageously with respect to conventional presses, it is not necessary to disassemble the cup 22 as well, an operation which requires interrupting the duct 24 to prevent the outflow of the powders.

[0036] As a whole, therefore, the operations for replacing the die with this machine architecture are distinctly simpler and ensure a perfect assembly of the parts besides ensuring that there is no dispersion of material.

[0037] The presence of the two hydraulic pistons 14 arranged on opposite sides of the lower plug 6 considerably reduces the vertical space occupation of the press 1 with respect to a conventional one, which by adopting a single piston had to arrange it at the center and below the lower plug 6, requiring the presence of a foundation excavation below the press 1 in order to ensure its accommodation.

[0038] It has thus been shown that the invention achieves the intended aim and objects.

[0039] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0040] All the details may further be replaced with other technically equivalent ones.

[0041] In the described embodiments individual characteristics, given in relation to specific examples, may actually be interchanged with other different characteristics that exist in other embodiments.

[0042] Moreover, it is noted that anything found to be already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

[0043] In practice, the materials used, as well as the shapes and the dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

[0044] 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 interpretation of each element identified by way of example by such reference signs.

Claims

1. A compacting press, of the type that comprises at least one pair of plugs, an upper one (5) and a lower one (6), a die supporting assembly (7), constituted by a cross-member (8) that can perform a translational motion along appropriately provided guides, fixed to the structure of the press (1), a containment rim supporting table (10) and a footing (11), and the corresponding movement means, **characterized in that** guiding columns (9) fixed to the structure (1) are distributed substantially along the external perimeter of the cross-member (8), said columns (9) guiding both said cross-member (8) and an upper plate (12) for accommodating the upper plug (5), and **in that** said cross-member (8) has a frustum-shaped receptacle (13), whose shape and dimensions are complementary to those of the containment rim supporting table (10), said table (10) and said receptacle (13) being mutually associable, in coaxiality conditions imposed by the taper, by way of removable coupling elements when they are forced one inside the other.
2. The press according to claim 1, **characterized in that** said means for moving the cross-member (8) comprise two hydraulic pistons (14), in which the upper end is rigidly coupled to the lower face of the cross-member (8) and the lower end is rigidly coupled to the supporting structure (2).
3. The press according to claim 1, **characterized in that** said guiding columns (9) are four, are fixed to the press (1), and are arranged approximate to the corners of said cross-member (8).
4. The press according to claims 1 and 3, **characterized in that** said cross-member (8) is constituted by a metallic element that has a substantially rectangular cross-section with four external arms (15) that branch out in symmetrical directions with respect to the centre of the rectangle, each arm (15) being provided with an end hole (16) in which a respective column (9) is accommodated even indirectly.
5. The press according to claim 4, **characterized in that** each one of said end holes (16) accommodates a bush (17), which is rigidly coupled and is engaged on the column (9) so that it can slide.
6. The press according to claims 1 and 3, **characterized in that** said upper plate (12) for accommodating the upper plug (5) has a substantially rectangular cross-section, with four external arms that protrude in symmetrical directions with respect to the centre of the rectangle, each arm being provided with an end hole which internally accommodates, even indirectly, a respective column (9).

7. The press according to claim 6, **characterized in that** each one of said end holes accommodates a rigidly coupled bush, in which said column (9) can slide.
8. The press according to claim 7, **characterized in that** said cross-member (8) rigidly supports, in an upper region, a fixed lamina (20) and a removable lamina (21), which is fixed above the upper end of the containment rim (18) and protrudes from the containment rim supporting table (10), said fixed lamina (20) and said movable lamina (21) having the same thickness.
9. The press according to claim 8, **characterized in that** a cup (22) for feeding the powders to the die can slide on the upper surface of said lamina (20, 21) and rests, in the inactive position, exclusively on said fixed lamina (20).
10. A method for replacing a die supporting assembly in a press (1), according to one or more of the preceding claims, comprising the steps of: lifting said cross-member (8) with respect to the upper end of said lower plug (6) until it is spaced from said end by an extent that is greater than the height of the rim supporting table (10); freeing from the coupling elements said rim supporting table (10) from said cross-member (8), removing the entire die supporting assembly from the press (1); replacing said containment rim (18) in the rim supporting table (10); reinserting the die supporting assembly (7) in the press (1); arranging again the rim supporting table (10) below the cross-member (8); causing the descent of the cross-member (8) until the receptacle (13) is forced onto the rim supporting table (10), ensuring alignment by way of the conical mating; and fixing the containment rim supporting table (10) by means of said elements for coupling to the cross-member (8).
11. The method according to claim 12, **characterized in that** during all the operations the cup for feeding the powders (22) to the die remains in contact against said fixed lamina (20) in the inactive position.

Patentansprüche

1. Verdichtungspressen der Art, die mindestens ein Paar von Stopfen, einen oberen (5) und einen unteren (6), eine Matrizenträgeranordnung (7), bestehend aus einer Traverse (8), die eine Verschiebewegung entlang entsprechend bereitgestellter Führungen ausführen kann und die an der Struktur der Presse (1) befestigt ist, einen Einhausungsrandträgertisch (10) und eine Basis (11) sowie die entsprechenden Bewegungsmittel umfasst, **dadurch gekennzeichnet, dass** an der Struktur (1) befestigte

Führungssäulen (9) im Wesentlichen entlang des äußeren Umfangs der Traverse (8) verteilt sind, wobei die Säulen (9) sowohl die Traverse (8) als auch eine obere Platte (12) zur Aufnahme des oberen Stopfens (5) führen, und dadurch, dass die Traverse (8) eine kegelstumpfförmige Aufnahme (13) aufweist, deren Form und Abmessungen zu denen des Einhausungsrandträgertisches (10) komplementär sind, wobei der Tisch (10) und die Aufnahme (13) in von dem Kegel erzwungenen Koaxialitätszuständen mit Hilfe abnehmbarer Kopplungselemente miteinander verbunden werden können, wenn sie ineinander gedrückt sind.

2. Presse nach Anspruch 1, **dadurch gekennzeichnet, dass** die Mittel zum Bewegen der Traverse (8) zwei hydraulische Kolben (14) umfassen, bei denen das obere Ende starr mit der Unterseite der Traverse (8) gekoppelt ist und das untere Ende starr mit der Trägerstruktur (2) gekoppelt ist.
3. Presse nach Anspruch 1, **dadurch gekennzeichnet, dass** die Führungssäulen (9) vier an der Zahl sind, sie an der Presse (1) befestigt und in der Nähe der Ecken der Traverse (8) angeordnet sind.
4. Presse nach Anspruch 1 und 3, **dadurch gekennzeichnet, dass** die Traverse (8) aus einem Metall-element besteht, das einen im Wesentlichen rechteckigen Querschnitt mit vier äußeren Armen (15) aufweist, die in Bezug auf den Mittelpunkt des Rechtecks in symmetrischen Richtungen abzweigen, wobei jeder Arm (15) mit einem Endloch (16) versehen ist, in das jeweils eine Säule (9), auch indirekt, aufgenommen ist.
5. Presse nach Anspruch 4, **dadurch gekennzeichnet, dass** jedes der Endlöcher (16) eine Buchse (17) aufnimmt, die starr gekoppelt ist und die formschlüssig an der Säule (9) liegt, sodass sie gleiten kann.
6. Presse nach Anspruch 1 und 3, **dadurch gekennzeichnet, dass** die obere Platte (12) zur Aufnahme des oberen Stopfens (5) einen im Wesentlichen rechteckigen Querschnitt aufweist, mit vier äußeren Armen, die in Bezug auf den Mittelpunkt des Rechtecks in symmetrischen Richtungen hervorstecken, wobei jeder Arm mit einem Endloch versehen ist, innerhalb dessen jeweils eine Säule (9), auch indirekt, aufgenommen ist.
7. Presse nach Anspruch 6, **dadurch gekennzeichnet, dass** jedes der Endlöcher eine starr gekoppelte Buchse aufnimmt, in der die Säule (9) gleiten kann.
8. Presse nach Anspruch 7, **dadurch gekennzeichnet, dass** die Traverse (8) in einem oberen Bereich starr ein befestigtes Blättchen (20) und ein abnehm-

bares Blättchen (21), das über dem oberen Ende des Einhausungsrandes (18) befestigt ist und über den Einhausungsrandträgertisch (10) hinausragt, trägt, wobei das befestigte Blättchen (20) und das bewegliche Blättchen (21) die gleiche Dicke aufweisen.

9. Presse nach Anspruch 8, **dadurch gekennzeichnet, dass** ein Napf (22) zum Einfüllen der Pulver in die Matrize auf der Oberseite der Blättchen (20, 21) gleiten kann und in der inaktiven Position ausschließlich auf dem befestigten Blättchen (20) aufliegt.

10. Verfahren zum Auswechseln einer Matrizenträgeranordnung in einer Presse (1) nach einem oder mehreren der vorhergehenden Ansprüche, folgende Schritte umfassend:

Anheben der Traverse (8) in Bezug auf das obere Ende des unteren Stopfens (6), bis sie von diesem Ende mit einer Länge beabstandet ist, die größer als die Höhe des Randträgertisches (10) ist, Lösen des Randträgertisches (10) von der Traverse (8) über die Kopplungselemente, Abnehmen der gesamten Matrizenträgeranordnung von der Presse (1), Austauschen des Einhausungsrandes (18) im Einhausungsrandträgertisch (10), erneutes Einsetzen der Matrizenträgeranordnung (7) in die Presse (1), erneutes Anordnen des Randträgertisches (10) unterhalb der Traverse (8), Herbeiführen des Absenkens der Traverse (8), bis die Aufnahme (13) auf den Randträgertisch (10) gedrückt wird, Sicherstellen der Ausrichtung mit Hilfe des konischen Formschlusses und Befestigen des Einhausungsrandträgertisches (10) mit Hilfe der Elemente zum Koppeln mit der Traverse (8).

11. Verfahren nach Anspruch 12, **dadurch gekennzeichnet, dass** während all der Vorgänge der Napf zum Einfüllen der Pulver (22) in die Matrize in der inaktiven Position in Kontakt mit dem befestigten Blättchen (20) bleibt.

Revendications

1. Presse de compactage d'un type comprenant au moins une paire de bouchons, soit un bouchon supérieur (5) et un bouchon inférieur (6), un assemblage de support de matrice (7) constitué par une traverse (8) qui peut effectuer un déplacement en translation le long de guides agencés de manière appropriée, fixés à la structure de la presse (1), une table de support de bord de retenue (10) et un socle (11), et le moyen de déplacement correspondant, **carac-**

térisée en ce que des colonnes de guidage (9) fixées à la structure (1) sont distribuées essentiellement le long du périmètre externe de la traverse (8), lesdites colonnes (9) guidant ladite traverse (8) ainsi qu'une plaque supérieure (12) qui loge le bouchon supérieur (5), et **en ce que** ladite traverse (8) comporte un réceptacle en forme de tronc de cône (13) dont la forme et les dimensions sont complémentaires à celles de la table de support de bord de retenue (10), ladite table (10) et ledit réceptacle (13) pouvant être associés mutuellement, dans des conditions de coaxialité imposées par le cône, à l'aide d'éléments d'accouplement amovibles lorsqu'ils sont forcés l'un dans l'autre.

2. Presse selon la revendication 1, **caractérisée en ce que** ledit moyen de déplacement de la traverse (8) comprend deux pistons hydrauliques (14), dans laquelle l'extrémité supérieure est accouplée de manière rigide à la face inférieure de la traverse (8) et l'extrémité inférieure est accouplée de manière rigide à la structure de support (2).

3. Presse selon la revendication 1, **caractérisée en ce que** lesdites colonnes de guidage (9) sont au nombre de quatre, fixées à la presse (1) et agencées approximativement aux coins de ladite traverse (8).

4. Presse selon les revendications 1 et 3, **caractérisée en ce que** ladite traverse (8) est constituée d'un élément métallique présentant une coupe transversale essentiellement rectangulaire avec quatre bras externes (15) qui s'étendent dans des directions symétriques par rapport au centre du rectangle, chaque bras (15) étant pourvu d'un trou d'extrémité (16) dans lequel une colonne respective (9) est agencée, même indirectement.

5. Presse selon la revendication 4, **caractérisée en ce que** chacun desdits trous d'extrémité (16) comporte une bague (17) qui est accouplée de manière rigide et engagée sur la colonne (9) de manière à pouvoir coulisser.

6. Presse selon les revendications 1 et 3, **caractérisée en ce que** ladite plaque supérieure (12) pour loger le bouchon supérieur (5) présente une coupe transversale essentiellement rectangulaire, avec quatre bras externes qui s'étendent dans des directions symétriques par rapport au centre du rectangle, chaque bras étant pourvu d'un trou d'extrémité dans lequel une colonne respective (9) est agencée, même indirectement.

7. Presse selon la revendication 6, **caractérisée en ce que** chacun desdits trous d'extrémité comporte une bague accouplée de manière rigide dans laquelle peut coulisser ladite colonne (9).

8. Presse selon la revendication 7, **caractérisée en ce que** ladite traverse (8) supporte de manière rigide, dans une région supérieure, une lame fixe (20) et une lame amovible (21), qui est fixée au-dessus de l'extrémité supérieure du bord de retenue (18) et fait saillie de la table de support de bord de retenue (10), ladite lame fixe (20) et ladite lame amovible (21) ayant la même épaisseur. 5
9. Presse selon la revendication 8, **caractérisée en ce qu'une** coupelle (22) pour alimenter les poudres dans la matrice peut coulisser sur la surface supérieure de ladite lame (20, 21) et repose, dans la position inactive, exclusivement sur ladite lame fixe (20). 10 15
10. Procédé pour remplacer un assemblage de support de matrice dans une presse (1) selon une ou plusieurs des revendications précédentes, comprenant les étapes consistant à : lever ladite traverse (8) par rapport à l'extrémité supérieure dudit bouchon inférieur (6) jusqu'à ce qu'elle se trouve à une distance de ladite extrémité qui est supérieure à la hauteur de la table de support de bord (10) ; libérer des éléments d'accouplement ladite table de support de bord (10) de ladite traverse (8) ; enlever l'assemblage de support de matrice complet de la presse (1); remplacer ledit bord de retenue (18) dans la table de support de bord (10); réinsérer l'assemblage de support de matrice (7) dans la presse (1) ; réagencer la table de support de bord (10) sous la traverse (8) ; commander la descente de la traverse (8) jusqu'à ce que le réceptacle (13) soit forcé sur la table de support de bord (10) en assurant l'alignement à l'aide de l'emboîtement conique ; et fixer la table de support de bord de retenue (10) à l'aide desdits éléments d'accouplement à la traverse (8). 20 25 30 35
11. Procédé selon la revendication 12, **caractérisé en ce que** durant toutes les opérations, la coupelle d'alimentation des poudres (22) dans la matrice reste appuyée en contact sur ladite lame fixe (20) dans la position inactive. 40

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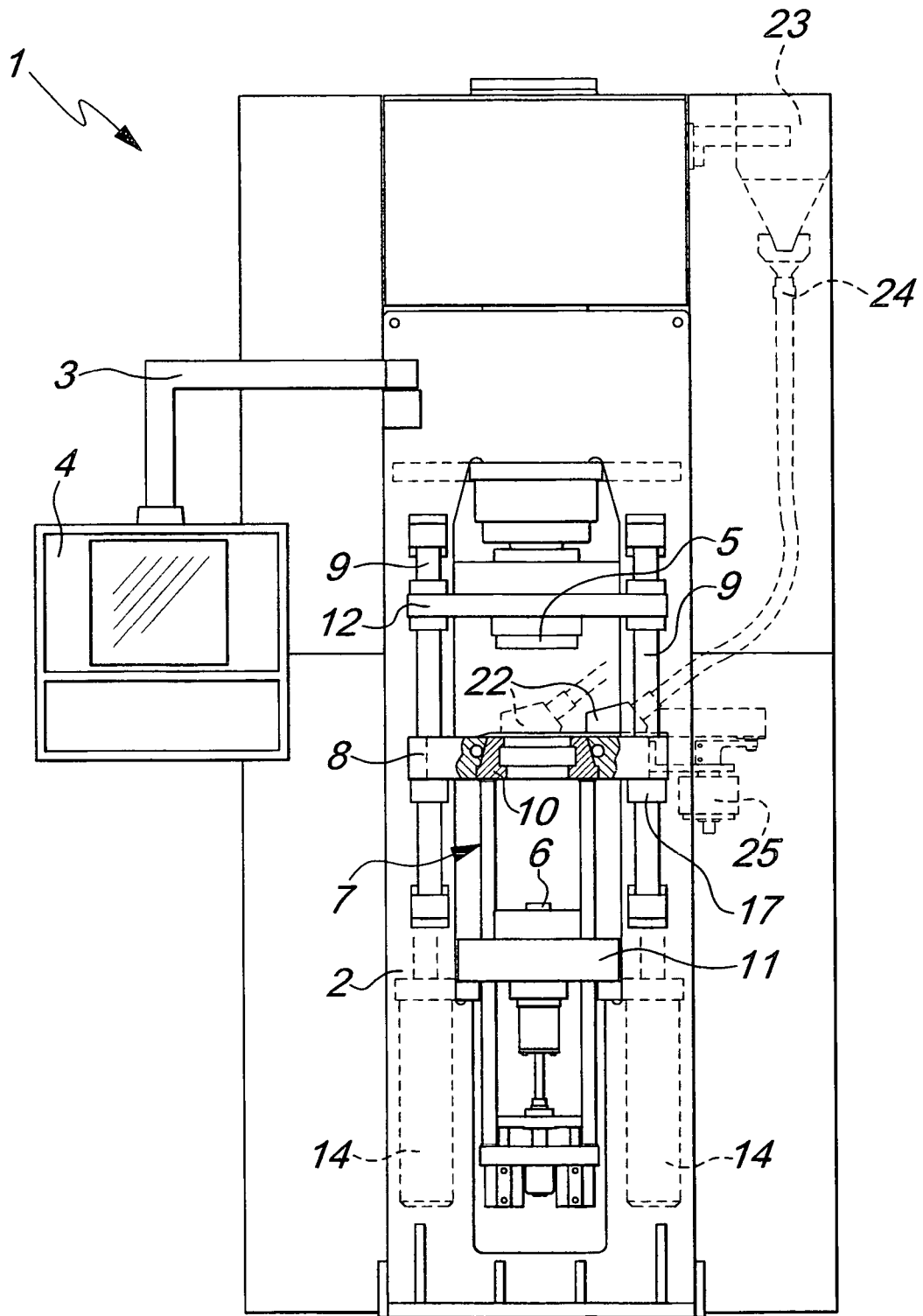


Fig. 1

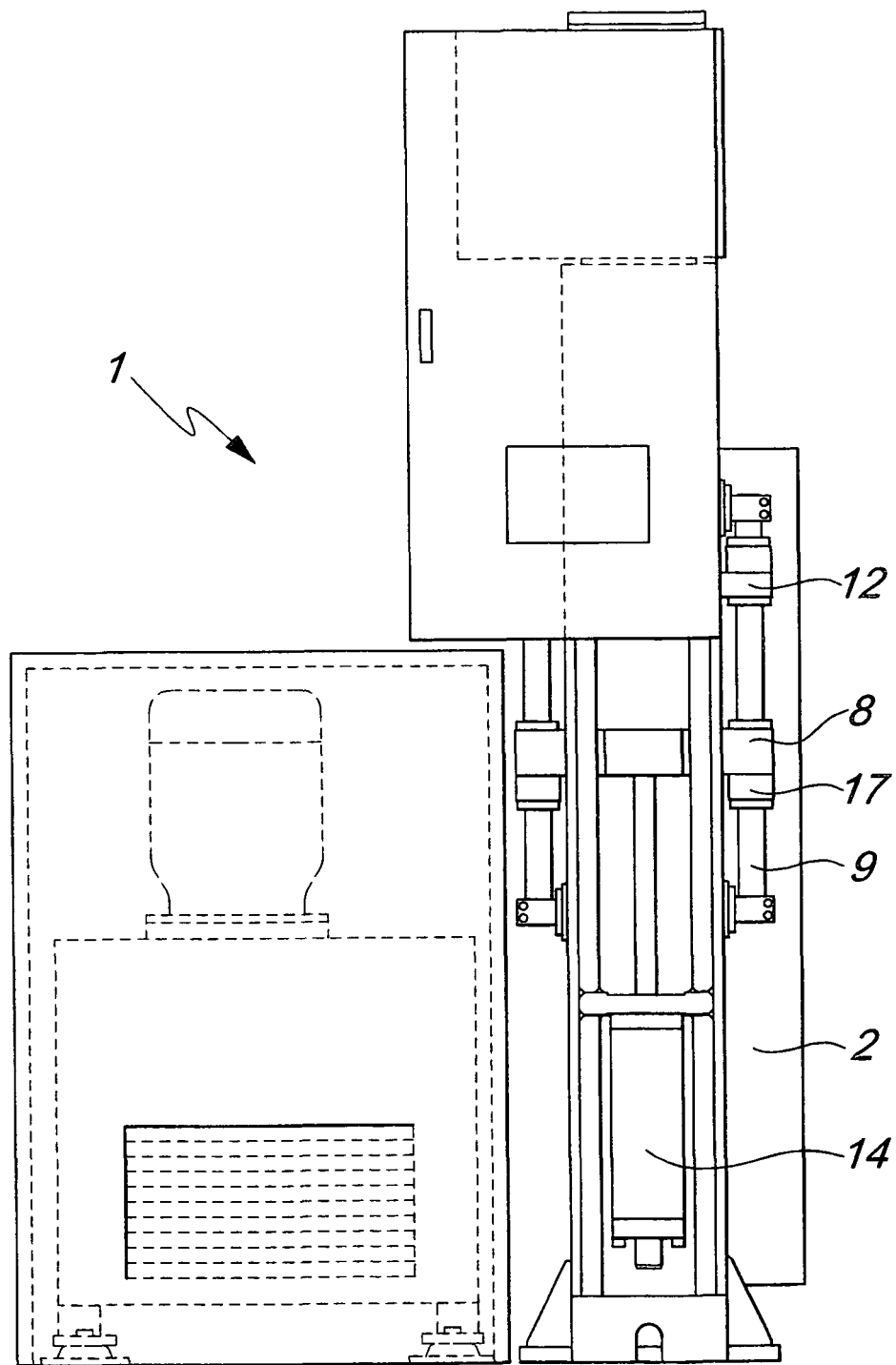


Fig. 2

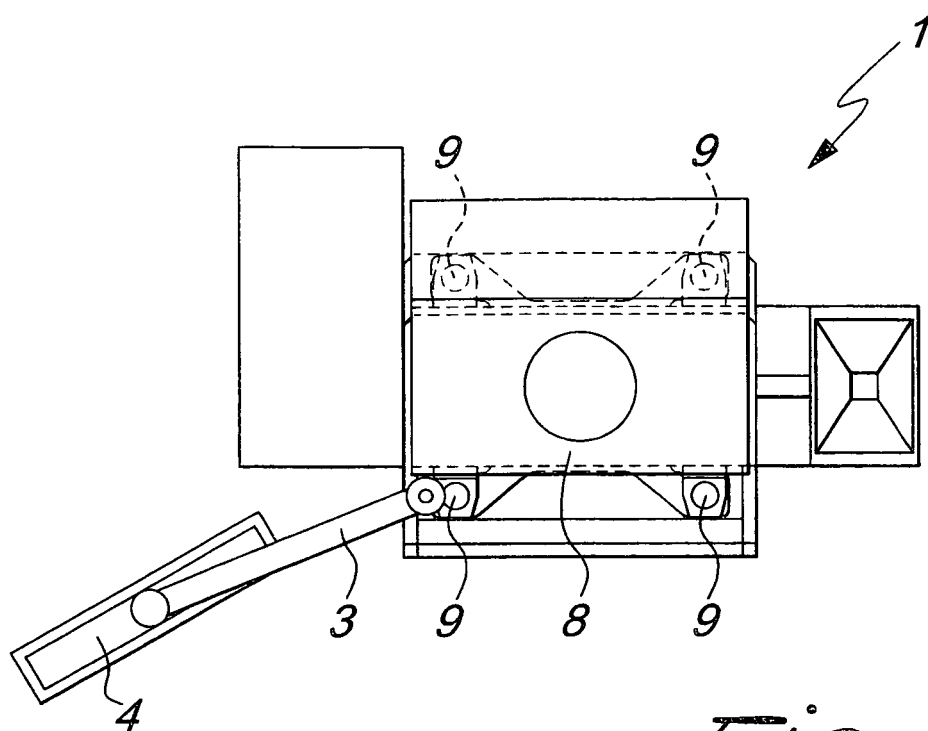


Fig. 3

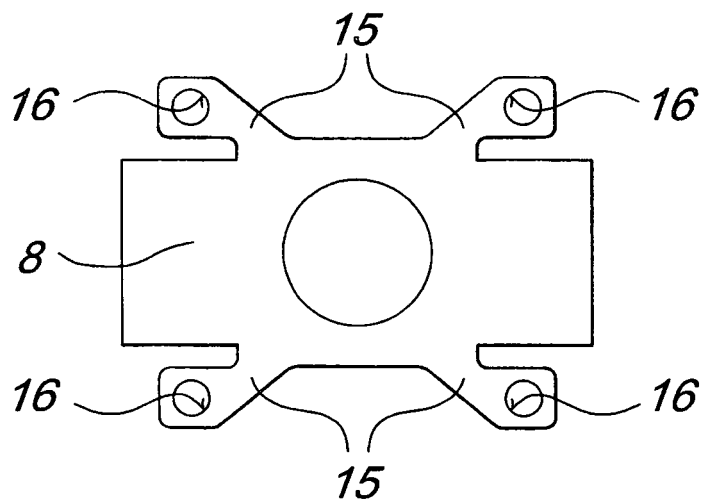


Fig. 4

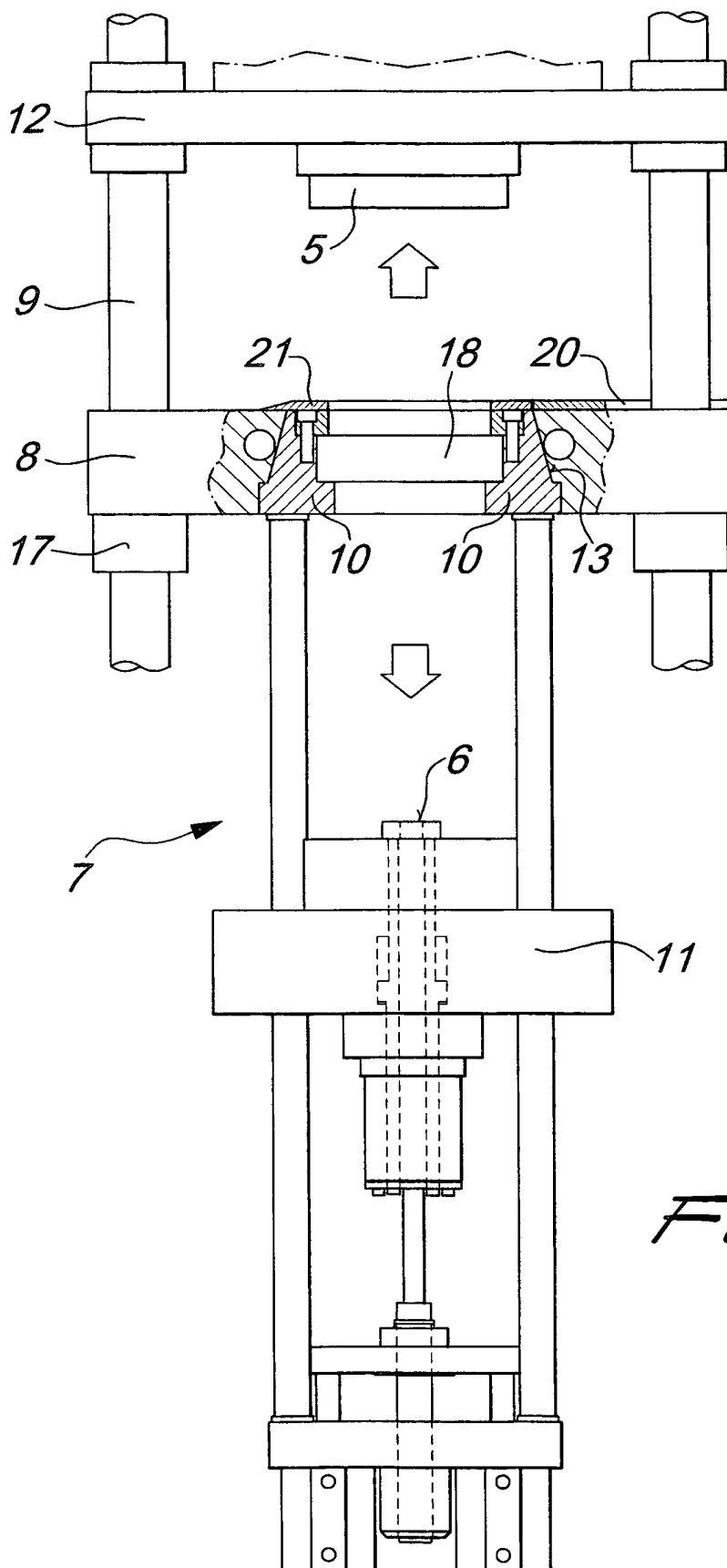


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0183135 A [0005]