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(54) Fabrication process and plant for grinding wheels

(57) A method and a relative plant, differently from the known approaches, contemplates the fabrication of planar "biscuits", press consolidated at room temperature, thus avoiding the problems and criticalities connected to the use of cup-shaped molds for producing grinding wheels with a depressed center, and a press shaping workstation of the "biscuit" (planar wheel not yet hardened) between a mold and a countermold, shaped in order to impress the so press consolidated "biscuit", but not yet hardened, the desired depressed center shape.

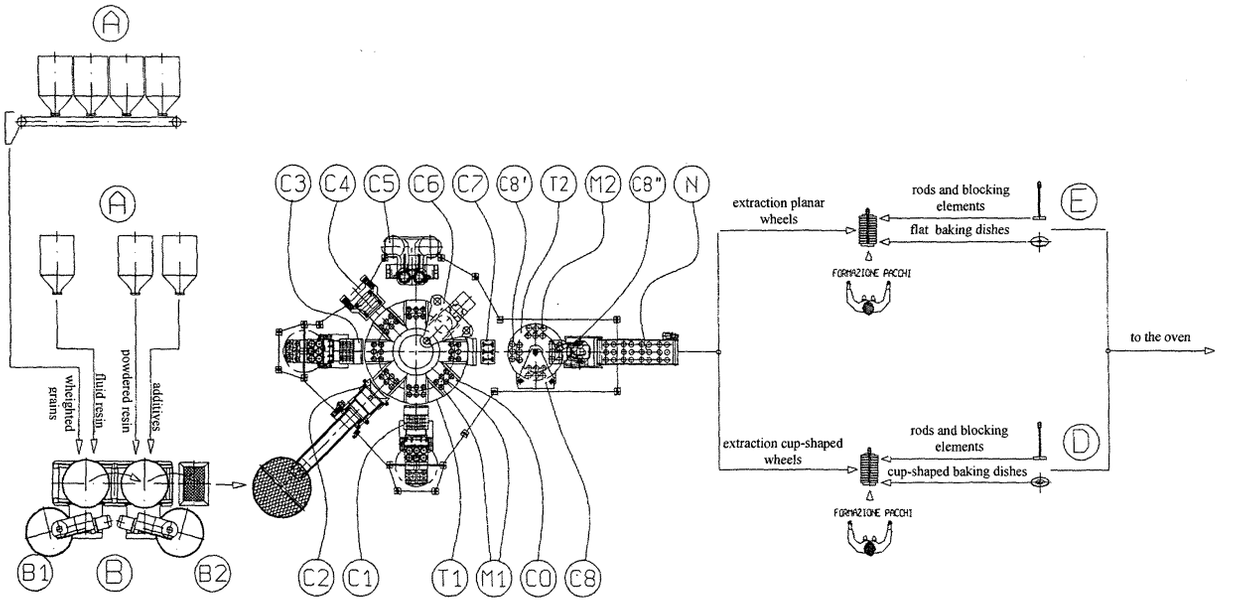

FIG. 8

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Description

[0001] This invention relates to the fabrication of grinding wheels and in particular of grinding wheels with depressed center, that is grinding wheels whose central portion immediately around the reinforced fixing hole of the wheel for fixing the wheel to the end of a spindle, is shaped as a cup in order to keep the tightening ring nut of the grinding wheel at the end of the spindle below the end plane of the wheel.

[0002] Fabrication processes of grinding wheels are well known as well as fabrication plants that tend to be ever more automated, with processing lines defined by a succession of workstations each dedicated to perform one or more steps of the fabrication process.

[0003] A first fundamental step of fabrication of these consumable tools consists in dosing and weighting the different solid and fluid components of the abrasive mixture and in mixing them all together in a single step or preferably adding them to the mixture in more steps in order to form an abrasive mixture with reproducible properties of homogeneity and structure. This phase of preparation of the mixture is generally carried out in a batch-wise manner, producing a certain quantity of mixture.

[0004] The processing line has a certain number of automated workstations for introducing in the cavity of a mold the different components of the grinding wheel in the right sequence. A first operation may consist in optionally introducing a first reinforcement metal grommet of the central hole of the grinding wheel on a central pin of the mold, and essentially in laying at least a first disk of reinforcement net on the bottom of the mold.

[0005] In a dedicated workstation, the cavity of the mold is filled, generally flush filled, with the pre-mixed abrasive mixture, optionally vibrating the mold and/or the feed belt conveyor of the mixture to the traveling filling hopper-drawer for ensuring the filling of the mold cavity as homogeneously as possible.

[0006] In a successively reached automated workstation, at least a second disk of reinforcement net is laid on the filling mixture of the mold and, in a further station, even a pre-printed label with data and characteristics of the grinding wheel being fabricated is eventually laid on top of the reinforcement net.

[0007] The processing line usually comprises a further workstation in which either a unique reinforcement metal grommet of the central hole of the grinding wheel is introduced, if no metal grommet was introduced before filling the mold with the abrasive mixture, or a second metal grommet.

[0008] The successive workstation is a press for consolidating at room temperature the components introduced in the mold, in order to shape the grinding wheel in the mold as a "biscuit" pre-consolidated only by pressure, but whose thermosetting binder has not yet been subjected to the hardening conditions (reticulation of the builder resin, commonly of phenolic type).

[0009] The not yet hardened grinding wheels so produced, even if they are perfectly consolidated and may be handed without excessive care, are still flexible and plastically deformable.

[0010] In a successive workstation, the grinding wheels not yet hardened are extracted from the mold and stacked alternately with baking plates, commonly of aluminum, on a central rod rising from a basement plate and having a threaded end for tightening the stack after having inserted the last baking plate, a press plate and pressed the stack under a press, by inserting on the threaded end of the rod a washer a spring and screwing a stop nut of the properly compressed spring that will maintain a correct compression on the stack once it is removed from the press.

[0011] These steps are commonly carried out by hand by a worker, or are only in part automated.

[0012] The so formed and tightened stacks are then introduced in an oven and baked for many hours, while keeping the oven temperature at about 180°C for promoting and reaching a complete reticulation of the thermosetting binder of the grinding wheel.

[0013] The baking of the thermosetting binder is typically carried out in a batch-wise manner, because it takes many hours (from 20 to 24) at a temperature that, for a phenolic binder, in general may range from 175°C to 200°C.

[0014] Baking costs are significant and normally the available space in the oven is completely filled by stowing in it the largest number of tightened stacks for increasing productivity of this batch treatment.

[0015] When grinding wheels with depressed center instead of planar grinding wheels must be produced, the known processes contemplate two alternatives.

[0016] According a first approach, the grinding wheels with depressed center are produced by using properly shaped molds in order to give the desired shape with a depressed central zone around the assembling hole to the grinding wheel being realized, already when pressing the components in the mold at room temperature for consolidating together the various components. This known process has many drawbacks due to the increased difficulty of ensuring a homogeneous filling of a cup-shaped mold, to possible reciprocal misalignments between the two reinforcement nets in the central deflection zone of the nets while pressing the grinding wheel in the mold (possible loss of a perfect parallelism between the two nets in the deflection zone).

[0017] According to the alternative approach, consolidated grinding wheels are pressed in the normal form of planar grinding wheels for not incurring in the above mentioned drawbacks, using in practice the same molds used for producing planar grinding wheels. The deformation of the central zone of the not yet hardened grinding wheels for depressing the central portion of the wheel is simultaneously performed on all the not yet hardened grinding wheels stacked in a pack ready to be baked, by exploiting the shape of purposely cup-shaped

baking plates for plastically deforming the central portion of the press consolidated planar grinding wheels, not yet hardened, when pressing the elements stacked along the central rod, at the threaded end of which the spring and the stop ring nut are installed.

[0018] This known technique is graphically shown in Figures 1, 2, 3, 4, 5 and 5bis.

[0019] Figure 1 shows, in an exploded view, the stacking sequence of the different elements on the rod Ac that rises from the basement Bc, starting from a first adapter bottom plate P1, a first shaped baking plate 4 and a first press consolidated grinding wheel 1, up to a top most plate P2 and an eventual press ring S.

[0020] Even this second approach is not free from drawbacks and problems.

[0021] First, the realization of so stacked bake packs imposes that between the hole of the reinforcement metal grommet 2 of the central hole of each grinding wheel 1 and the stacking rod Ac there be a certain clearance G, for enabling an easy stacking of the preformed disks and subsequently an easy extraction of the baked grinding wheels after the packs are baked. Unfortunately the clearance G is hardly uniformly distributed because of unavoidable shifts from perfect concentricity upon stacking the elements.

[0022] Moreover, according to a common configuration, the reinforcement metal grommets 2 of the central hole for mounting the wheels 1 are L-shaped, that is they have a small flange at one end of the grommet. Whether a single reinforcement grommet, introduced before or after having filled the mold, or two grommets are used, the not yet hardened fluid binder, commonly a phenolic resin, may seep to some extent when the not yet hardened grinding wheels of the stacked pack are pressed to produce a plastic deformation in the central zone 3 between the opposite faces of the shaped baking plates 4. This locally accentuated plastically deforming stress to which the central portion 3 of the planar consolidated wheel is subjected, may cause a local seepage of the binder near the edge not completely covered by the unique reinforcement metal grommet 2 or between the abutted faces of two reinforcement grommets.

[0023] The occurrence of seepages of resin when compressing the stack and a not perfect concentricity makes drops of resin touch an wet the stacking rod, on the surface of which it bonds during the baking. This makes difficult extracting the baked grinding wheels at the end of the baking.

[0024] In order to prevent these inconveniences, the clearance G between the circumference of the hole of the reinforcement grommets of the grinding wheels and the outer surface of the stacking rod is often purposely incremented, however, this inevitably increases dimensional mismatches of the fabricated wheels, as shown by the magnified view of Figure 5bis.

[0025] Another drawback is due to the fact that in order to maximize productivity, the realization of each pack may require repeated pressings for deforming a first number of stacked grinding wheels and shaped plates as depicted in Figures 2 and 3, for freeing space on the stacking rod Ac on which to stack other wheels 1 and plates 4, as far as stacking the maximum number of wheels for each pack, as depicted in Figure 4.

[0026] Besides the laboriosity of these repeated partial pressing of the stacks that require laying the plate P2 and the pressing ring S and then removing them for stacking additional grinding wheels, they worsen the dimensional "spread".

[0027] These problems and drawbacks are overcome by the method and plant object of this invention that, differently from the above mentioned known approaches, contemplates the fabrication of planar "biscuits", press consolidated at room temperature, thus avoiding the problems and criticalities connected to the use of cup-shaped molds for producing grinding wheels with a depressed center, and a press shaping workstation of the "biscuit" (planar wheel not yet hardened) between a mold and a countermold, shaped in order to impress the so press consolidated "biscuit", but not yet hardened, the desired depressed center shape.

[0028] This second pressing workstation of the single pre-consolidated wheels at room temperature is completely automated.

[0029] The grinding wheels not yet hardened (or biscuits), extracted from the deformation mold of this central portion depressing workstations are eventually stacked between conformably cup-shaped baking plates, and tightened in the pack ready for baking without this operation implying any stress in the central zone, having this zone already been depressed by molding singularly each pre-consolidated "biscuit".

[0030] It has been found that the noted problems of plastic flow (seepage of the binder resin) are much less evident and almost negligible and above all the alternated stacking of shaped baking plates and the grinding wheels not yet hardened preformed with their central portion already depressed, benefits of a sensible degree of self-alignment due to the mutual complementarity of the abutment surfaces of an element on top of the other. This enhances concentricity and thus a more uniform "distribution" of the clearance between the hole of the reinforcement grommet (or grommets) and the stacking rod, an enhanced dimensional uniformity of the grinding wheels and a unhindered collection of the grinding wheels at the end of the baking.

[0031] Another advantage consists in that it is no longer necessary to perform repeated pressings after having stacked a certain number of wheels for freeing space along the stacking rod on which to stack other grinding wheels not yet hardened and baking plates until the pack to be introduced in the baking oven is completed and tightened.

[0032] **Figures 1, 2, 3, 4, 5 and 5bis** illustrate, as already discussed above, the known technique of deforming the central portion of the press consolidated grinding wheels upon pressing a stack of wheels alternated to

cup-shaped baking plates, before introducing the completed pack in the baking oven.

[0033] **Figures 6, 7 and 7bis** illustrate the stacking operations for realizing the pack to be baked in a single operation, according to this invention.

[0034] **Figure 8** is a layout of a plant for fabricating grinding wheels according to this invention.

[0035] Referring to Figures 6, 7 and 7bis, the number of operations to be carried out by hand is clearly reduced and the advantages in terms of reduced dimensional spread and reduced or eliminated incidence of binder seepage wetting the stacking rod Ac, that are obtained by the present invention, are evident.

[0036] As it may be noticed from the exploded view of Figure 6, each single wheel 1, consolidated at room temperature in an easy to make planar shape, is preventively press deformed between cooperating mold and countermold, in order to impress to it its final shape with depressed center 3, while it is still in the form of a press consolidated biscuit.

[0037] The so singularly shaped wheels 1 are then stacked on the stacking rod Ac by alternating them with coordinately shaped baking plates 4, as far as the baking pack is completed, in a single stacking step.

[0038] As depicted in Figure 7, the pressed stack is commonly tightened by placing the plate P2 and the pressing ring S over the last baking plate 4 of the stack.

[0039] While the pack is under the press, the washer, the spring and the stop nut are installed, according to common practice.

[0040] As highlighted in the magnified view of Figure 7bis, the effects of deforming singularly the grinding wheels 1 for depressing their central portion 3 in a pressing workstation dedicated to this operation of plastically deforming the pre-consolidated planar "biscuit" and of stacking the so preformed wheels 1 between the baking plates 4 the shape of which perfectly conforms with that of the wheels 1, favors a self-centering of the grinding wheels between the plates 4 and in respect to the stacking rod Ac, enhancing concentricity and the presence of a minimum and uniform separation gap between the reinforcement grommet 2 of the central hole of each wheel and the stacking rod Ac, thus preventing undue glueings while baking.

[0041] Moreover, manual stacking operations are advantageously simplified and made less laborious, because it is no longer necessary to press the pack several times for freeing stacking space on the rod. On the contrary, according to the process of this invention, the pack is completed with a single stacking, pressing and tightening sequence.

[0042] Figure 8 depicts the layout of a grinding wheels fabrication plant according to the present invention.

[0043] In the depicted example, the mixing of the different components is carried out in two stages, the first stage B1 for mixing the solid particles of abrasive and the fluid binder resin and the second stage B2 for adding powder resin, additives, colors and the like to the premixed components.

[0044] According to the shown example, the fabrication line comprises a first revolving table machine T1, moving by angular increments, carrying a certain number of molds M1 (six in the example) from a first workstation CO, whereat a first reinforcement metal grommet of the central hole of the grinding wheels may optionally be introduced in case two metal grommets are contemplated, to a second workstation C1 whereat a first reinforcement net is automatically placed on the bottom of each mold.

[0045] By a further incremental rotation of the revolving table the group of molds reaches the workstation C2 whereat the volume of each mold is flush filled with the mixture coming from the second mixing stage B2.

[0046] With the successive incremental rotation of the table, the filled molds reach the workstation C3, in which automatic actuators place a second reinforcement net on the filling mixture.

[0047] In the successive workstation C4 reached by the molds a printed label may be optionally placed on the second reinforcement net.

[0048] The successive workstation C5 reached by the molds is dedicated to the automated introduction of a reinforcement metal grommet (or second grommet in case two grommets are contemplated) of the central hole of the grinding wheel.

[0049] The molds thus reach the pressing workstation C6 where the grinding wheels are consolidated at room temperature in a planar disk shape, according to a common sequence of the fabrication process of these articles.

[0050] In the last workstation C7 of the machine, the consolidated planar grinding wheels are extracted automatically from the molds and weighted for verifying whether the established tolerances are fulfilled or not. Grinding wheels out of tolerances are automatically discarded.

[0051] According to the main aspect of the fabrication plant of this invention, the consolidated planar a grinding wheel is automatically introduced in a respective shaping mold M2 for plastically deforming the central zone of the wheel in order to impart to the wheel the desired shape with depressed center.

[0052] According to the embodiment depicted in Figure 8, this additional pressing workstation C8 is realized with a second revolving table machine T2. The selected grinding wheels from the end workstation C7 of extraction and weighting of the first revolving table machine, are automatically transferred inside six respective shaping molds M2 in the sub-station C8' of the second machine. By incremental anti-clockwise rotation of the table T2, the molds M2 reach the pressing station C8, where they are closed under the press by conformably shaped countermolds that deform a circular central portion of each planar wheel imparting to each wheel the desired geometry with depressed center.

[0053] The molds M2, reach the successive sub-sta-

tion C8" of the second revolving table machine T2, whereat the grinding wheels are automatically extracted from the respective shaping molds and placed on a belt conveyor N that feeds the formed wheels to one or more workstands of manual formation of the packs, as shown in Figures 6 and 7.

[0054] The packs are thus stowed in the oven for the final heat hardening treatment, according to the common practice.

Claims

1. A plant for fabricating grinding wheels (1) comprising means for dosing (A) solid and fluid components of the abrasive mixture, at least one of which is a thermosetting resin, means for mixing (B, B1, B2) the abrasive mixture, a plurality of workstations (C0, C1, C2, ... C7) for introducing sequentially in a mold (M1) components of the grinding wheel including a certain amount of said abrasive mixture for flush filling the cavity of the mold (M1) after having laid on the bottom of the mold at least a first net and optionally a first reinforcement metal grommet (2) of reinforcement of the central hole of the grinding wheel and before laying over the filling mixture at least a second reinforcement net and introducing a metal grommet or a second metal grommet (2) of reinforcement of the central hole of the grinding wheel, at least a workstation (C6) of pressing said components introduced in the mold for forming a consolidated biscuit at room temperature of the components of the grinding wheel (1), at least a stacking workstand (E, D) of the grinding wheels not yet hardened (1) alternated to baking plates (4) on a central rod (Ac) with an end thread for receiving a spring and a stop nut of the stack tightened under a stacking press, baking ovens of a plurality of packs of stacked grinding wheels for a time and at a temperature sufficient to harden said thermosetting resin binder, **characterized in that** it further comprises

   a second workstation (C8) for pressing each biscuit, press consolidated at a room temperature in said first pressing station (C6), between a mold (M2) and a cooperating countermold shaped for plastically deforming a central circular zone (3) of the biscuit (1) for imparting to the planar biscuit impressing a desired depressed center shape before conveying the so press consolidated and plastically grinding wheels (1), to said stacking workstand of the preformed and not yet hardened grinding wheels (1) between the conformably shaped baking plates (4) with depressed center.

2. The plant according to claim 1, **characterized in that** it further comprises

   a workstation (C7) for extracting the press consolidated planar biscuits from said mold (M1) and for weighting and sorting them.

3. The plant according to claim 1, **characterized in that** said plurality of workstations (C0, C1, C2, ..., C7) are sequentially reached by at least a mold (M1) by incremental angular rotation of a revolving table (T1) on which said mold (M1) is installed.

4. The plant according to claim 1, **characterized in that** said second workstation (C8) is reached by at least a shaped mold (M2) by incremental angular rotation of a second revolving table (T2) on which said mold (M2) is installed, about said second revolving table (T2) being defined at least a first substation (C8') for introducing the weighted and sorted press consolidated wheels (1), in the form of a planar biscuit, in said shaped mold (M2) and at least a further substation (C8") for extracting the plastically deformed wheel (1) from said mold (M2) and for placing on a belt conveyor (N) feeding said stacking workstand.

5. The plant according to any of the preceding claims, **characterized in that** all said workstations and substations (C0, C1, C2, ..., C7, C8, C8', C8") are completely automated.

6. A fabrication process of grinding wheels (1) with depressed center comprising the operations of mixing in a single or multiple step solid and fluid components of an abrasive mixture including a thermosetting binder, disposing in a first mold (M1) the components of a grinding wheel including an amount of same mixture for flush filling the cavity of the mold after having laid on the bottom of the cavity at least a first reinforcement net and optionally a first metal grommet (2) of reinforcement of a central hole of the grinding wheel (1), and before laying over the filling mixture at least a second reinforcement net and introducing a single or a second metal grommet (2) of reinforcement of the central hole of the grinding wheel (1), pressing said components in the mold at room temperature, forming a press consolidated biscuit, stacking the not yet hardened press consolidated wheels alternated to baking plates (4) with depressed center on a central rod (Ac) with an end thread pressing and tightening the pack and baking the packs for a time and at a temperature sufficient to harden the thermosetting binder, **characterized in that** it further comprises

   pressing individually each press consolidated planar biscuit in a second mold (M2) with a cooperating countermold with conformably shaped depressed centers for plastically deforming a central circular zone (3) of the planar biscuit impart to it a desired depressed center shape, before stacking the so preformed wheels not yet hardened, tighten-

ing the baking pack, and baking them.

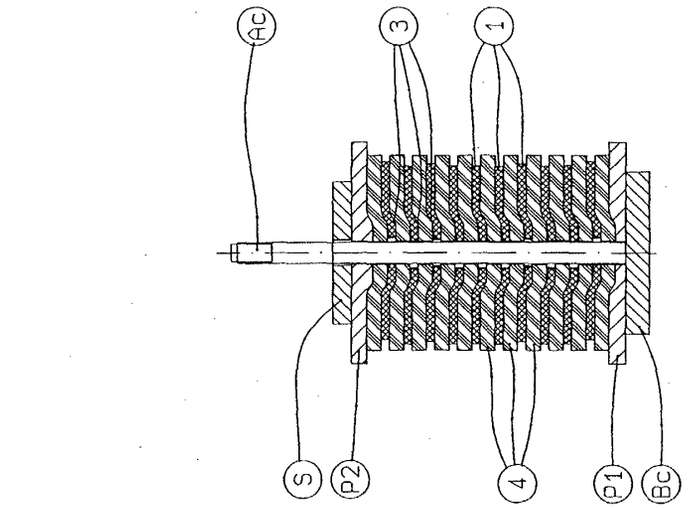

FIG.3

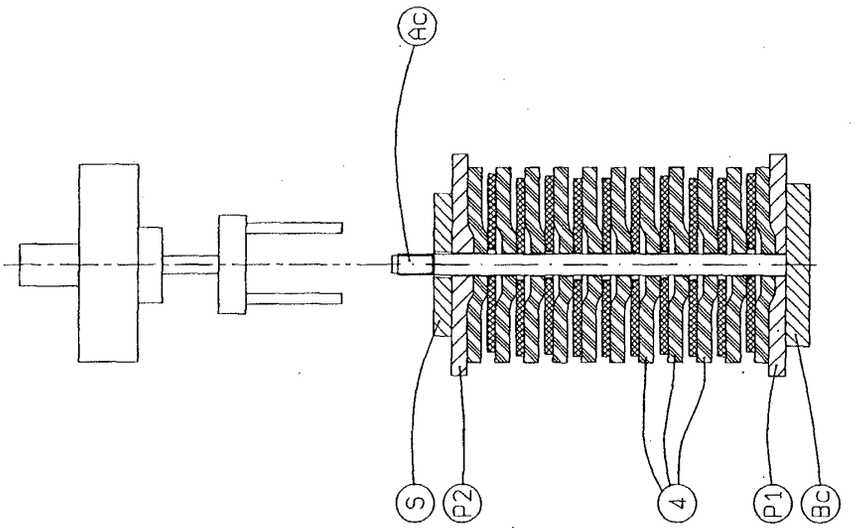

FIG.2

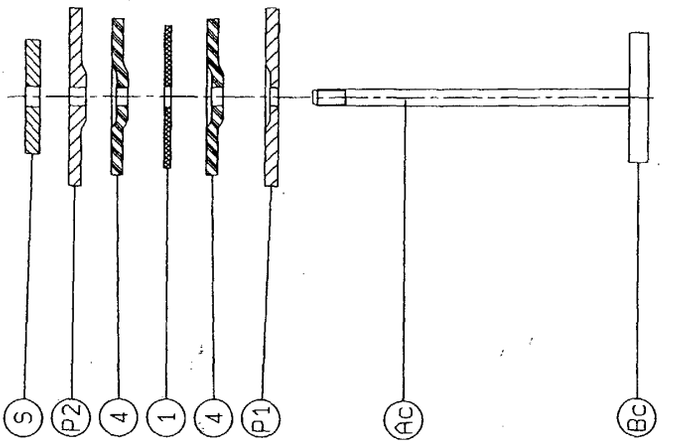

FIG.1

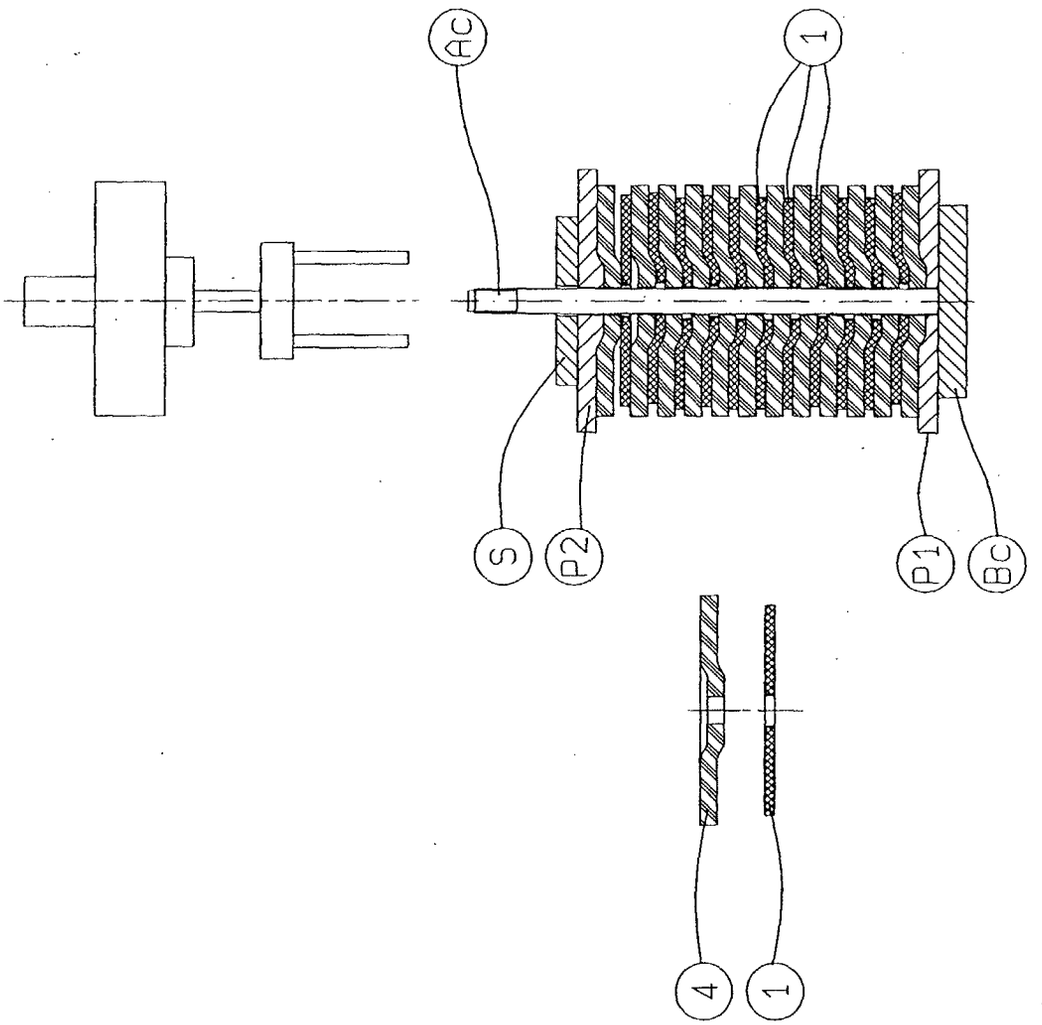

FIG. 4

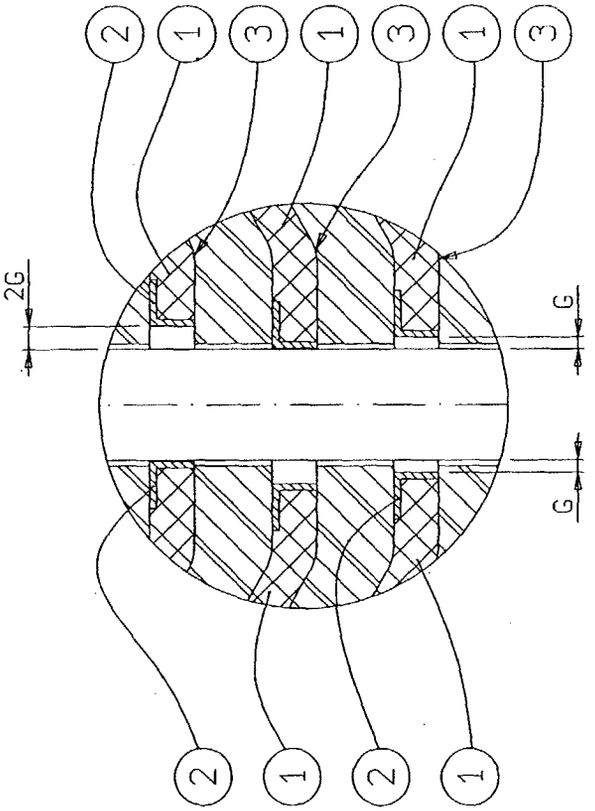

FIG.5 bis

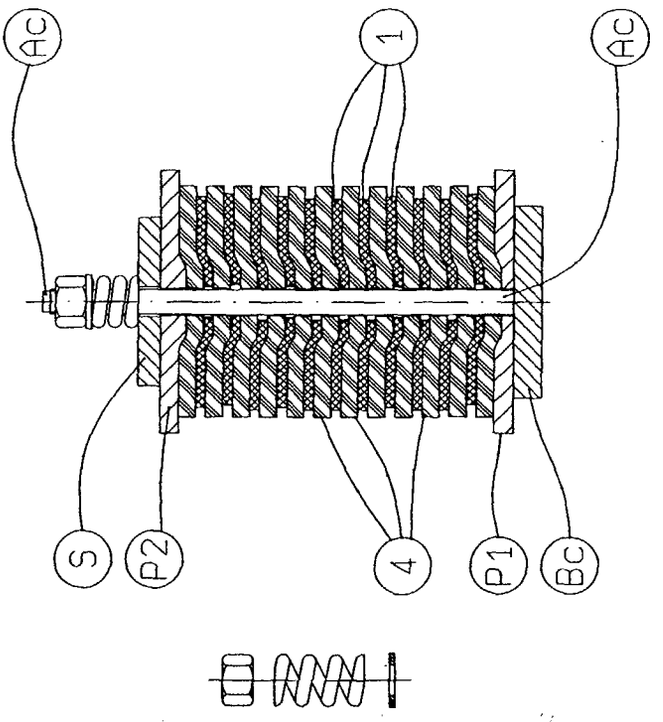

FIG.5

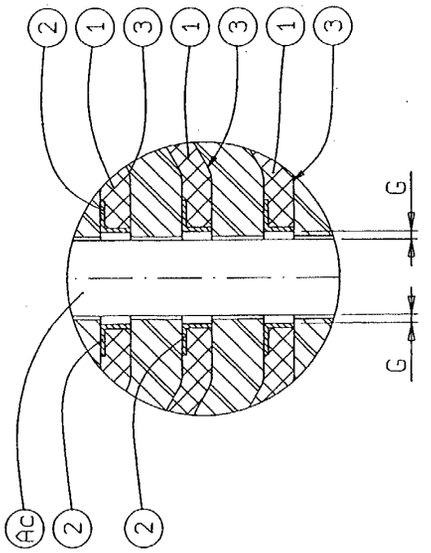

FIG.7 bis

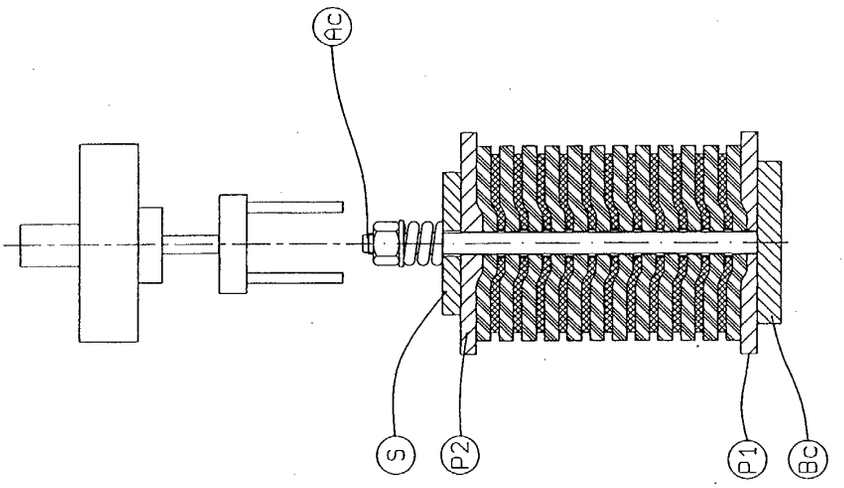

FIG.7

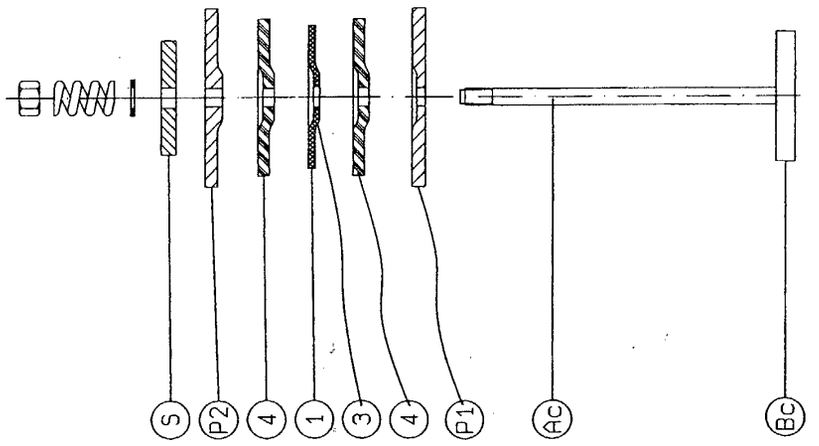

FIG.6

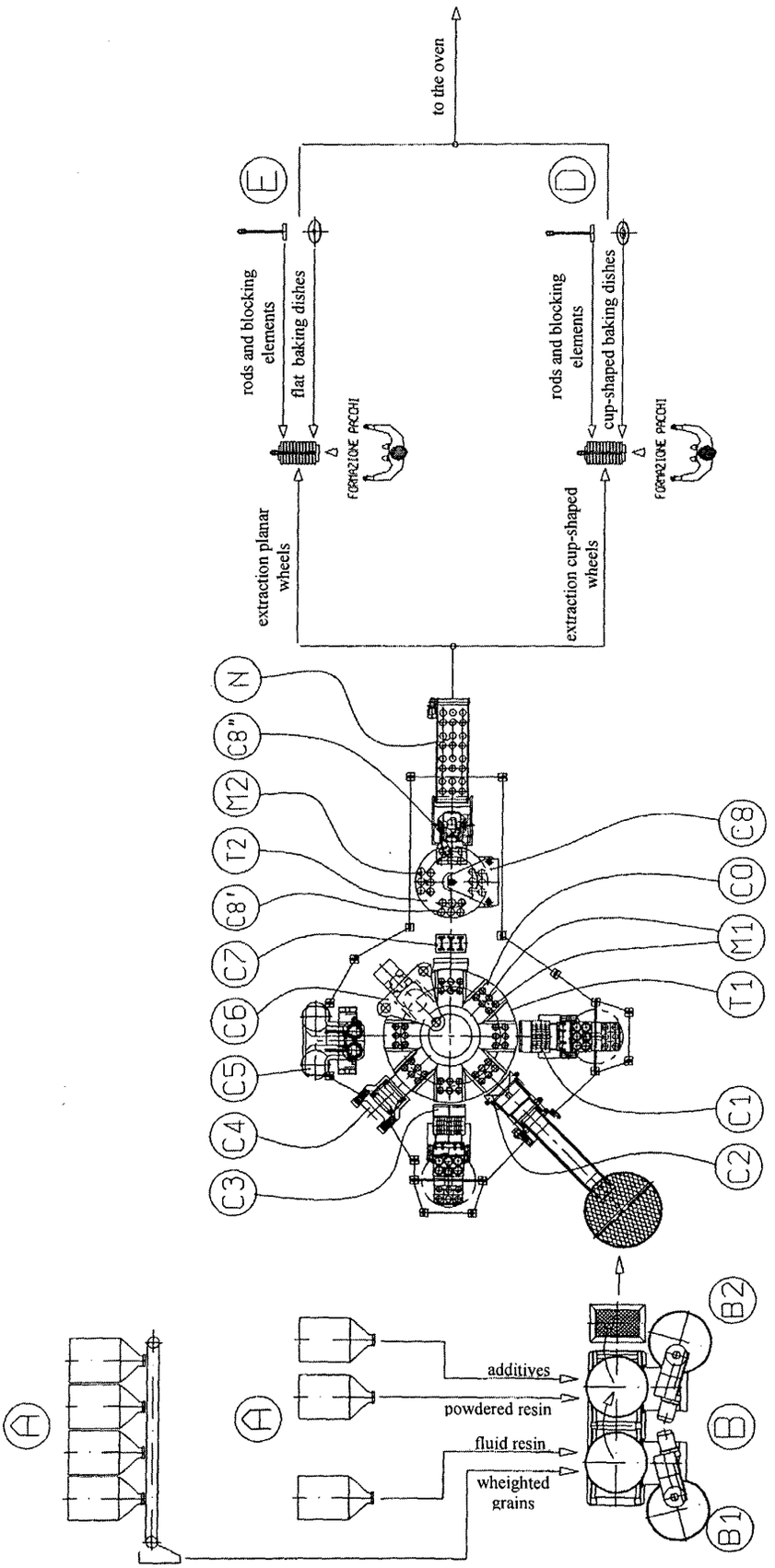
to the oven
E
D
rods and blocking elements
flat baking dishes
rods and blocking elements
cup-shaped baking dishes
FORMAZIONE PACCHI
FORMAZIONE PACCHI
extraction planar wheels
extraction cup-shaped wheels
N
C8"
M12
T2
C8'
C7
C6
C5
C4
C3
C8
C0
M1
T1
C1
C2
B2
B
B1
A
A
additives
powdered resin
fluid resin
wheighted grains

FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 42 5263

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.7)
A	DE 38 20 548 A (DAVIDE MATERNINI S R L) 5 January 1989 (1989-01-05) * page 3, line 30 - page 4, line 32 * ---	1,6	B24D18/00 B24D7/04 B24D5/12
A	US 6 193 771 B1 (PATRELLO JOSEPH) 27 February 2001 (2001-02-27) * column 1, line 53 - line 64 * -----	1,6	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B24D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 October 2003	Eschbach, D

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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14-10-2003

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82