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(54) **Casting mould and process for its manufacturing**

(57) It presents a casting mould (1), of the types used to form casting sand (10) to reproduce pieces (2), and the process for the manufacturing of said casting mould. The casting mould is composed of a hollow body, essentially rigid and closed, whose interior is totally filled by a

hardenable filling material. The wall of the hollow body is provided with at least one portion composed of a nickel coquille (8) arranged gap-free with respect to the rest of the body wall, and the entire inner surface of each nickel coquille being in contact with said filling material.

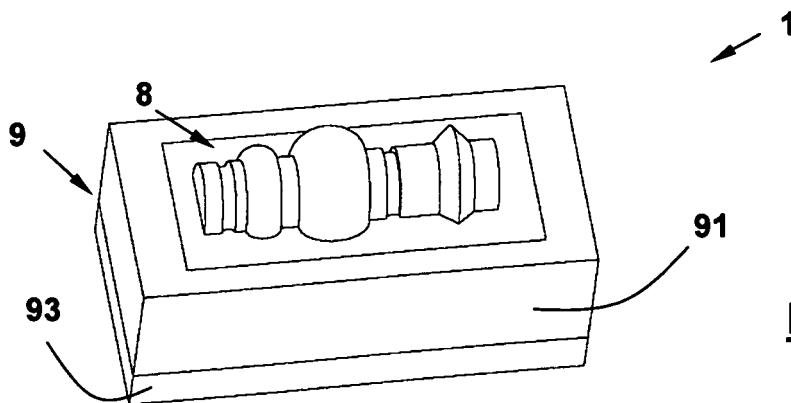


Fig. 8

Description

Technical field of the invention

[0001] The invention relates to a mould applicable to casting, of the type which serves to form the casting sand to reproduce at least one cast piece from the preparation of print model of a non-metallic material for each cast piece that one wants to reproduce.

Background of the invention

[0002] It is known that for the manufacturing of a cast piece it is necessary to have a mould which reproduces the negative of said piece where the liquid metal is poured. The moulds used for this purpose are classified in permanent moulds, normally metal and also known as coquilles, and sand waste moulds. Compound moulds also exist wherein parts of moulds are joined, whether they are semi-coquilles or parts of sand moulds.

[0003] Permanent moulds are prepared without the aid of any models, i.e. without any reproduction of the piece that one want to cast. Instead, the piece is directly reproduced in negative on one or several metal blocks composing the coquille, which can be used in numerous castings. In this type of moulds, after each casting it is necessary to wait for the coquille to cool, which becomes a disadvantage in comparison with the sand moulds wherein it is not necessary to wait for the mould to cool.

[0004] Sand waste moulds are suitable for the casting of all class of metals and for pieces of any size. These moulds are contained in a moulding box where the casting sand is compressed around a model of the piece placed in the interior.

[0005] In the moulds where several parts of sand moulds are joined, each of these parts is formed from frameworks or cases by way of a sand caisson which comprise the negative reproduction of a part of the piece to cast. This partial reproduction of the negative is the result of having die-pressed the corresponding part of the model on the surface of the caisson. Once all the parts of the sand moulds are joined, the liquid metal is poured during the casting process in the hollow space created on placing all the partial negative reproductions opposite one another.

[0006] It is noteworthy that in addition to compacting the sand against the piece model, other sand forming processes exist, such as the vacuum process, steam process or vibration process.

[0007] The models used for the forming of the casting sand are usually pieces of steel, when it is a long series, or resin pieces, when the series is short or prototypes are worked with. Wooden models also exist, although these are deformable and sensitive to atmospheric action.

[0008] Due to the stresses that the model must withstand when it is compressed against the casting sand, the most typical thing in long series is to use a steel model.

The accuracy of the surface details of the piece to be reproduced and the effects of dilation and contraction, involve a rigorous study of the model design and subsequent and laborious machining work, in addition to the impossibility of performing modifications on the metal model once this is finished.

[0009] Thus, the need for simplifying the casting sand forming work is revealed, without having to produce a metal model to manufacture a cast piece with the drawbacks this involves.

Explanation of the invention

[0010] The casting mould object of the invention is of the type designed to form casting sand to reproduce cast pieces.

[0011] Essentially, the casting mould is characterized in that said mould is composed of a hollow body, essentially rigid and closed, whose interior is totally filled by a hardenable filling material, the wall of the hollow body being provided with at least one portion composed of a nickel coquille arranged gap-free with respect to the rest of the body wall, and the entire inner surface of each nickel coquille being in contact with said filling material.

[0012] According to another characteristic of the invention, each nickel coquille comprises a first layer of nickel/cobalt electrodeposited on the surface of a corresponding conductivized negative of each piece to be reproduced, and a second layer of pure nickel electrodeposited on the first layer.

[0013] In accordance with another characteristic of the invention, each nickel coquille has a minimum thickness of 2.5 mm.

[0014] In accordance with another characteristic of the invention, the hollow body is provided with a cover equipped with at least one taphole and at least one air outlet.

[0015] According to another characteristic of the invention, the hardenable filling material which totally fills the interior of the hollow body is a resin resistant to temperature, a heat sink and of low linear shrinkage.

[0016] According to another aspect of the invention, a process is revealed for the manufacturing of the mould applicable to casting object of the invention.

[0017] Essentially, the process for the manufacturing of the casting mould is characterized in that it comprises:

- a first stage of production and surface finishing of a negative for each print model of each piece to be reproduced, in non-porous resin or on a machinable plate, wherein said negative is provided with a perimeter band;
- a second stage of conductivizing the negative of each print model;
- a third stage of placing enrichment anodes in each negative, placing them close to the concave areas thereof;
- a fourth stage of introducing the negatives with the

- corresponding anodes in a nickel electrolyte bath;
- a fifth stage of producing a nickel coquille for each negative, produced by electrodepositing a first layer of nickel/cobalt on the conductive surface of the negative, followed by electrodepositing a second layer of pure nickel, controlling and adjusting at all times the separation distance of the enrichment anodes with respect to said depositions as they are being deposited on the negative, so that the enrichment anodes do not come into contact with said depositions;
- a sixth stage wherein the negative of each nickel coquille is demolded, once this has been removed from the electrolyte bath, an outer surface being differentiated on each nickel coquille, which corresponds to that which was oriented towards the corresponding negative, and an inner surface opposite the first one and which is provided with trees, in addition to a second perimeter band which corresponds to the deposition of nickel on the perimeter band of the negative;
- a seventh stage of tightly fitting each nickel coquille in a corresponding opening made in the wall of a container, the inner surface of each nickel coquille remaining oriented towards the interior of the container; and
- an eighth stage wherein, the container being provided with a rear cover mechanically fixed and equipped with at least one taphole and at least one air outlet, and having joined and sealed the unit composed of the container, its rear cover and each nickel coquille, the interior of said unit is filled, via each taphole, with a temperature resistant resin, which permits good heat sinkage and low linear shrinkage, producing the casting mould.

[0018] According to another characteristic of the invention, in the second stage of conductivizing each negative, a metal paint is applied covering the entire surface of the negative to be reproduced in the mould, the areas of the negative which one does not want to reproduce remaining uncoated, or coated with insulating paint if the negative is metal.

[0019] In accordance with another characteristic of the invention, the electrodepositions of the fifth stage are performed for the necessary time until each nickel coquille has a minimum thickness of 2.5 mm.

[0020] In accordance with another characteristic of the invention, in the nickel electrolyte bath, the electrolytes are nickel sulfamate solutions and nickel sulfate solutions.

[0021] According to another characteristic of the invention, the perimeter band of each negative has a minimum width of 10 mm.

[0022] In accordance with another characteristic of the invention, in the first stage, the negative is made with a layer of non-porous resin surface, of a colour substantially different to that of the electrodeposition of the sec-

ond layer of pure nickel, and with a filling resin applied by pouring.

[0023] In accordance with another characteristic of the invention, before the third stage of placing enrichment anodes in each negative, an anode-placing diagram is made on each negative and in accordance with this diagram a computer simulation of the electrolytic plating of nickel is performed on each negative.

[0024] According to another characteristic of the invention, after the eighth stage, a dimensional control of the mould produced is performed.

Brief description of the drawings

[0025] The attached drawings illustrate, by way of non-limiting example, a preferred embodiment of the casting mould object of the invention. In said drawings:

Fig. 1 is a perspective view of the cast piece to manufacture with the casting mould object of the invention;

Fig. 2 is a perspective view of a print model of the cast piece of Fig. 1;

Fig. 3 is a perspective view of a negative of the print model of Fig. 2;

Fig. 4 is a perspective view of another embodiment of a negative of the print model of Fig. 2;

Fig. 5 is a perspective view of the nickel coquille corresponding to the negative of Fig. 3;

Fig. 6 is another perspective view of the nickel coquille of Fig. 5;

Fig. 7 is a perspective view of the mounting of the nickel coquille of Fig. 5 in a container;

Fig. 8 is a perspective view of the casting mould;

Fig. 9 is a sectional view of a horizontal cut of the nickel coquille of Fig. 4 electrodeposited on the negative of Fig. 3;

Fig. 10 is a detailed view of a partial cross-section of the nickel coquille of Fig. 5; and

Fig. 11 is a perspective view of a sand block formed by the casting mould of Fig. 8;

Fig. 12 is a partial sectional view of a cross section of the fitting of the nickel coquille of Fig. 5 in a container;

Fig. 13 is a perspective view of a second embodiment of a nickel coquille; and

Fig. 14 is a partial sectional view of cross-section of the fitting of the nickel coquille of Fig. 13 in a container.

Detailed description of the drawings

[0026] Sand waste moulds, confined in a moulding box, are known to manufacture a cast piece 2. A moulding box is usually formed from two or more parts of waste moulds and each of these parts comprises a casting sand block 10 which partially reproduces the cast piece 2 in negative. Obviously, the number of parts of waste moulds

which form the moulding box of a sand waste mould will depend on the geometry of the piece or pieces to manufacture.

[0027] Fig. 11 depicts a casting sand block 10 whose cavity reproduces in negative half of the piece 2 of Fig. 1. Bearing in mind that the cast piece 2 of Fig. 1 is symmetrical with respect to its axial axis, the sand waste mould can be formed from two parts of opposite waste moulds. Each one of these parts of moulds must comprise the casting sand block 10 of Fig. 11, so that when both parts are opposed, an interior space will be configured, a negative reproduction of the piece 2 of Fig. 1, which will be filled with liquid metal during the casting process.

[0028] The forming of the casting sand 10 represented in Fig. 11 may be performed according to different processes, such as that consisting of compacting the sand by pressing the casting sand block against an expensive metal model of the piece 2 or against a casting mould 1 such as that represented in Fig. 8.

[0029] As is observed in Fig. 8, the casting mould 1 is composed of a hollow body, which is rigid and closed, represented in the drawings as a prismatic body, provided with a rear cover 93, mechanically joined to the perimeter frame of the hollow prismatic body 5 by four screws, not represented, or any other similar means. The drawing shows that the wall of the hollow body is provided with a portion composed of a nickel coquille 8, arranged gap-free with respect to the rest of the wall of the hollow body. The interior of the hollow prismatic body is filled with a temperature-resistant epoxy resin, with low linear shrinkage and which easily chills the temperature, the entire inner surface 84 of the nickel coquille 8 being in contact with this filling material. For its part, as shown in Fig. 7, the rear cover 93 is provided with a taphole 94 to introduce the resin inside the hollow prismatic body and four air outlets 95.

[0030] Below, the process for the manufacturing of a casting mould 1, represented in Fig. 8 is described, which permits forming a casting sand block 10 in the form shown in Fig. 11 for the casting of the cast piece 2 of Fig. 1.

[0031] The starting situation for the production of the nickel coquille 8 comprised in the casting mould 1 consists of placing a print model 3, represented by way of example in Fig. 2, three-dimensionally modelled in a computer file or having a contour plan. The most typical form wherein the plans to make the mould are submitted are in computer files with three-dimensional modelling. This file permits, using a data translating program, its transformation in a machining file, with which the print model 3 can be performed by a moldable and/or machinable plate of non-metallic material, such as, for example, polyurethane with density over 0.75 g/cm^3 .

[0032] The traditional form, which is increasingly less used, is that of producing the print model 3 from a contour plan. In this case, the print model 3 is manually made in wood or resin.

[0033] Said Fig. 2 shows the print model 3 in accord-

ance with the cast piece 2 of Fig. 1. The usefulness of the print model 3 lies in the fact that on this it is possible to make all the modifications and modifications and adjustments to achieve the cast piece 2 with the final specifications, as the materials wherein it is made can be easily modified.

[0034] The first stage for the manufacturing of the casting mould 1 consists of the production and surface finishing of a negative 4 of the print model 3. This negative 4 is made of non-porous resin and its outer surface must be a colour visibly different to that of the nickel plating, i.e. a colour other than grey. For the embodiment of the negative 4, firstly, a brush is used to apply a surface layer of a resin and then a filling resin is applied which has high dimensional stability. For those cases where the pouring volume of resin exceeds 10 mm, a core is placed inside the negative 4 to avoid excessive thickness in the pouring which may create an exothermic reaction which is unfavourable for the process.

[0035] It is also possible to make the negative 4 on a machinable plate, if the dimensional stability requirements are important, despite the fact that adjusting the dimensions with the plate involves a long time duration, and consequently, a higher cost. In these cases, it is advisable that the plate has a density over 1 g/cm^3 to ensure a correct surface finishing.

[0036] As will be seen below, a factor to be taken into account when making the negative 4 is that it must have a perimeter band 41 with a minimum width of 10 mm, as is shown in the two embodiments of negatives 4 of Figs. 3 and 4 wherein the perimeter band 41 is flat. On occasions, the print model 3 used already has a band, so that the negative 4 is already created with this flat perimeter band 41.

[0037] The negative 4 is conductivized in the second stage of the casting mould 1 production process. Said conductivizing consists of applying, generally with an air pistol or similar device, a silver paint with micron thickness on the entire surface of the negative 4 that one wants to reproduce in the electrodeposited nickel coquille 8. In the case of negatives 4 made with metal plate, an insulating paint should be applied on the metal surface of the negative 4 whereon one does not want to electrodeposit nickel. It is important to ensure that the flat perimeter band 41 of the negative 4 is conductivized, as the nickel plating in this zone will permit the subsequent fitting of the nickel coquille 8 in the container 9.

[0038] As previously mentioned, the nickel coquille 8 is a coquille formed by the electrodeposition of said metal on the negative 4. This electrodeposition is performed in a nickel electrolyte bath basically formed from two electrodes, an anode and a cathode, immersed in a conductor electrolyte which contains the metal salts and by a DC source. When the current circulates between the two electrodes, the metal ions in Ni^{2+} solution are reduced to nickel metal on the cathode surface and they are deposited micron by micron producing a continuous deposit. The phenomenon of growth of all points by elec-

trodeposition is known as electroforming and can be advantageously applied for the manufacturing of many fine products, such as metal sheets, whose manufacturing by smelting processes involve a greater cost.

[0039] Nevertheless, the electroforming process is not exclusively limited to the deposition of metals to form fine objects but it also permits producing electroforms from a metal deposit of a determined thickness on the conductivized surface of a negative 4, being able to then separate the electroform from said negative 4.

[0040] In the electroforming of the nickel which composes the nickel coquille 8, the two electrolytes used are nickel sulfamate solutions and nickel sulfate solutions, due to their favourable physical and mechanical properties. Properties such as hardness, ductility or internal stress of the electroform may be varied changing the electrolyte and the operating conditions thereof. It has been demonstrated that nickel sulfamate and nickel sulfate solutions allow very high deposition rates to be produced in comparison with other electrolytes.

[0041] In addition to the electrolytes, the other two basic components for electroforming are the anode and the cathode. In this case, the anode used is nickel metal and this will dissolve according to the anodic conditions used. For its part, the cathode is the conductivized negative 4, which is where the nickel will be deposited during the electrodeposition of the metal.

[0042] The electroforming which composes the nickel coquille 8 enable high accuracy to be obtained in the reproduction of forms and surface, such as those which the cast piece 2 of Fig. 1 have.

[0043] Returning to the stages of the manufacturing process of the casting mould 1 of Fig. 8, after the negative 4 conductivizing stage, the third stage is performed, consisting of placing the enrichment anodes in the negative 4. Using the enrichment anodes, the aim is to achieve that the final thickness of the nickel deposition is as homogeneous as possible, in turn favouring homogeneity in current intensity throughout the electrolyte.

[0044] In this stage, the enrichment anodes are placed in the conductivized negative 4, bearing in mind that once the negative 4 is introduced in the electrolyte bath, there will be a drop in the electric field in the concave zones 43 and a high field intensity in the convex zones. For this reason, it is very important to place the enrichment anodes close to the concave zones 43 of the conductivized negative 4.

[0045] Optionally, before the third stage of placing the enrichment anodes in the conductivized negative 4, a diagram of said arrangement is made, being able to convert said arrangement diagram in a computer file which allows a computer simulation to be made of the electrolytic deposition of the nickel on the negative 4.

[0046] The fourth stage consists of introducing the negative 4 with the corresponding enrichment anodes in a nickel electrolyte bath such as that described above. To be able to introduce the negative 4, and later remove it, the latter must be held by cinches to correctly position

it in the electrolytic pot of the bath.

[0047] Once inside the electrolyte bath, in the zones of the negative 4 considered as critical, the anodes should be positioned as close as possible to the negative 4, controlling during the electrodeposition process that said anodes cannot come into contact with the deposition, as said contact would spoil them. To do this, the enrichment anodes will be placed in an enveloping metal structure (not represented) of the negative 4 with mobile regulation to be able to vary and adjust the distance of these anodes to the nickel which is being deposited on the conductivized surface of the negative 4.

[0048] Another of the problems that this may present is related to the arrangement of the negative 4 within the nickel electrolyte bath, as there may exist zones wherein the electrolyte does not circulate, zones without fluid circulation, in this way causing the localized derichment of the nickel concentration. To resolve this problem, currents are generated in the bath so that there always exists a movement of current throughout the zones of the bath, increasing the power and placing current thermocouples close to these complicated zones.

[0049] In the way indicted above, homogeneity is produced in both current intensity and in the nickel ions within the electrolyte bath.

[0050] The fifth stage comprises the production of the nickel coquille 8 by electrodepositing a first layer 81 of nickel/cobalt on the conductive surface of the negative 4, followed by electrodepositing a second layer 82 of pure nickel. The first layer 81 of nickel/cobalt serves to give greater hardness to the layer whereon the pure nickel will be deposited. As has already been mentioned, it is very important to control and adjust at all times the distance of separation of the enrichment anodes with respect to said depositions as the latter are deposited on the negative. Fig. 9 shows the section of a horizontal cut of the nickel coquille 8 electrodeposited on the negative 4 of Fig. 3.

[0051] To produce a nickel coquille 8 appropriate for a casting mould 1, it must have a variable thickness between 2.5 and 3 mm, as the irregularity of the thickness usually varies approximately 0.5 mm, and below a thickness of 2.5 mm there may be later difficulties if one wants to make any modifications to a piece, a situation very typical in the casting field. This deposition modification will be what sets the time the conductivized negative 4 must be in the bath, whereby the electrodepositions of the fifth stage are performed the time necessary to achieve that the nickel coquille 8 has a minimum thickness of 2.5 mm.

[0052] In the sixth stage of the process, the negative 4 of the nickel coquille 8 is demolded, once the latter has been removed from the electrolyte bath. In normal conditions, the nickel coquille 8 represented in Figs. 5 and 6 will easily be separated from the negative 4. If this was not the case, it is recommended not to force the demolding as the nickel coquille 8 may be deformed.

[0053] Fig. 10 shows a partial section of a cross-sec-

tion of the nickel coquille 8 produced according to the negative 4 of Fig. 3. The drawing shows that two surfaces are clearly distinguished in the nickel coquille: an outer surface 83, which corresponds to the one oriented towards the negative 4 during the electrodeposition, and an inner surface 84, opposite the outer one and which is provided with trees 85. It is also observed in Figs. 6 and 9 that, on the flat perimeter band 41 of the negative 4, a corresponding second flat perimeter band 86, also provided with trees 85, has been formed in the nickel coquille 8.

[0054] The electroformed nickel, i.e. the nickel coquille 8 produced, is highly resistant to compression moulding processes, where high pressures are attained, achieves high accuracy in the reproduction of surface details and has good resistance to wear and corrosion, for which reason it is considered a material technically suitable for the manufacture of casting moulds 1. Among its most important physical properties are included resistance to traction, ductility or elongation, hardness or internal stress. For its part, nickel has greater resistance to wear in heat than other metals.

[0055] The mechanical and physical properties of the electroform or nickel coquille 8 are of particular importance as it will work alone once it has separated from the negative 4. This fact what differentiates a nickel coquille 8 from a nickel coating, as the latter is deposited on a substrate to improve the appearance or resistance of the substrate against corrosion, a reason for which the mechanical properties of the coating are not normally of great importance.

[0056] In the seventh stage of the process, the nickel coquille 8 is fitted in a container 9, represented in the drawings with prismatic configuration, provided with a rear cover 93, represented in Fig. 7. This container 9 is provided with an opening made in its wall whose contour comprises a coupling zone 92, also called fitting zone, adapted to tightly receive the fitting of the second flat band 86 of the nickel coquille 8. To facilitate the coupling and fitting, and achieve that the nickel coquille 8 is flush with the upper wall of the container 9, it is recommended to polish the perimeter zone of the second band 86, eliminating the trees 85 from this zone, as is seen in Fig. 6, flattening the support part of the coupling of the nickel coquille 8. It has previously been commented that the flat perimeter band 41 of the negative 4 has a minimum width of 10 mm. This width is what makes the second band 86 of the nickel coquille 8 capable of resting in said coupling zone 92.

[0057] According to the above, the nickel coquille 8 coupled to tightly fit to the container 9 wall, provided in turn with a rear cover 93 equipped with a taphole 94 and several air outlets 93, composes a rigid, closed hollow body.

[0058] Figs. 12 and 14 show a cross section of the coupling of the nickel coquille 8 of Figs. 5 and 13, respectively, in an opening of one of the walls of the container 9 body. As has previously been mentioned, the container

9 opening is provided in its contour with a coupling zone 92 designed to tightly receive the fitting of the second flat band 86 of the nickel coquille 8. In Fig. 12, the coupling zone 92 is formed by an external perimeter inlet whereon the second flat band 86 of the nickel coquille 8 of Fig. 5 rest. It is observed that the nickel coquille 8 is tightly fitted and arranged gap-free, and flush, with respect to the rest of the container 9 wall.

[0059] On the other hand, in Fig. 14 the coupling zone 92 is formed by an internal inlet wherein the second flat band 86 of the nickel coquille 8 of Fig. 13 is fitted. In this case, the nickel coquille 8 will have to be introduced through the rear part of the container 9, removing the rear cover 93. It is noteworthy in this point that it is recommendable to have performed an enrichment of the nickel deposition on the perimeter band 41 of the negative 4 to produce a second flat perimeter band 86 of the nickel coquille 8 of greater thickness for the purposes of strengthening the coupling and anchoring of the coquille in the container 9 wall.

[0060] Figs. 12 and 14 show that the inner surface 84 of the nickel coquille 8 is oriented towards the interior of the container 9, and therefore, towards the interior of the hollow body, which is rigid and closed, so that the only surface which is externally seen is the outer surface 83, which will be the one that comes into contact with the casting sand 10 to form it.

[0061] Once the nickel coquille 8 is fitted in the container, the rear cover 93 is mechanically fixed to said container, e.g. screwing it to the base of the perimeter frame which forms the container 9. As is seen in Fig. 7, the rear cover 93 is provided with a taphole 94 and several air outlets 95.

[0062] The unit formed by the container 9, its rear cover 93 and the nickel coquille being formed and sealed, all this forming a hollow body, which is rigid and closed, the interior of said hollow body is filled, via the taphole 94, with a hardenable filling material, a resin, e.g. epoxy type, which is temperature resistant, of low linear shrinkage and which permits good heat sinkage. In this way, the casting mould 1 represented in Fig. 8 is produced.

[0063] It is worthy of note that the part of the nickel coquille 8 not seen in the casting mould 1, i.e. the inner surface 84, has not been polished nor have the trees 85 been eliminated, as precisely the roughness of the trees 85 improves the adhesion of the resin which fills which the interior of the hollow body, which is rigid and closed, which composes the casting mould 1.

[0064] Once the casting mould 1 is finished, it will undergo a three-dimensional control, after which it is considered suitable for its use to form the casting sand 10.

[0065] The previous description based on the drawings explains the manufacturing process of a casting mould 1 which comprises a single nickel coquille 8. It should be added that a single casting mould 1 may comprise more than one nickel coquille 8, depending on whether one wants to use the casting mould 1 to manufacture more than one cast piece 2.

[0066] In this way, if one wants to form the casting sand 10 to cast several cast pieces 2, the container 9 will have as many openings as print models 3 in its wall corresponding to the pieces 2 to cast and corresponding nickel coquilles 8 will be fitted in these openings. The rear cover 93 which the container 9 is provided with will be equipped with at least one taphole 94 and several air outlets 95 to fill the interior of the rigid and closed hollow body which composes the casting mould 1 with the hardenable filling material, the inner surface 84 of each nickel coquille 8 remaining in contact with the filling material.

Claims

1. Casting mould (1), of the type designed to form casting sand (10) to reproduce pieces (2), **characterized in that** said mould is composed of a hollow body, essentially rigid and closed, whose interior is totally filled by a hardenable filling material, the wall of the hollow body being provided with at least one portion composed of a nickel coquille (8) arranged gap-free with respect to the rest of the body wall, and the entire inner surface (84) of each nickel coquille being in contact with said filling material.
2. Casting mould (1) according to claim 1, **characterized in that** each nickel coquille (8) comprises a first layer (81) of nickel/cobalt electrodeposited on the surface of a corresponding conductivized negative (4) of each piece (2) to be reproduced, and a second layer (82) of pure nickel electrodeposited on the first layer.
3. Casting mould (1) according to claim 2, **characterized in that** each nickel coquille (8) has a minimum thickness of 2.5 mm.
4. Casting mould (1) according to one of the previous claims, **characterized in that** the hollow body is provided with a cover (93) equipped with at least one taphole (94) and of at least one air outlet (95).
5. Casting mould (1) according to one of the previous claims, **characterized in that** the hardenable filling material which totally fills the interior of the hollow body is a resin resistant to temperature, heat sinker and of low linear shrinkage.
6. Process for the manufacturing of the casting mould (1) according to claims 1 to 5, **characterized in that** it comprises
 - a first stage of production and surface finishing of a negative (4) for each print model (3) of each piece (2) to be reproduced, in non-porous resin or on a machinable plate, wherein said negative is provided with a perimeter band (41);

- a second stage of conductivizing the negative of each print model;
 - a third stage of placing enrichment anodes in each negative, placing them close to the concave areas (43) thereof;
 - a fourth stage introducing the negatives with the corresponding anodes in a nickel electrolyte bath;
 - a fifth stage of producing a nickel coquille (8) for each negative, produced by electrodepositing a first layer (81) of nickel/cobalt on the conductive surface of the negative, followed by electrodepositing a second layer (82) of pure nickel, controlling and adjusting at all times the separation distance of the enrichment anodes with respect to said depositions as they are being deposited on the negative, so that the enrichment anodes do not come into contact with said depositions;
 - a sixth stage wherein the negative of each nickel coquille is demolded, once this has been removed from the electrolyte bath, an outer surface (83) being differentiated on each nickel coquille, which corresponds to that which was oriented towards the corresponding negative, and an inner surface (84) opposite the first one and which is provided with trees (85), in addition to a second perimeter band (86) which corresponds to the deposition of nickel on the perimeter band (41) of the negative;
 - a seventh stage of tightly fitting each nickel coquille in a corresponding opening made in the wall of a container (9), the inner surface of each nickel coquille remaining oriented towards the interior of the container; and
 - an eighth stage wherein, the container being provided with a rear cover (93) mechanically fixed and equipped with at least one taphole (94) and at least one air outlet (95), and having joined and sealed the unit composed of the container, its rear cover and each nickel coquille, the interior of said unit is filled, via each taphole, with a temperature resistant resin, which permits good heat sinkage and low linear shrinkage, producing the casting mould.
7. Process for the manufacturing of a casting mould (1) according to claim 6, **characterized in that**, in the second stage of conductivizing each negative (4), a metal paint (52) is applied covering the entire surface of the negative to be reproduced in the mould, the zones (42) of the negative which one does not want to reproduce remaining uncoated, or coated with insulating paint (51) if the negative is metal.
 8. Process for the manufacturing of a casting mould (1) according to claim 6 or 7, **characterized in that** the electrodepositions of the fifth stage are performed

the time necessary until achieving that each nickel coquille (8) has a minimum thickness of 2.5 mm.

9. Process for the manufacturing of a casting mould (1) according to one of claims 6 to 8, **characterized in that** in the nickel electrolyte bath, the electrolytes are nickel sulfamate solutions and nickel sulfate solutions. 5
10. Process for the manufacturing of a casting mould (1) according to one of claims 6 to 9, **characterized in that** the flat perimeter band (41) of each negative (4) has a minimum width of 10 mm. 10
11. Process for the manufacturing of a casting mould (1) according to one of claims 6 to 10, **characterized in that** in the first stage, the negative (4) is made with a surface layer of non-porous resin, of a colour substantially different to that of the electrodeposition of the second layer (82) of pure nickel, and with a filling resin applied by pouring. 15 20
12. Process for the manufacturing of a casting mould (1) according to one of claims 6 to 11, **characterized in that** before the third stage of placing enrichment anodes in each negative (4), an anode-placing diagram is made on each negative and, in accordance with this diagram, a computer simulation is made of the electrolytic deposition of nickel on each negative. 25 30
13. Process for the manufacturing of a casting mould (1) according to one of claims 6 to 12, **characterized in that** after the eighth stage a dimensional control of the mould produced is performed. 35

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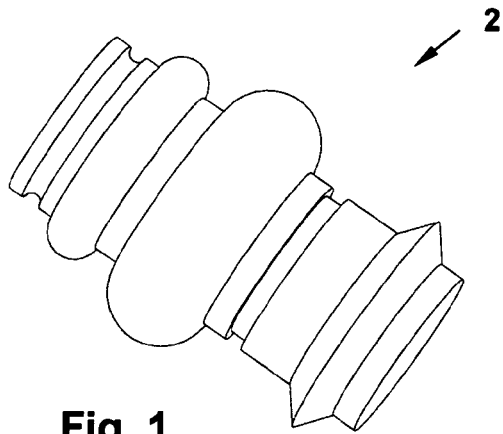


Fig. 1

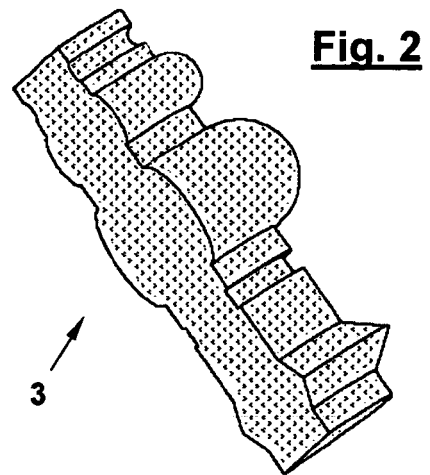


Fig. 2

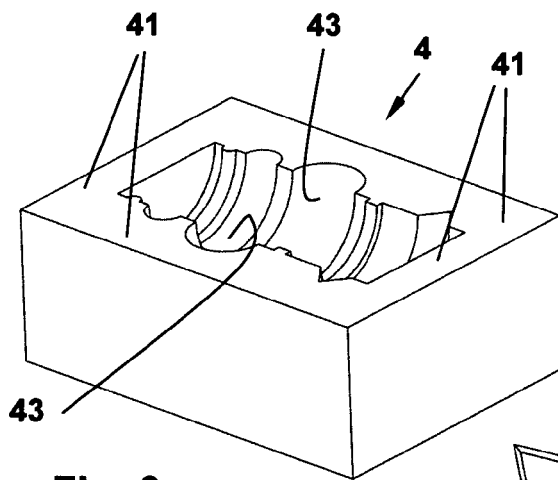


Fig. 3

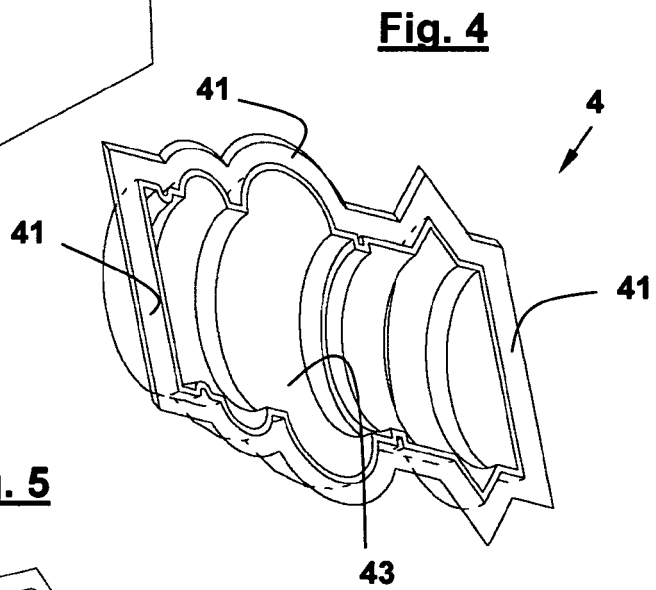


Fig. 4

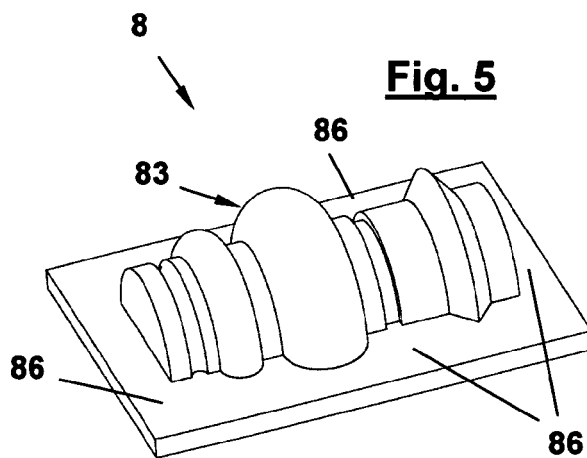


Fig. 5

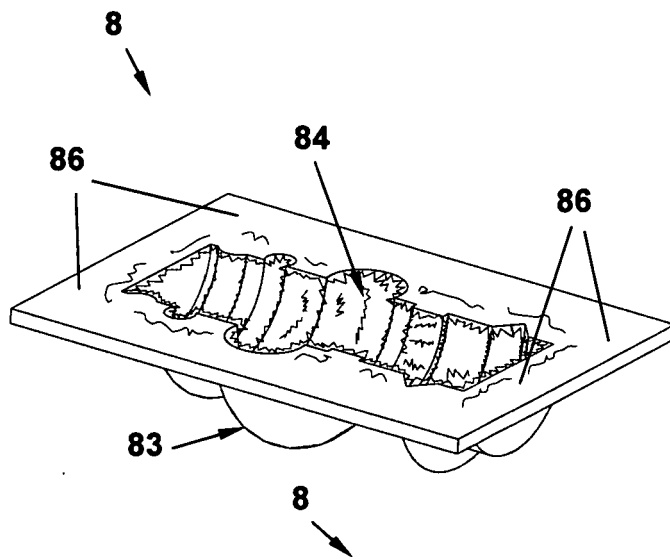


Fig. 6

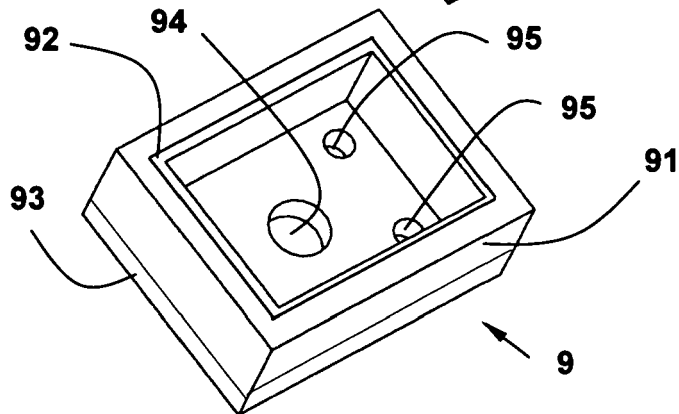
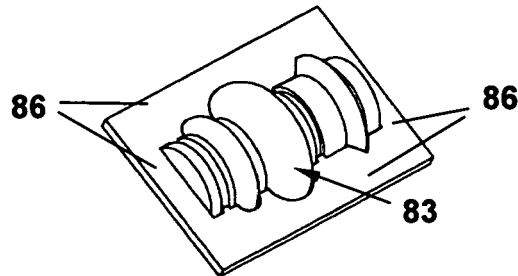


Fig. 7

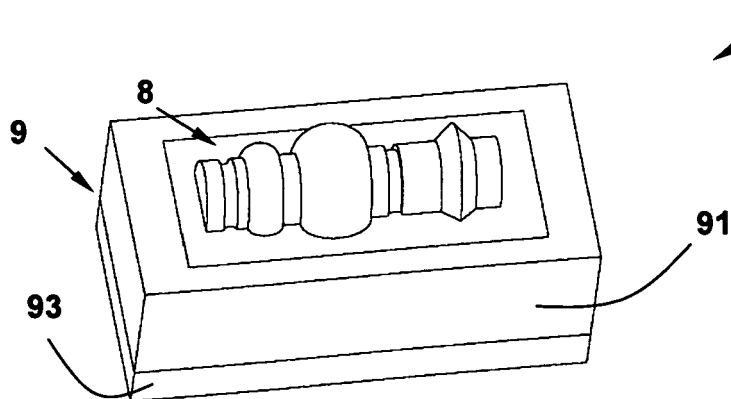
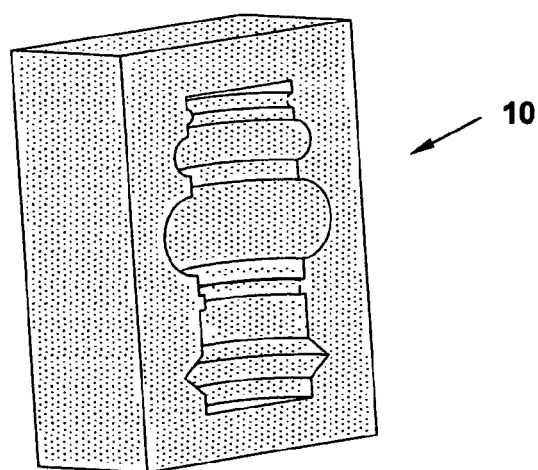
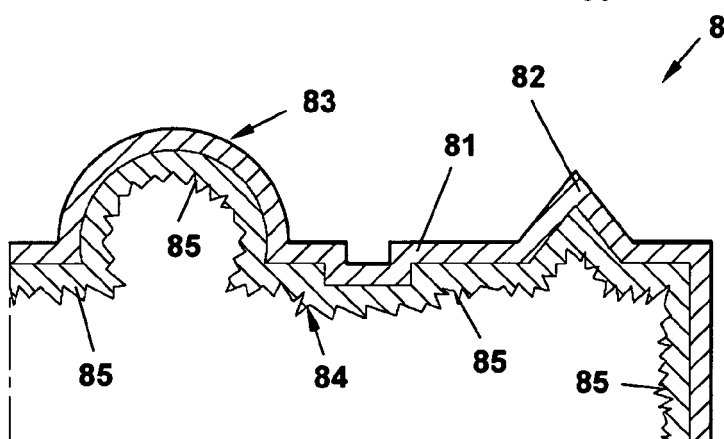
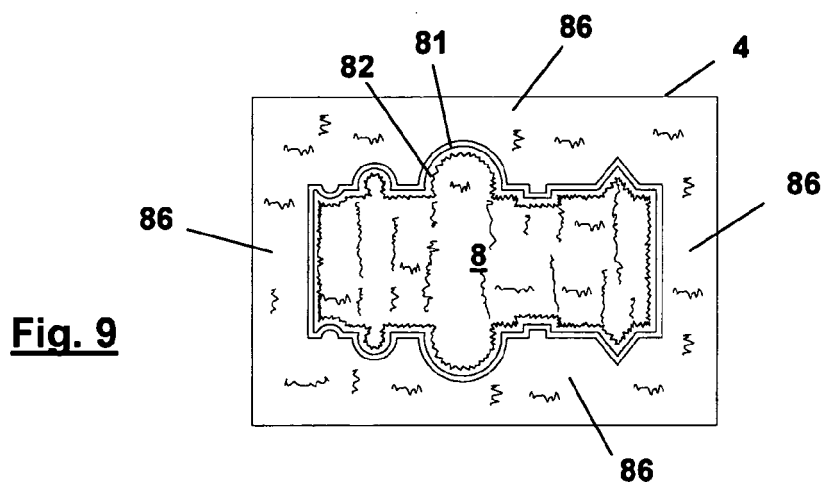


Fig. 8



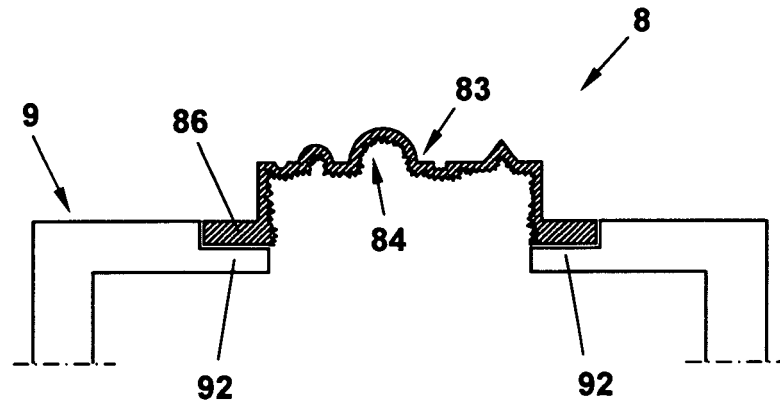


Fig. 12

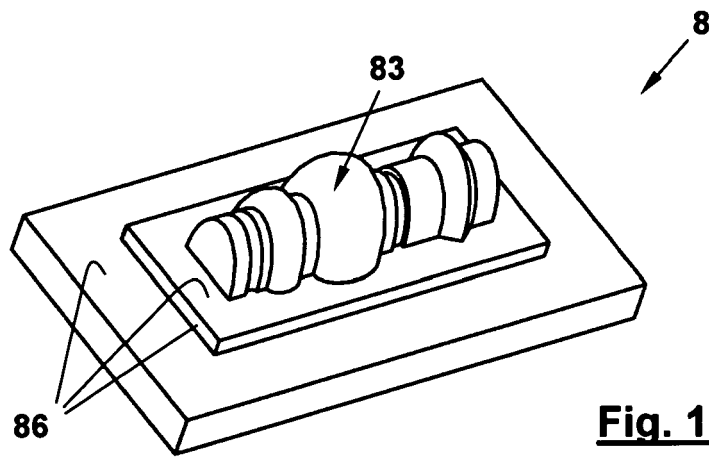


Fig. 13

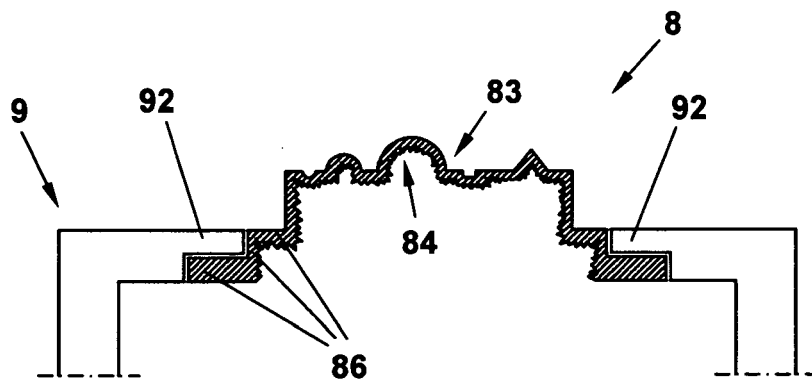


Fig. 14