United States Patent

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Original application July 12, 1968, Ser. No. 744,484, now Patent No. 3,552,480.
Divided and this application May 13, 1970, Ser. No. 36,869

[54] METHOD OF MAKING A SAND MOLD WITH A BACK DRAFT

9 Claims, 12 Drawing Figs.

[52] U.S. Cl. 164/44, 164/245

[51] Int. Cl. B22c 9/00
[50] Field of Search 164/15, 23, 27, 44, 43, 227, 245

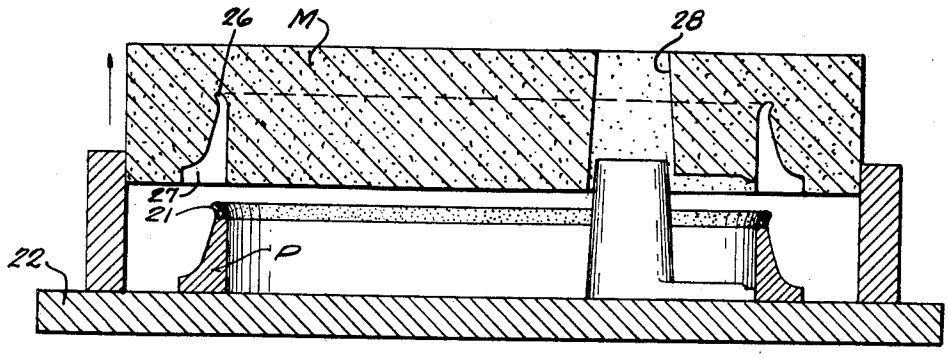
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Primary Examiner—R. Spencer Annear
Attorney—James E. Nilles

ABSTRACT: A method of making a sand mold of the heat-cured type by using a composite metal and flexible material pattern. An improved product made from such a method.



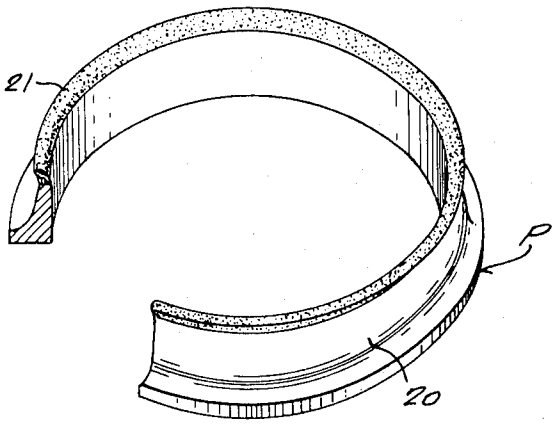


Fig. 1

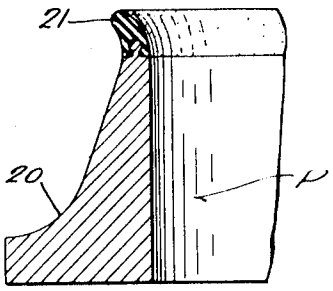


Fig. 2

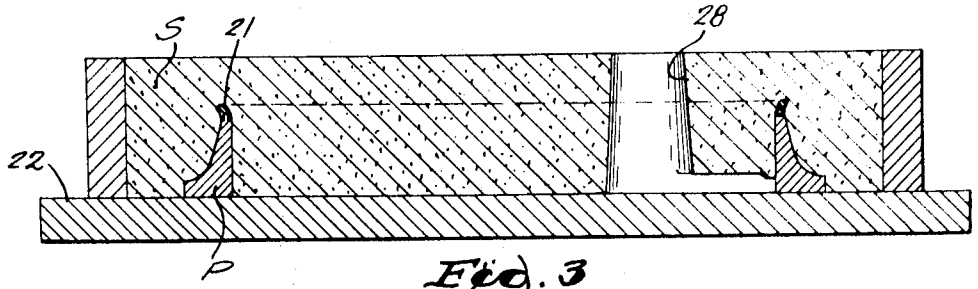


Fig. 3

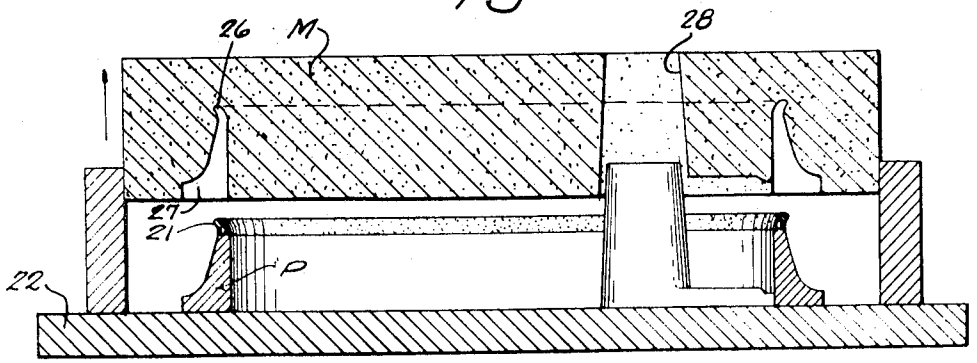


Fig. 4

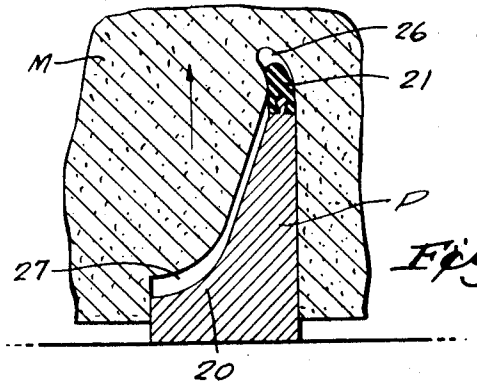


Fig. 5

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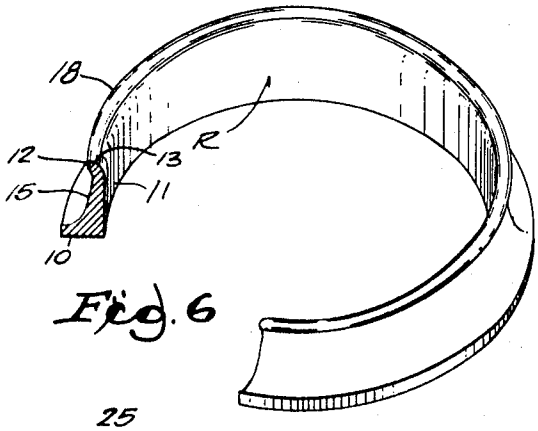


Fig. 6

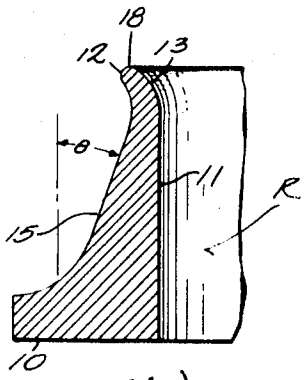


Fig. 7

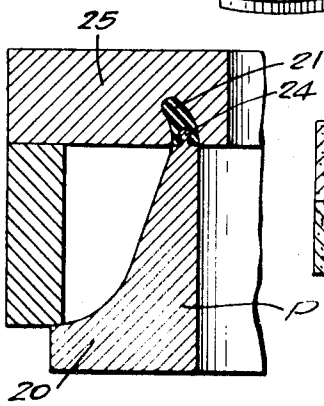


Fig. 8

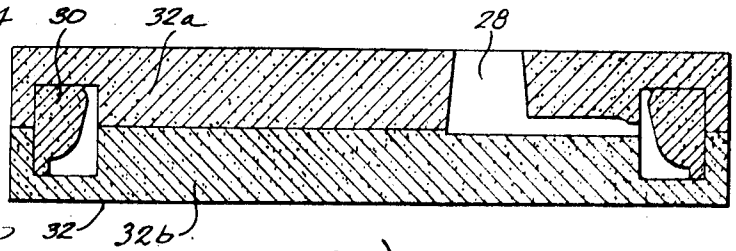


Fig. 9
PRIOR ART

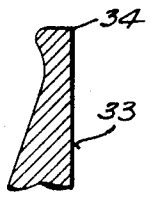


Fig. 10
PRIOR ART

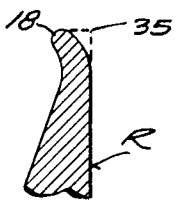


Fig. 11

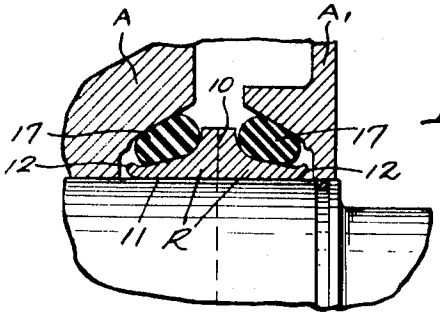


Fig. 12

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METHOD OF MAKING A SAND MOLD WITH A BACK DRAFT

CROSS-REFERENCE TO RELATED APPLICATION

This a divisional application of the copending U.S. application Ser. No. 744,484, filed July 12, 1968, and entitled "Pattern for Making a Sand Mold with a Back Draft" issued as U.S. Pat. No. 3,552,480 on Jan. 5, 1971.

BACKGROUND OF THE INVENTION

The invention pertains generally to a method of making a sand mold. Prior methods have not been generally successful for making shell molds in which resin-bonded sand is cured at a relatively high heat in a relatively short period of time. In making sand molds of this character, it has heretofore been necessary to make the pattern of three pieces if back draft areas were present in the mold. These patterns and molds were costly to make and incapable of high production rates.

SUMMARY OF THE INVENTION

The presently invention provides a method for making a sand mold of the heat-cured type, which method includes the use of a composite metal and flexible pattern, the flexible material being bonded to the metal and functions to form the back draft area of the mold.

The invention provides a method of making a sand mold having a back draft and of heat-cured sand, such as resin-bonded sand which may be cured at about 400° F. or more. The method includes providing a pattern of metal having flexible material bonded thereto, and with the flexible material arranged to form the area of back draft in the sand mold, placing heat-curable resin-bonded sand around the pattern, heating the sand to at least about 400° F. and withdrawing the pattern and thereby causing the flexible material to flex out of the back draft area of the sand mold and without damaging the sand mold. A more specific aspect of the invention contemplates the use of silicone rubber as the flexible material.

These and other objects and advantages of the present invention will appear hereinafter as this disclosure progresses, reference being had to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a pattern, used with the present invention, for a mold for making a seal ring, a portion being shown as broken away and in section for clarity;

FIG. 2 is a cross-sectional view through FIG. 1, but on an enlarged scale;

FIG. 3 is a cross-sectional view through a pattern as shown in FIG. 2 and as it is located in a sand mold;

FIG. 4 is a view similar to FIG. 3 but showing the cured sand mold being removed;

FIG. 5 is an enlarged view of a portion of the FIG. 3 arrangement, but with the mold as it is partially removed and with the pattern back draft portion deformed;

FIG. 6 is a perspective view, with a portion broken away, of a seal ring made in accordance with the present invention;

FIG. 7 is an enlarged, fragmentary, sectional view through a seal ring made in the mold shown in FIGS. 3, 4, and 5;

FIG. 8 is a cross-sectional view through a pattern of FIG. 2, but showing the negative mold used to cast the flexible material to the metal portion of the pattern;

FIG. 9 is a cross-sectional view through a conventional three-piece mold for making a seal ring;

FIG. 10 is a fragmentary, cross-sectional view on an enlarged scale of a portion of a conventional seal ring made in the conventional mold shown in FIG. 9;

FIG. 11 is a fragmentary, sectional view of a seal ring made in accordance with the present invention, similar to the FIG. 7 showing, but in addition showing in dotted line the conventional corner of the conventional seal ring of FIG. 10;

FIG. 12 is a fragmentary, cross-sectional view through a shaft and its parts and showing a pair of seal rings in use and which have been made in accordance with the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

The seal ring R made in accordance with the present invention, is shown in cross section in FIG. 7 and in perspective in FIG. 6. These extremely hard ferrous alloy rings are also shown in use in FIG. 12 and are slipped on a shaft in back-to-back relationship, that is with their radial surfaces 10 abutting one another. A pair of metal parts A and A1, such as for example a track roller and a seal cover, respectively, are also mounted on the shaft and must be sealed.

The rings are mounted on the shaft by their generally cylindrical axially extending central opening, defined by their relatively long internal, cylindrical surface 11. The small end 12 (FIG. 7) of a ring has a rounded corner 13 extending from the cylindrical surface 11 and then curves radially away from the surface 11. The rounded internal corner 13 at the junction of the central opening of the ring, is important and will be referred to later. The ring R also has an external, annular inclined surface 15 which diverges in an axial direction away from the smaller end of the ring R. The angle θ of this inclination is about 15° from the longitudinal axis, as shown in FIG. 7. This inclined surface 15, is inclined radially outwardly in a direction away from the part P or P1 against which its O-ring will seal. It is on this inclined surface that a flexible O-ring seal 17 is mounted so that when assembled, the seal 17 is pushed against the metal part to thereby urge it into sealing position.

Referring again to the shape of the metal seal ring R, it has a generally radially extending flange 18 which extends radially beyond a portion of the inclined surface 15 and functions to hold the flexible O-ring seal 17 on the ring R until final assembly of the parts and seals can be made. Thus the small rounded flange 18 forms an important part of the metal seal ring R, and the ring R must be made precisely and with a good finish so as to prevent injury to the flexible seal 17 and also to ensure accurate and easy assembly. The surface 10 of each of the ring R is precisely finished to form a seal against the adjacent surface 10 of the adjacent ring R.

The ring R is preferably made of Stellite, and is made by a shell-molding process and by a novel mold pattern now to be described.

A pattern P is made of a relatively larger, metal portion 20, for example of aluminum. A portion of the pattern 21 is also formed of flexible material, and silicone rubber has been found to be particularly desirable in this respect. Other flexible materials may be used, such as for example, Teflon which are resistant to the high heat necessary to cure the resin-bonded sand S of which the mold is to be made. The invention will be described as using silicone rubber as the flexible material.

When a mold is to be made, the pattern P is placed on a heated surface 22, such as for example, a heated table used in core-making machines of the type shown in the copending U.S. application Ser. No. 719,130, filed Apr. 5, 1968, issued as U.S. Pat. 3,516,477, on June 23, 1970. If a description of the means and method for placing the sand around the pattern P is deemed to be either necessary or desirable, reference may be had to that patent. However, it is believed sufficient to say for purposes of this disclosure, that the pattern P and the resin-bonded sand S which is poured over the pattern P, are heated to cure the sand. Preferably, a curing temperature at least about 400° F. is used with the present invention, which gives good production rates. Of course lower temperatures can be used, but undesirably long curing times are then required.

The entire pattern P is of a shape such as above described for the finished seal ring R, and it will be noted that the silicone rubber forms only a relatively small portion of the whole pattern. The rubber is provided for that portion of the pattern which will form the back draft portion of the sand mold, namely, that portion which ultimately forms the rounded flange 18 of the ring R.

The silicone rubber used in the present pattern not only can withstand the necessary curing heat, but it is of a sufficient durometer hardness to hold its proper shape during the sand-filling operation of the mold box and pattern, and also during the heat curing of the mold. On the other hand, the silicone rubber has sufficient resiliency to be withdrawn from the cured mold, as will appear, without damage to itself or to the mold. A durometer hardness of about 40 to 50 has been found to be very satisfactory.

As shown in FIG. **8**, in making the pattern P, the silicone rubber is fixed or bonded to the metal portion **20** of the pattern by injection molding, and the metal portion **20** has an undercut projection **24** around which the rubber flows in binding relationship in the negative mold **25** which is used to cast the rubber on the end of the metal portion **20** of the pattern. Variously shaped, roughened or notched surfaces may be used on the end of the metal portion of the pattern to insure a good connection with the rubber portion.

As shown in FIG. **4**, after the sand mold M has been heat cured, the pattern P is removed or the mold is lifted from the pattern. FIG. **5** shows this initial relative movement during which the silicone rubber portion **21** of the one-piece pattern P must be withdrawn from the back draft area **20** of the mold. As shown in FIG. **5**, the pattern has been partially removed, the silicone rubber deforming temporarily so as to pass from the back draft area **26** and into the larger, unrestricted area **27** of the mold.

FIG. **9** illustrates a conventional three-piece, sand mold previously used, the inner sand mold part **30** being of a ring shape and set within the outer mold part **32** which is formed in halves **32***a* and **32***b*. Considerable labor is required in manufacturing and assembling these three mold pieces which were previously required to form metal parts with back draft areas.

Passages **28** have also been formed in the mold through which the metal is poured in casting the finished parts.

FIG. **10** shows the shape of the flange end of a seal ring **33** made on the conventional three-piece mold of FIG. **9**. It will be noted that inside corner **34** is square.

FIG. **11** shows a comparison of the cross-sectional shapes of the ring R made with the present invention and the ring **33** made by conventional means. By making the inner corner of a round shape as in ring R, the silicone rubber can be withdrawn from the mold, as shown in FIG. **5**. If the corner were square, the extra rubber material in the square corner area **35** (FIG. **11**) would not permit twisting of the flange-shaped, silicone rubber **21** in an axially direction (to the right as viewed in FIG. **4**) as the rubber **21** is being pulled from the back draft area **26**.

With the present invention, it is possible to provide a one-piece pattern for making a heat-cured mold having a back draft area, and from resin-bonded sand, for use in a shall molding process. The metal portion **20** of the pattern P acts to conduct the necessary curing heat from the heated surface **22** and to the sand. The larger metal portion **20** also can transfer the necessary heat to the sand which surrounds the smaller rubber portion **21** of the pattern. Thus the metal is required to properly and adequately conduct the heat, but an all metal pattern could not be used. On the other hand, a pattern of all flexible material could not be used in this mold-making process.

Thus the present invention provides an improved method for making a heat-cured, sand mold, and also provides an improved product.

I claim:

1. A method of making a sand mold having an internal back draft portion in its cavity, said mold being of the cured type, comprising; forming a composite pattern of metal portion and flexible portion, said flexible portion joined to said portion complementing the shape of the said back draft portion of such cavity in said mold; placing curable sand mixture around said pattern; curing said sand mixture to thereby cure and harden said sand and form a cavity having a back draft portion; and separating said mold from said composite pattern in a substantially straight line of movement so that the shape of the mold causes said flexible portion to temporarily deform sufficiently to permit it to egress from said back draft portion without damage to said mold or flexible material.

2. A method of making a sand mold having an internal back draft portion in its cavity, said mold being of the heat-cured type, comprising; forming a composite pattern of metal portion and silicone rubber portion, said silicone rubber portion joined to said metal portion complementing the shape of the said back draft portion of such cavity of said mold; placing heat-curable sand mixture around said composite pattern; heating said composite pattern and said mixture to cure and harden said sand mixture and form a cavity the resulting cured mold having a back draft portion; and separating said mold from said composite pattern in a substantially straight line of movement so that the shape of the mold causes said silicone rubber to temporarily deform sufficiently to permit said composite mold to be withdrawn from said back draft portion without damage to said mold or silicone rubber.

3. A method according to claim **2** wherein the sand mixture is a resin-bonded and heat-curable sand and it is heated to at least about 400° F.

4. (Amended) A method of making a sand mold having an internal back draft portion in its cavity, said mold being of the heat-cured type, comprising; providing a composite pattern formed of a metal portion and silicone rubber portion, the silicone rubber portion complementing the shape of the said back draft area of said mold; placing resin-bonded and heat-curable sand mixture around said pattern; heating said pattern and sand mixture to at least approximately 400° F. to thereby cure and harden said sand and form a mold having an internal back draft portion in its cavity; and separating said mold by shifting it bodily in a substantially straight line from said composite causing said silicone rubber portion to temporarily deform sufficiently to permit it to be withdrawn from said back draft portion without damage to the resulting cured sand mold.

5. A method of making a sand mold having an internal back draft portion in its cavity, said mold being of the cured type, comprising; forming a composite pattern formed of a metal portion and flexible portion, said metal portion having a generally cylindrical and axially extending central opening and also having an external surface inclined to the longitudinal axis of said pattern and forming a large end and a small end of said metal portion, the flexible portion complementing the shape of the said back draft portion of said mold; said flexible portion forming a generally radially extending flange extending from said small end, said flexible portion having a rounded internal corner at the junction of said central opening; placing curable sand mixture around said composite pattern; heating said composite pattern and sand mixture to cure and harden said sand mixture and form a resulting cured sand mold having a back draft portion in its cavity and then separating said cured mold by shifting it bodily in a substantially straight line from said composite pattern to cause said flexible portion to temporarily deform sufficiently to permit it to be withdrawn from said back draft portion without damage to said cured mold.

6. A method of making a one-piece sand mold for castings having back draft portions which prevent the withdrawal of a rigid pattern from such a one-piece mold comprising:

forming a composite pattern of a metal portion and a silicone rubber portion, said silicone rubber portion complementing the shape of any back draft portion of said pattern which would prevent removal of said pattern from a one-piece mold;

placing said composite pattern on a surface having curing means for a sand mold mixture;

enveloping said composite mold so placed with a curable sand mold mixture;

curing said curable sand mixture with said curing means to form a one-piece cured mold; and

separating said one-piece cured mold in said composite pattern by withdrawing the metal portion thereof in a direction avoiding disruption of said one-piece sand mold

during which withdrawal said silicone rubber portion attached thereto recedes from any said back draft area by deflecting without damage to said one-piece cured mold.

7. The method according to claim 6 wherein the curable sand mold mixture is a heat-curable type and the curing means includes a heating device.

8. The method according to claim 6 wherein the composite pattern is circular and the back draft area includes a projection flange preventing removal of said rigid pattern from a one-piece sand mold.

9. The method according to claim 6 wherein the silicone rubber portion forming any back draft portion is tapered from its attachment to the metal portion of the composite pattern whereby it can freely recede from any back draft area as said metal portion is withdrawn.

* * * * *