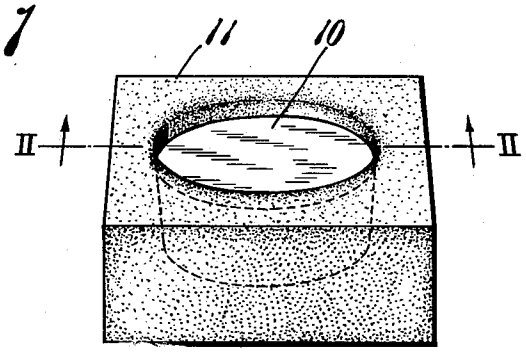
Oct. 23, 1951 W. C. SLINKARD ET AL 2,572,064

METHOD OF CONTROLLING SHRINKAGE OF CASTINGS

Filed Nov. 22, 1948 2 SHEETS—SHEET 1

Fig. 1



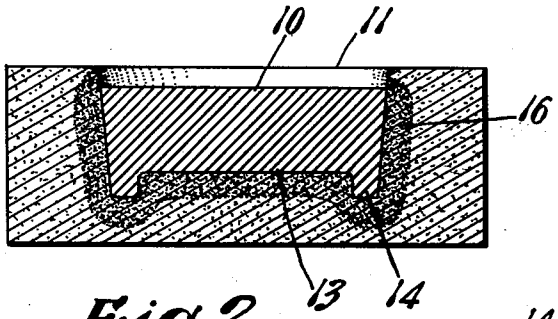
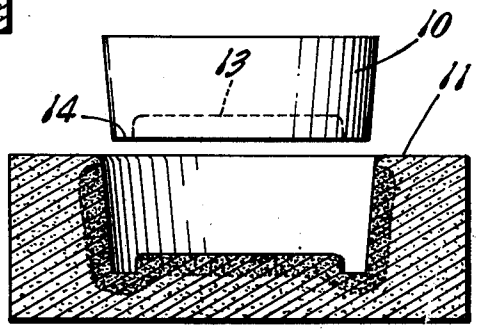


Fig. 2

Fig. 3



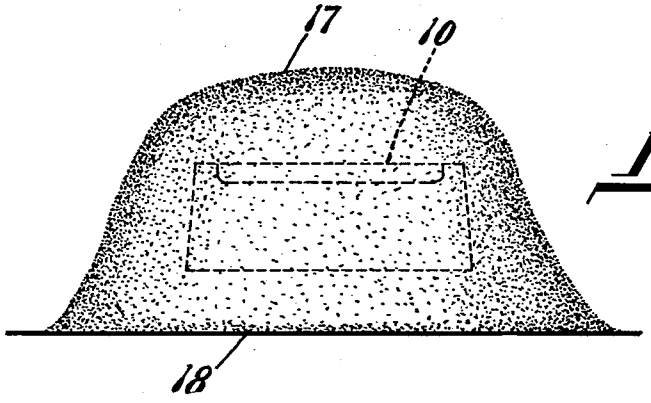


Fig. 4

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METHOD OF CONTROLLING SHRINKAGE OF CASTINGS

Filed Nov. 22, 1948 2 SHEETS—SHEET 2

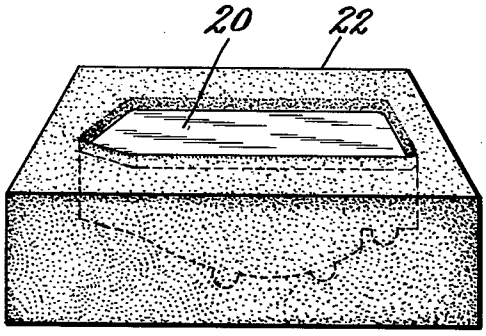

Fig. 5

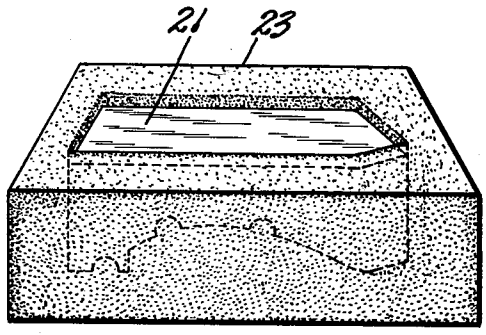

Fig. 6

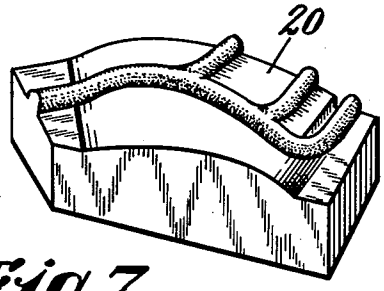

Fig. 7

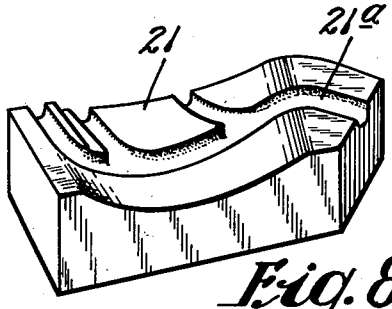

Fig. 8

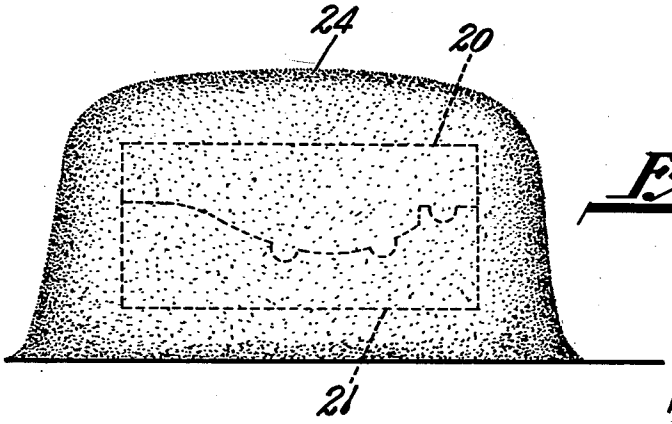

Fig. 9

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METHOD OF CONTROLLING SHRINKAGE OF CASTINGS

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2 Claims. (Cl. 148—3)

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This invention relates to the art of making castings in sand molds, and is particularly useful in connection with the casting of dies for use in drop hammer or press operations.

An object of the invention is to control shrinkage of castings cast in sand molds and to reduce distortion resulting from unequal shrinkage.

In making relatively large castings in sand molds, particularly with some casting metals and alloys, it is found that unequal shrinkage occurs during cooling of the casting in the mold. This has created difficulty, particularly in the casting of mating dies for use in hammer or press forming operations. The distortion has been found to be particularly severe where there is a concave portion of the casting filled with a sand core. It appears that, as a result of the heat from the hot metal, the sand core becomes extremely hard and unyielding so that it prevents normal contraction of that portion of the casting surrounding it. However, even when neither of two mating dies cast in sand molds contained shallow cavities in which the sand of the mold could become compacted, it has been found that the two dies were often relatively distorted during the cooling operation, so that their fit was very poor.

In accordance with the present invention, this unequal contraction is largely prevented by removing the castings from the sand molds as soon as they have cooled enough to retain their shape, and permitting them to complete their cooling down to room temperature exterior of the said mold. In many instances it is found advisable after removing the hot castings from the sand molds to bury them in loose sand to produce a more uniform cooling throughout.

Further in accordance with the invention it has been found that much improvement in a pair of mating dies can be had by removing both dies from their molds as soon as they have solidified enough to be handled and then placing them in mating relation with each other to complete their cooling down to room temperature. During this cooling operation the two mated dies can preferably be buried in loose sand to further equalize the temperatures throughout. It appears that although some shrinkage of the casting occurs while it is cooling to a temperature at which it can be removed from the mold, most of the shrinkage occurs during the cooling from the temperature of solidification down to room temperature. It further appears that the slight amount of shrinkage occurring during cooling to a safe handling temperature does not exceed the elastic limit of the metal, so that the casting recovers its normal size when the inhibiting effect of hard packed sand of the mold is removed therefrom. In the case of mating dies of large dimensions, it appears that, where the dies are cooled separately, relatively unequal contractions of the working faces of the dies occur because of the varying masses of material adjacent different portions of the die face. However, if the two

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mating dies are placed together in mating relation before shrinkage occurs, then the only portions of the dies that are exposed are the exterior faces which are usually flat or round and relatively regular in shape. Since the working faces are completely within the external exposed surfaces, they maintain a substantially uniform temperature gradient throughout during the cooling process.

A full understanding of the invention may be had from the following description describing certain particular practices in accordance with the invention with reference to the drawing, in which:

Fig. 1 is a perspective view of a sand mold containing a casting that has been poured in the cavity defined by the mold;

Fig. 2 is a section in the plane II—II of Fig. 1 showing how the sand becomes hardened adjacent the casting by the heat emanating therefrom;

Fig. 3 is a view showing the casting removed from the mold;

Fig. 4 is a view showing the casting buried in loose sand for completion of the cooling operation;

Figs. 5 and 6 are perspective views of two sand molds containing complementary dies cast therein;

Figs. 7 and 8 show the two complementary dies removed from the molds; and

Fig. 9 shows the two complementary dies placed together in mating relation and buried in loose sand for completion of the cooling to room temperature.

Figs. 1 to 4 inclusive show the application of the present process to the cooling of a simple casting having a cavity therein. Fig. 1 shows the casting 10 in a conventional sand mold 11. It will be observed from Fig. 2 that this casting 10 has a concavity 13 in one face, this concavity being surrounded by an annular rim 14. After the molten casting metal has been poured into the mold, the metal cools by radiation and conduction of heat into the sand of the casting. This raises a portion 16 of the sand immediately adjacent the casting to a relatively high temperature, and it is frequently found to bake the sand into a hard substantially incompressible formation. This hard baked sand may not have much effect in restraining normal contraction of a casting having no cavities therein, but in a casting of the shape shown in Figs. 1 to 4, the hard baked sand within the cavity 13 has a very pronounced effect on the radial contraction of the rim portion 14 and portions adjacent thereto. When the casting metal is Kirksite and the diameter of the cavity 13 is from 21 to 23 inches, the cavity may acquire an oversize, if the casting is cooled in the sand mold, of from .025 inch to .109 inch. This distortion can be substantially completely avoided in accordance with the present invention by removing the casting 10 from the mold as

shown in Fig. 3 as soon as it has cooled enough to retain its shape, and completing cooling exterior of the mold while buried in loose sand as shown in Fig. 4 in which the casting 10 is shown buried in a pile of loose sand 17 thrown on a floor 18. Where a casting the shape of casting 10 might show at the rim 14 an oversize varying from .025 to .109 inch when allowed to cool in the mold, the tolerances can be maintained less than .005 inch by the described process involving removing the casting from the mold as soon as it is cool enough to be self-supporting.

The method has been tested with a common die metal known in the trade as Kirksite A which is an alloy of relatively pure zinc with aluminum, copper and magnesium. The melting temperature of this alloy is 717° F. and it is found that castings of this material can be safely removed from the mold when they have dropped to a temperature within the range from 665° F. to 655° F. The normal shrinkage of this alloy during cooling from the solidification temperature to room temperature is approximately .14 inch per foot, whereas the corresponding shrinkage for zinc is .125 inch per foot.

Figs. 5 to 9 inclusive show the application of the invention to the casting of mating dies for use in stamping sheet metal manifold parts. First, the two complementary dies 20 and 21 are separately cast in sand molds 22 and 23 respectively. As soon as the castings are solid enough to handle, they are removed from the molds 22 and 23 and are placed in mating relation as shown in Fig. 9, after which the mated dies are covered with loose sand 24 and left to cool down to room temperature.

It will be noted that whereas the working faces of the dies 20 and 21 are quite irregular in shape, the other faces of the die blocks are simple and plain, so that very few inequalities in the cooling rate are afforded. Placing of the working surfaces of the dies in mating relation with each other during the major portion of the cooling time completely protects these surfaces from uneven cooling, and it is found that they fit much more accurately than do dies that have been cooled separately in accordance with prior practice. This method also prevents any possibility of distortion of the cavity 21a in the female die 21 due to the compacting of the mold sand therewithin. The weight of the top die 20 urges the mating faces of the dies into contact and any differential interface pressure tends to disperse and mate the dies more closely, whereas when the cooling occurs in the molds there is no assurance that the sand will deliver equal and opposite pressures to corresponding differential areas of the interface.

In the making of dies by previous casting practice, namely cooling in the mold, apparently center sagging almost always occurs, tending in most instances to cause both punch (the male die) and die (the female die) to have a slightly convex surface as compared to the surface desired. It was common for dies cooled in accordance with prior practice to have end positions ⅛ inch to ½ inch apart when the center parts were in contact, and in nearly all die sets the punch could be rocked by hand in the die. When the dies are in mating position during the major portion of their cooling range it is found that these discrepancies are eliminated.

The process is particularly effective in producing mating dies for stamping half stampings to be welded together into manifold structures

for airplane engines and the like because cooling the mating dies in mating relation as hereinabove described causes the dies to substantially conform to each other, even though they may not conform to the pattern they are made to. It is more important that such dies conform to each other in cross section than that they conform exactly to the pattern representing the ideal shape of the finished manifold. Thus, failure of the mating dies to properly fit each other results in stampings that are not truly semi-circular in cross section and that have edges that do not fit well and are not readily welded together. On the other hand, with manifolds and the like, departures from the desired shape longitudinally are often not serious, as they can be fairly readily overcome by clamping in a welding jig.

Although for the purpose of explaining the invention, certain particular procedures in accordance therewith have been shown and described, obvious modifications will occur to a person skilled in the art and we do not desire to be limited to the exact details illustrated and described.

We claim:

1. The method of reducing unequal shrinkage of mating cast dies cast in separate molds which comprises separating the two castings from their molds substantially as soon as they have solidified, placing said castings in mating relation for cooling, and cooling them to room temperature while in mating relationship with each other.

2. The method of reducing unequal shrinkage of mating cast dies cast in separate molds which comprises separating the two castings from their molds substantially as soon as they have solidified, placing said castings in mating relation for cooling, burying the mated dies in loose sand, and cooling them to room temperature while in mating relationship with each other.

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