Aug. 19, 1969 M. B. TRIMBLE ET AL 3,461,945

METHOD OF FORMING UNDERCUTS IN DIE CASTINGS

Filed July 7, 1967 2 Sheets-Sheet 1

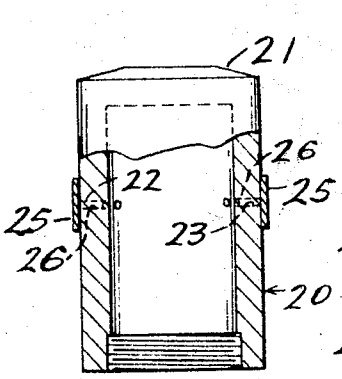


FIG-1-

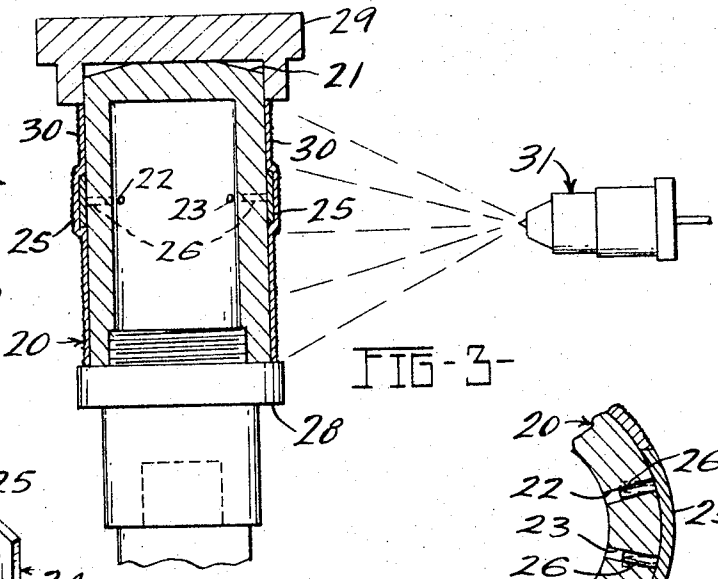


FIG-3-

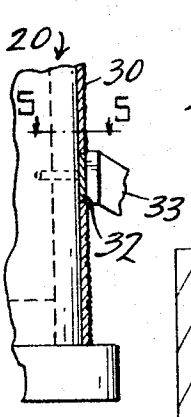


FIG-4-

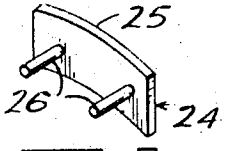


FIG-2-

FIG-5-

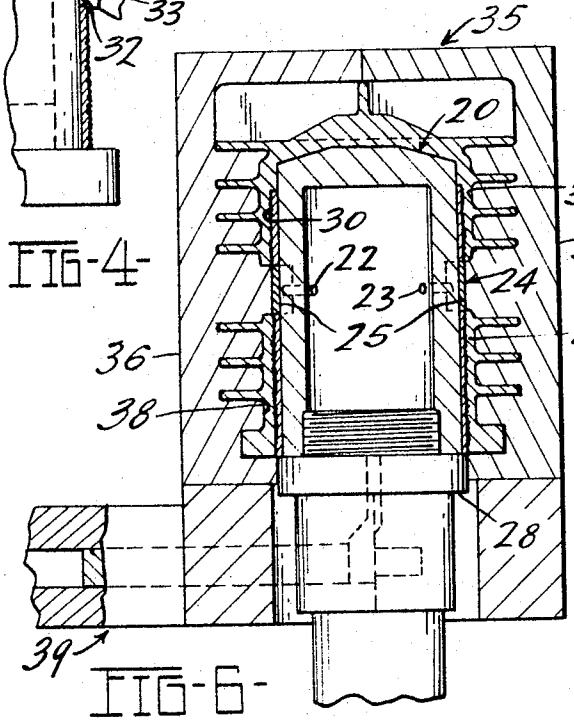


FIG-6-

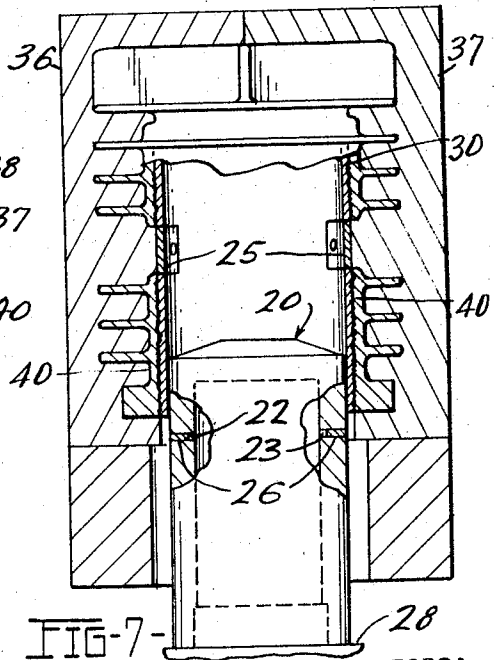


FIG-7-

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METHOD OF FORMING UNDERCUTS IN DIE CASTINGS

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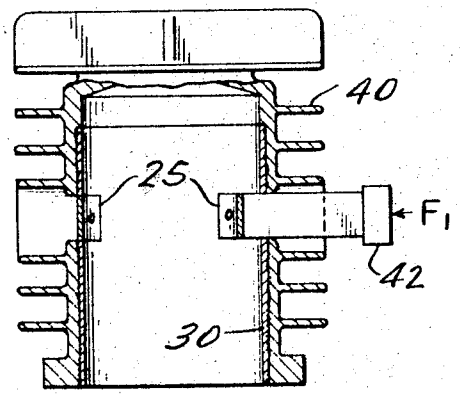


FIG-8-

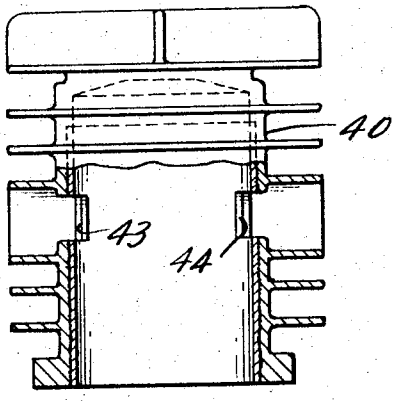


FIG-9-

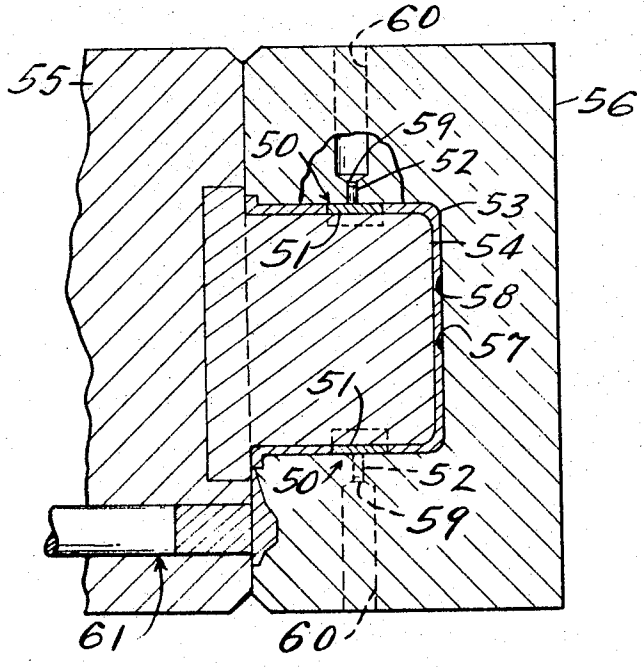


FIG-10-

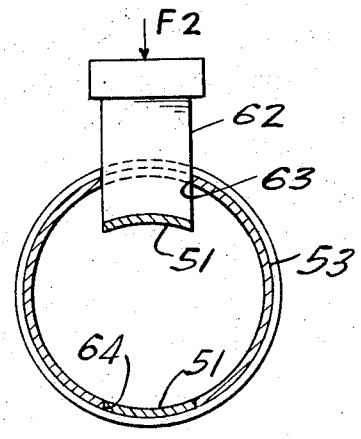


FIG-11-

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METHOD OF FORMING UNDERCUTS IN DIE CASTINGS

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Int. Cl. B28b 7/20; B22d 19/00, 17/00
U.S. Cl. 164—112 10 Claims

ABSTRACT OF THE DISCLOSURE

The present disclosure is of a method of forming undercuts in die castings. A severable insert is attached to either a core or to the die. The assembly is then placed into a die. Molten metal is injected into the die cavity and is solidified. In one embodiment after removing the casting from the die, the core is displaced from the casting, and the displacement severs one portion of the insert which remains with the core. In another embodiment, where the insert has been attached to a die half, the insert is severed as the casting is displaced relative to the die. The portion of the insert, which has defined the desired undercut, is then removed from the die casting.

Background of the invention

The present invention is in the field of die casting and relates to a method for forming undercuts in die castings. As used in the present specification and claims, the word "undercut" means any type of indentation or depression having a portion extending into the casting at an angle other than normal to the parting plane, which is desired in a die casting. For example, slots, lips, and holes of many cross-sectional shapes are included when reference is made to undercuts.

Two paramount considerations govern the design of die cast parts, namely, part quality and economy of production. It is rarely possible to take a casting design which was originally intended to be made by sand casting, or some other equivalent method of manufacture, and form it by die casting without making drastic changes to the casting design.

Unlike sand castings, which are shaped by sand molds and wherein the cores are destroyed after one part is made, die castings are formed by dies that are used for very large quantity production. Thus, if a part would be anchored by a die projection or depression disposed at an angle to the direction of removal, special and costly die construction such as the inclusion of a separately operable side core has had to be resorted to in the past.

The prior art teaches methods of forming undercuts in die castings by other than separate side cores. In one prior art method, loose die pieces are utilized. After the casting is removed, the loose die pieces are reassembled, for example, around the main core in the die and the process repeated. However, it has been found that the flash left in the casting at the joining line of the loose pieces is often difficult to remove, depending upon the shape of the casting. Furthermore, complex means for holding the loose pieces in place during the high pressure casting operations must be designed. This method of casting an undercut, although it may be better than machining the undercut into the solid portion of the casting, is a rather slow and expensive operation.

The prior art also teaches a method of using collapsible cores in forming undercuts in die castings. This method often necessitates rather intricate die designs, including complex slide mechanisms which are utilized in the removal of the solidified casting.

The use of the prior art methods to cast undercuts has several major disadvantages. The additional cost of a specially designed die and complex operating devices is a major disadvantage. Other disadvantages are that tolerances across loose die members cannot be held as close as is true across solid die sections. Also, the casting speed is reduced and the trimming and finishing are made more difficult due to the additional flash lines and seams on the casting.

Brief summary of the invention

Briefly, the invention comprises a method of forming undercuts in die castings in which a severable insert is attached to a die core or to the die. The insert is attached, for example, by providing attaching legs on the insert which are received in mating openings. In another embodiment the insert is attached by a coating layer. Molten metal is injected into the die cavity and is solidified. In one embodiment after removing the casting from the die, the core is displaced from the casting. The insert is severed and one portion of the insert is displaced along with the core. In another embodiment, where the insert has been attached to the die, the insert is sheared from its attached relationship as the casting is displaced relative to the die. The remaining portion of the insert, which has defined the undercut, is then removed from the die casting.

As used herein, and in the appended claims, the word "coating" means a relatively thick and substantial body of a surfacing material which in one embodiment of the invention is applied to the exterior of the core and insert as distinguished from a thin coating such as results from a normal die lubrication. The coating is a metallic coating of such a nature that the coating will be transplanted to the casting upon removal thereof from the die. The coating may be, for example, a metallic transplant coating as disclosed in United States Patent No. 3,083,424.

In one embodiment, after casting, the solidified casting and the core-insert unit are removed and the core is displaced relative to the solidified casting. During displacement, the insert is severed, for example, by the application of a shear force, and a severed portion of the insert is removed with the core. Subsequently, the remaining portion of the insert is removed from the solidified die casting.

In another embodiment, after casting, the core is stationary with respect to one of the die halves and while the casting is being removed the core remains in its original position.

The present invention solves many of the problems inherent in prior art methods of forming undercuts in die castings. Complex die designs including intricate slide mechanisms are normally not required when using the present method.

It is, therefore, the primary object of the present invention to provide an improved method for producing undercuts in die castings.

Brief description of the drawings

FIG. 1 is an elevational view, with parts broken away, showing a core and two severable inserts;

FIG. 2 is a perspective view of one embodiment of severable insert;

FIG. 3 is a diagrammatic view showing the application of a metallic coating to the structure illustrated in FIG. 1;

FIG. 4 is a diagrammatic view illustrating the trimming of a portion of the coating;

FIG. 5 is a horizontal cross-sectional view taken along the line 5—5 of FIG. 4;

FIG. 6 is a partially diagrammatic, vertical cross-sectional view showing the core, the inserts, the coating, the die casting, and the die halves, immediately after a die casting shot;

FIG. 7 is a partially diagrammatic, cross-sectional view showing the severing of the inserts and the displacement of the core and a severed portion of each of the inserts relative to the die casting;

FIG. 8 is a fragmentary, partially diagrammatic, cross-sectional view showing the removal of a remaining insert portion from the die casting;

FIG. 9 is an elevational view, with a portion broken away, showing the completed die casting;

FIG. 10 is a partially diagrammatic, vertical cross-sectional view of another embodiment showing a stationary core, inserts attached to a die half, the die halves and a casting immediately after a die casting shot; and

FIG. 11 is a fragmentary, partially diagrammatic cross-sectional view showing the removal of a remaining insert portion from the die casting shown in FIG. 10.

Description of the preferred embodiment

Referring to FIG. 1, a die casting core is generally indicated by the reference number **20**. The core **20** in the present embodiment is a steel cylinder having an upper end **21** which preferably has a lower coefficient of thermal expansion than the metal to be cast.

The core **20** has adjacent pairs of holes **22** and **23** (see FIG. 5) located at predetermined positions in its periphery. In the core **20**, the holes **22** and **23** preferably extend completely through the sidewall of the core. Inserts **24**, having head portions **25** and leg portions **26**, are attached to the core **20** by manual or automatic insertion into the adjacent holes **22** and **23**. The inserts **24** are made of a readily severable material and it has been found that metallic inserts, for example zinc inserts, are suitable. Referring to FIG. 2, in the present embodiment, the legs **26** of the insert **24** are generally parallel to one another prior to their attachment to the core **20**. Preferably the core holes **22** and **23** are of a diameter slightly larger than the diameter of the insert legs **26**. Referring to FIG. 5, as the legs **26** are forced into adjacent holes **22** and **23** their free ends bend toward one another. The elasticity of the legs **26** exert opposed outward forces against the sidewalls of core holes **22** and **23**. Normally this construction is suitable to securely attach the inserts **24** to either the core **20** or to a die half, as discussed below.

Referring to FIG. 3, the core **20** is placed on a revolving support **28**. A holder **29** supports the opposite end of the core **20**. The support **28** and holder **29** may be a lathe headstock and tailstock respectively. A coating layer **30** is applied to the exterior surfaces of the core **20** and the head portions **25** of the inserts **24** as by a metalizing spray. The coating **30** serves as a protecting layer for a cylinder wall in the present embodiment.

While in the present embodiment the attaching means are the insert legs **26** cooperating with the core holes **22** and **23**, other attaching means are within the scope of the present invention. For example, the coating layer **30** may serve as the attaching means for securing inserts to either the core or directly to the die. Other attaching means are mechanical press fits and the use of adhesive bonding means such as epoxy resins.

In the present embodiment, the coating **30** is applied by using a conventional metalizing gun, which is indicated by the reference number **31**. The metal coating **30** is preferably a metal coating layer having extremely good wear characteristics and is preferably between 0.015 inch and 0.025 inch thick. It has been found that stainless steel and bronze alloys are suitable materials for the coating **30**, depending on the ultimate use of the casting as explained in Bauer Patent 3,083,424.

Referring to FIG. 3, if stainless steel is utilized as the transplant coating material, stainless steel wire is supplied to the gun **31**. Within the gun, the wire is fed into an oxyacetylene flame where it is melted and molten alloy is carried from the gun by a blast of compressed air onto the exterior portions of the core **20** and the inserts **24**. The rate of flow of the alloy from the gun **31** and the rate of rotation of the support **28** are regulated to insure the proper deposition of the alloy or coating **30**.

Referring to FIG. 4, after the coating **30** has been applied, under a preferred method, the coating **30** is turned down or trimmed to make such coating very thin over outermost surfaces **32** of the inserts **24**. The trimming also establishes a positive and close dimension adjacent the outermost surfaces **32** of the inserts **24** to facilitate proper positioning within opposed die halves. In the present embodiment, the turning operation is performed by a tool **33**. It should be noted that the trimming step is not an essential step in the practice of the method of the present invention.

Referring to FIG. 6, a die is indicated generally by the reference number **35** and includes mating die halves **36** and **37**. The core **20**, and the inserts **24**, which in the present embodiment are attached to the core by the cooperation of the insert legs **26** and the core holes **22** and **23**, are positioned in the die **35**. The outer surface of the core **20**, the exterior surfaces of the head portions **25** of the inserts **24**, and the die **35** define the inner walls of a die cavity **38**. Molten metal which forms the die casting, in this example a cylinder block, is then forced into the die cavity **38** through the die gate from a shot sleeve, generally indicated by the reference number **39**, by a conventional shot plunger. The die casting metal may be, for example, a molten aluminum alloy which is introduced into the die **35** under normal pressures of between 4,000 and 10,000 pounds per square inch. The molten aluminum alloy enters the die cavity **38** and completely fills the die cavity **38** entering into all of the surface irregularities present in the exposed surface of the metal coating **30**.

As molten metal solidifies, it shrinks in and around the coating **30** and is interlocked mechanically therewith forming a very tenacious bond. After the molten metal has solidified, normally within a few seconds after completion of injection of the casting alloy, the core **20** is moved downwardly relative to the die halves **36** and **37**. As the core **20** is displaced the inserts **24** are severed, in the present embodiment by shearing. The severed portions of the inserts **24**, in this embodiment the leg portions **26**, are displaced axially with the core **20**, while the head portions **25** remain with the solidified die casting **40**.

Referring to FIG. 7, it will be noted that the coating layer **30** is mechanically interlocked to the die casting **40** at this time.

The die halves **36** and **37** are separated and the die casting **40**, together with the head portions **25**, of the inserts **24**, are ejected as a unit.

Referring to FIG. 8, the next step is the removal of the remaining insert head portions **25** from the die casting **40**. In the present embodiment, a force, designated F_1 in FIG. 8, is applied to a punching ram **42**. The punching ram **42** strikes the head portion **25** and removes it from the casting **40**. While in the present embodiment the head portion **25** is removed inwardly toward the longitudinal center line of the casting **40**, it is sometimes advantageous to punch the remaining insert portions outwardly. Of course, the removal means and direction of removal will depend on the configuration of the desired undercut and also the location of such undercut relative to the remainder of the die casting.

FIG. 9 shows the completed aluminum die casting **40**, having an inner stainless steel coating **30** which has been transplanted thereon. The casting **40** has undercuts **43** and **44** which in the present embodiment are right angle openings. The undercuts **43** and **44** were defined by the head portions **25** of the inserts **24**.

FIGS. 10 and 11 show another embodiment of the present invention. In this embodiment, inserts **50** having head portions **51** and leg portions **52** are attached to a die half rather than to a core. The inserts **50** are generally similar to inserts **24**.

Referring to FIG. 10, a generally cup shaped die casting **53** is formed on a stationary core **54**. The core **54** is removably secured to a die half **55**. A mating die half **56**

defines a cup shaped recess **57**. The recess **57** and the outer surface of the core **54** define a die cavity **58**.

The die half **56** defines holes **59** which receive the leg portions **52** of the insert **50**. The leg portions **52** deflect as they are inserted into the die holes **59** and form a secure attachment between the die half **56** and the inserts **50**. In the present embodiment, the die half **56** has relief openings **60** in communication with the die holes **59** to facilitate removal of the severed leg portions **52**.

Molten metal is forced into the die cavity **58** through the die gate from a shot sleeve, generally indicated by the reference number **61**, by a conventional shot plunger. The molten alloy enters the die cavity **58** and completely fills the cavity forming the die casting **53**.

After the molten metal has solidified the cover die **56** is displaced thereby severing, in this case shearing the inserts **50**. In this embodiment the core **54** remains stationary.

Subsequently, the die casting **53** is ejected and the head portions **51** of the inserts **50** are removed. Referring to FIG. 11 a punching ram **62** applies a force F_2 to the severed head portions **51**. The head portions **51** define opposed undercuts **63** and **64** in the die casting **53**.

The severed leg portions **52** are removed from the die half **56**, new inserts **50** are attached to the die half and the above casting cycle is repeated.

While the present invention has been disclosed in connection with a preferred embodiment of the present invention, it should be understood that numerous modifications and changes may be made without departing from the scope of the appended claims.

We claim:

1. The method of forming undercuts in die castings, wherein a die and core assembly defines a die cavity, which comprises attaching at least one insert to the die and core assembly wherein at least a portion of the insert defines a portion of the wall of the die cavity, injecting molten metal under pressure into the die cavity, solidifying the molten metal in the die cavity, effecting relative movement between the die core and at least one portion of the die shearing the insert, and removing the sheared portion of the insert from the casting, said sheared portion of the insert having defined the desired undercut in the casting.

2. The method of forming undercuts in die castings according to claim **1**, wherein the inserts are attached by inserting portions of the inserts into receiving holes defined by one portion of the die and core assembly, the remaining portion of the insert extending into the die cavity to define the desired undercut.

3. The method of forming undercuts in die castings according to claim **2**, wherein insert leg portions are placed into core receiving holes to attach the insert to the core and wherein the core is displaced relative to the die halves to shear the inserts.

4. The method of forming undercuts in die castings according to claim **3**, wherein the core and attached insert is rotated and a metallic coating is sprayed on the exterior surfaces of the core and insert prior to the insertion of the core and insert into the die.

5. The method of forming undercuts in die castings according to claim **2** wherein insert leg portions are placed into die receiving holes to attach the insert to the die.

6. The method of forming undercuts in die castings according to claim **5** wherein the core remains stationary and a die half is displaced relative to the core to shear the insert.

7. The method of forming undercuts in die castings which comprises attaching at least one severable insert to a die core, placing the core and insert into a die, whereby the core, at least a portion of the insert, and the die define the walls of a die cavity, injecting molten metal under pressure into the die cavity, solidifying the molten metal in the die cavity, removing the casting, the core, and the attached insert from the die, displacing the core relative to the casting in a direction to shear the insert during such displacement of the core, whereby one portion of the insert is displaced with the core, and removing a remaining sheared portion of the insert from the casting, said remaining portion of the insert having defined the desired undercut in the casting.

8. The method of forming undercuts in die castings which comprises, positioning at least one severable insert at a predetermined position on the periphery of a metallic die core, attaching the insert to the die core applying a metallic coating layer over the insert and core, positioning the assembled and coated insert and core unit in a die, whereby the core, at least a portion of the insert, and the die define the walls of a die cavity, injecting molten metal into the die cavity under pressure sufficient to force said molten metal into an interlocking relationship with the metallic coating, solidifying the injected metal in the die cavity, removing the solidified die casting, the core and the attached insert from the die. applying a shearing force between the core and casting to sever the insert and to displace the core relative to the die casting, whereby a severed portion of the insert is displaced with the core, and removing the remaining portion of the severed insert from the die casting, the remaining portion of said insert having defined the desired undercut in the casting.

9. The method of forming undercuts in die castings according to claim **8**, including the step of reducing the thickness of at least a portion of the metallic coating layer prior to placing the assembled and coated core and insert into the die.

10. The method of forming undercuts in die castings according to claim **9**, wherein the severable metallic insert is positioned in a receiving opening defined by the metallic die core.

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U.S. Cl. X.R.

164—70, 113; 264—318