June 3, 1969 A. G. BODINE, JR 3,447,587

METHOD AND DEVICE FOR MOLD CASTING UTILIZING SONIC ENERGIZATION

Original Filed May 10, 1965 Sheet 1 of 3

FIG. 1

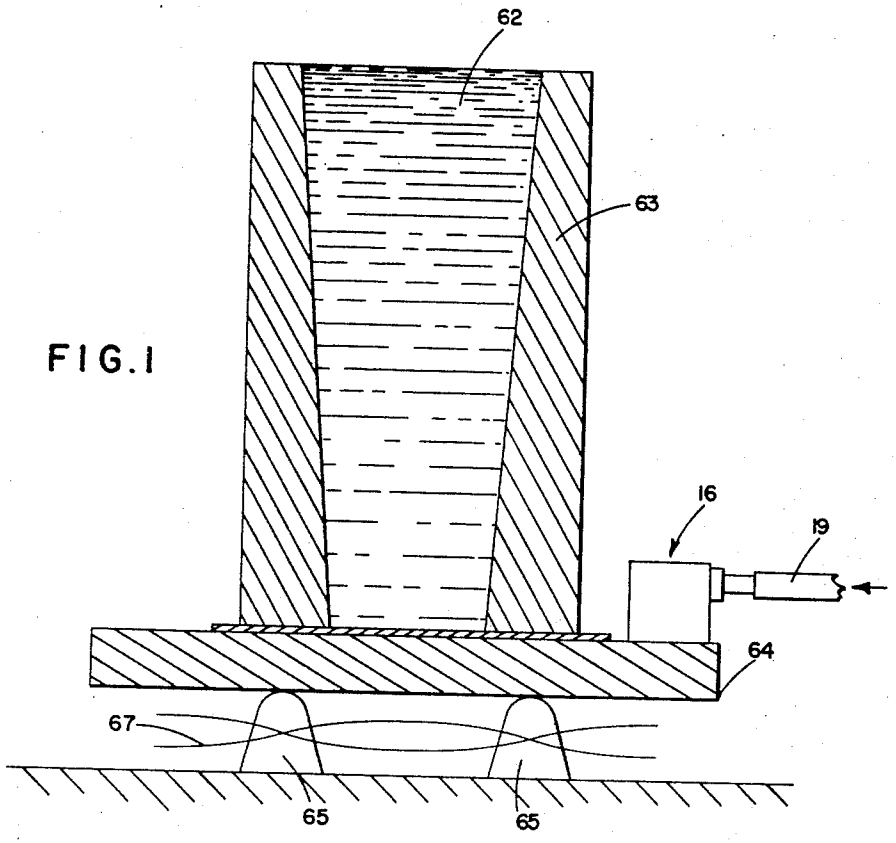
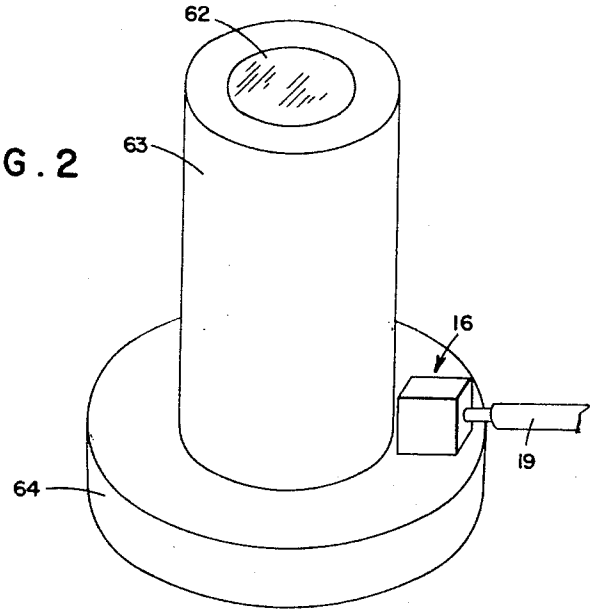


FIG. 2



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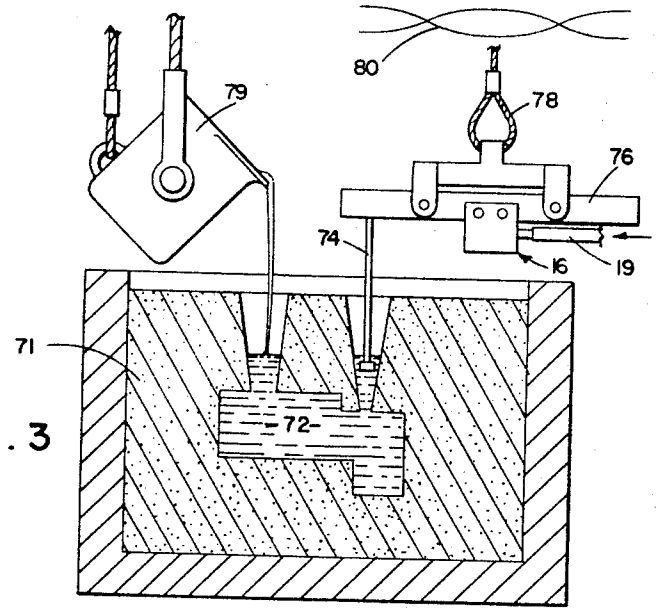


FIG. 3

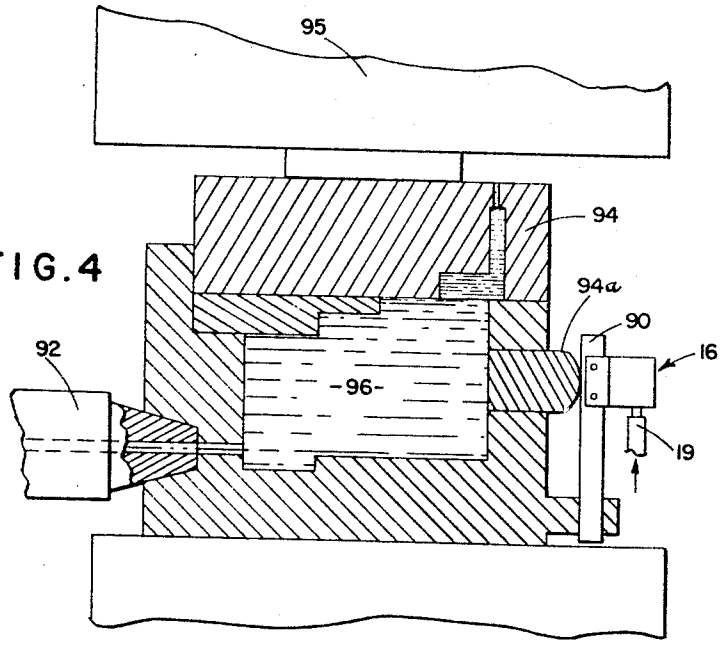


FIG. 4

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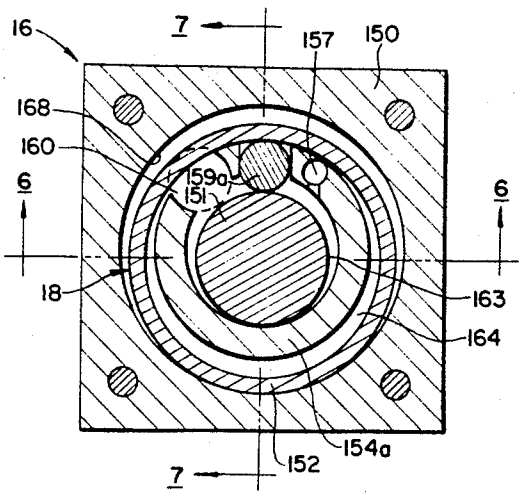


FIG. 5

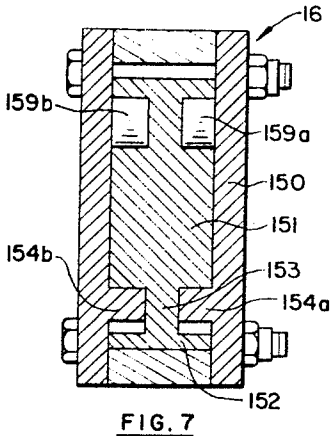


FIG. 7

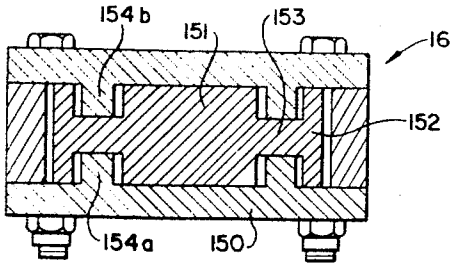


FIG. 6

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3,447,587

METHOD AND DEVICE FOR MOLD CASTING UTILIZING SONIC ENERGIZATION

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Original application May 10, 1965, Ser. No. 454,335. Divided and this application July 24, 1967, Ser. No. 655,481

Int. Cl. B22d 27/08

U.S. Cl. 164—49 6 Claims

ABSTRACT OF THE DISCLOSURE

Fluid material to be cast is poured into a static mold and while it transforms from a fluid to a solid state is subjected to high-level sonic energy as part of a resonant elastic vibration system. This vibration system is excited by means of an orbiting-mass oscillator which automatcally adjusts its frequency and phase of operation with changes in impedance characteristics of the material being cast as it goes from a fluid to a solid state, thereby maintaining optimum resonant operation at all times, such as to improve the temperature distribution within the large mass of material while changing from fluid to solid state.

This application is a division of my application Ser. No. 454,335 filed May 10, 1965, for Sonic Method and Apparatus for Facilitating Gravity Flow of Fluid Material.

Mold casting in which fluid material is poured into a mold and permitted to solidify as it cools to a solidfying temperature is utilized extensively in forming objects from metal and other materials. Several problems are encountered in this type of casting, particularly large ingots, as accomplished under the prior art. Firstly, the casting often adheres to the sides of the mold, making removal therefrom difficult. Further, in removal, the surfaces of the casting are oftentimes marred. Additionally, the material being cast often does not conform with the shape of the mold as accurately as would be desired. Moreover, in large ingot castings the center cools last, and thus solidifies last, shrinking and tearing from the outer portion, with resulting flaws.

The technique and device of this invention overcome the shortcomings of the prior art by applying high-level sonic energy at the interface between the mold and the static casing and into the casing itself. Such sonic energization acts to free the sides of the mold from the cast to facilitate removal from the mold and operates to remove gas and other impurities from the cast material as well as to stress-relieve the casting, and distirbute the temperature while in the plastic state, to improve its structural characteristics of large ingots.

In carrying out the invention, a resonant elastic vibration system which includes the mold itself and in one embodiment includes a dipstick coupled directly to the casting, is vibrated at a resonant frequency by means of an orbiting-mass oscillator. Fluid material is poured into the mold and then excited by the resonant vibration as it solidifies. The orbiting-mass oscillator utilized is adapted to adjust its frequency and phase with changes in the consistency of the casing material as it goes from a fluid to a solid state, thereby assuring the maintenance of optimum resonant vibration with such changes in the impedance of the casting.

It is therefore an object of this invention to provide an improved technique for mold casting.

It is a further object of this invention to facilitate the removal of a casting from its mold in a mold casting process.

It is still another object of this invention to improve the

structural characteristics of castings made by mold casting processes.

It is still a further object of this invention to enable the more accurate conformation of castings to their molds in mold casting processes.

Other objects of this invention will become apparent as the description proceeds in connection with the accompanying drawings, of which:

FIG. 1 is a cross-sectional view in elevation of a first embodiment of the device of the invention;

FIG. 2 is a perspective view of the first embodiment of the device of the invention;

FIG. 3 is a cross-sectional view in elevation of a second embodiment of the device of the invention;

FIG. 4 is a cross-sectional view in elevation of a third embodiment of the device of the invention;

FIG. 5 is a cross-sectional view of an oscillator which may be utilized in the various embodiments of the device of the invention;

FIG. 6 is a cross-sectional view taken along the plane indicated by 6—6 in FIG. 5; and

FIG. 7 is a cross-sectional view taken along the plane indicated by 7—7 in FIG. 5.

Referring now to FIGS. 1 and 2, the utilization of the device of the invention in ingot mold casting is illustrated. Here, molten material **62** which may be aluminum to be cast is poured into ingot mold **63**. Ingot mold **63** is supported on metallic base plate **64**, which in turn is supported on suitable isolation supports **65**. Base plate **64** is sonically energized by means of orbiting-mass oscillator **16** which is mounted thereon, which is pneumatically driven by air fed thereto through line **19**. Oscillator **16** is preferably of the type illustrated in FIGS. 5–7. Orbiting-mass oscillator **16** resonantly vibrates base plate **64** to produce standing waves **67** therein and these vibrations are fed to mold **63** and the bottom of the molten material **62**, and appear at the interfaces between the mold and the material **62** being cast. The sonic energy acts to stress-relieve the cast material **62**, removes gas and other impurities therefrom, provides for more uniform temperature, obtains better crystal structure, and thus generally improves the characteristics of the final end product. The active sonic condition established at the interfaces between material **62** and the sides of mold **63** prevents the cast material from adhering to the mold, and thus enables easy removal therefrom when the casting process has been completed. The sonic mechanical oscillator operates at maximum efficiency by automatically adjusting its frequency with changes in the characteristics of the cast material as it solidifies.

Referring now to FIG. 2, the utilization of the device of the invention in a gravity mold in which excitation is provided through a dipstick directly to the cast material, is illustrated. Molten material **72** is poured from hopper **79** into mold **71**. Dipstick **74** is suspended in the material being cast from resonant bar **76**, which is supported by pulley mechanism **78**. Orbiting-mass oscillator **16**, which is driven pneumatically through line **19**, is attached to resonant bar **76** and is oscillated to cause bar **76** to vibrate resonantly with standing waves **80** formed therealong. The material being cast **72**, which may be plastic or a metal such as zinc, forms part of the resonantly vibrating system. As already mentioned in connection with the other embodiment, orbiting-mass oscillator **16** adjusts its frequency as the material being cast hardens and changes in its density and elasticity, so as to maintain optimum resonant vibration throughout the casting process. As explained in connection with the other embodiment, the sonic energization prevents the casting from adhering to the mold and imparts superior characteristics to the final end product, removing impurities, gas bub-

bles, and providing for a better overall structure having greater density, and in the case of metallic castings, superior crystal structure.

Referring now to FIG. 3, the device of the invention is shown as utilized in conjunction with an injection molding process. Plastic or molten condition material **96** is injected through mold injector **92**, press **95** pushing down on the top of mold **94** to hold the mold in place. Sonic energy is provided to mold **94** from sonic oscillator **16**, which is pneumatically driven through line **19**. Sonic oscillator **16** is attached to resonant bar **90** to provide high "Q" resonant vibration, and bar **90** is attached to mold **94** at piston portion **94***a* thereof. Here again, as in the other casting processes described, the molding process is enhanced by the resonant sonic vibration to remove impurities and to provide a denser, better formed end product which can readily be removed from the mold.

Referring now to FIGS. 5, 6 and 7, a preferred embodiment of the pneumatically driven orbit ing-mass oscillator which may be utilized with the device of the invention is illustrated. This orbiting-mass oscillator has the unique characteristic of adjusting its frequency of operation with load changes, in effect locking in with a resonent load to maintain such resonant operating condition.

Mounted within case **150** is rotor member **18** which includes a central circular portion **151** and an outer circular portion **152** joined together by a web portion **153**. Extending inwardly from case **150** are a pair of C-shaped portions **154***a* and **154***b*. Pressurized air is fed through inlet port **157** to the interior of casing **150**. Disc-shaped members **159***a* and **159***b* are held between the ends of C-shaped portions **154***a* and **154***b* respectively. Disc-shaped members **159***a* and **159***b* are held so that they are free to rotate and to move radially and at the same time provide a divider which prevents any significant amount of the inlet air from passing directly from one side thereof to the other. An air outlet is provided from the interior of casing **150** by means of outlet aperture **160**.

The air entering through inlet **157** enters crescent-shaped cavity portions **163** and **164** and tangentially drives both inner portion **151** and outer portion **152** of the rotor in a conuterclockwise direction. Such counterclockwise rotation of the rotor on its axis results in a clockwise rolling of the rim of outer rotor portion **152** around the raceway formed by the inner wall **168** of casing **150**. In view of the eccentricity of the rotor in this rolling action, case **150** is vibrated in accordance with the rotor rotation frequency.

The oscillator just described is relatively simple and highly reliable in its operation and is capable of producing a high-amplitude sonic output which automatically locks in at the resonant vibration frequency of the load being driven.

The device and method of this invention thus provide sonic means for enhancing the molding of fluid material in which the adhesion of such material to the flow defining member is minimized. In addition, the sonic action improves the structure of the material and facilitates the forming process for same.

While the device and method of this invention have been described and illustrated in detail, it is to be clearly understood that this is by way of illustration and example only, the spirit and scope of this invention being limited only by the term of the following claims.

I claim:

1. A method for mold casting such as for large ingots, comprising the steps of:

pouring casting material into a static mold;

coupling the output of an orbiting-mass oscillator to said casting material and said mold; and

driving said oscillator at a frequency such as to produce resonant elastic vibration of the resonant vibration system comprising said casting material and said mold, said oscillator operating to automatically adjust the frequency and phase of its output to maintain resonant vibration of said vibration system as said fixed mass of casting material transforms from a liquid to a solid state.

2. The method of claim **1** wherein a dipstick is placed in said material and said sonic oscillator is connected to said dipstick.

3. The method as recited in claim **2** wherein said resonant vibration system includes a resonant bar attached to said dipstick, said oscillator being attached to said resonant bar.

4. In a device for casting fluid material,

a mold for forming said fluid material;

an orbiting-mass sonic oscillator;

means for coupling the vibration output of said oscillator to said mold and said material, said mold and said material forming a resonant elastic vibration system; and

means for driving said oscillator at a frequency such as to cause resonant elastic vibration of said system, said oscillator being adapted to automatically adjust its frequency and phase to maintain resonance with changes in the impedance of said system,

whereby said resonant vibration prevents said material from adhering to said mold and improves the qualities of the casting.

5. In a device for the casting of fluid material,

a mold for forming said fluid material;

a dipstick partially immersed in said fluid material;

an orbiting-mass sonic oscillator;

means for connecting the vibration output of said oscillator to said dipstick; and

means for driving said oscillator at a frequency such as to cause resonant vibration of the elastic vibrating system including said dipstick and said material, said oscillator being adapted to automatically adjust its frequency and phase to maintain resonance with changes in the impedance of said system,

whereby said resonant vibration prevents said material from adhering to said mold and improves the qualities of the casting formed.

6. The device as recited in claim **5** wherein said means for connecting the output of said oscillator to said dipstick includes a resonant bar having high "Q" characteristics attached to said dipstick, said oscillator being attached to said bar.

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164—260; 264—23, 70