

July 1, 1941.

H. F. HAGEMEYER

2,247,777

METHOD FOR FORMING CASTINGS

Original Filed Jan. 15, 1940 2 Sheets-Sheet 1

Fig. 1.

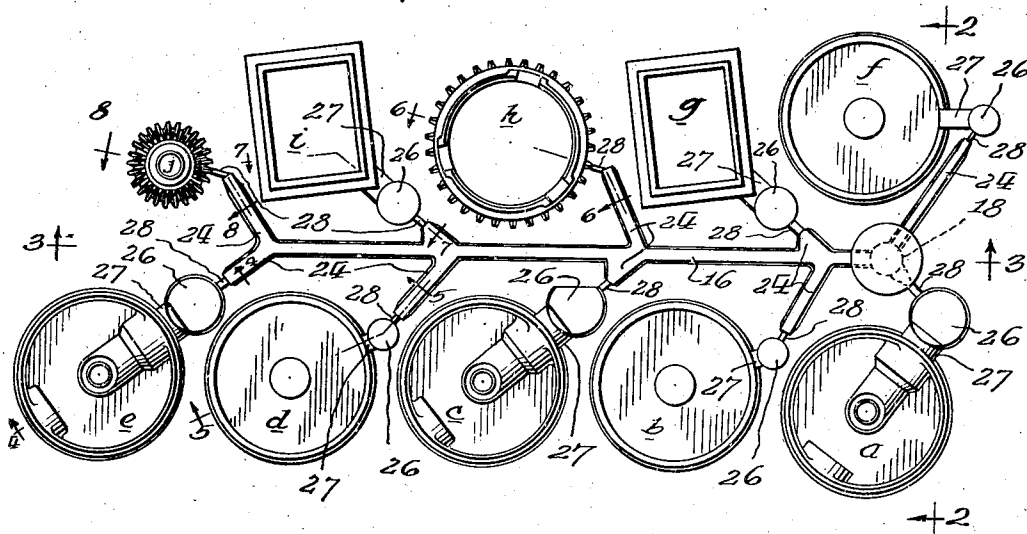


Fig. 2.

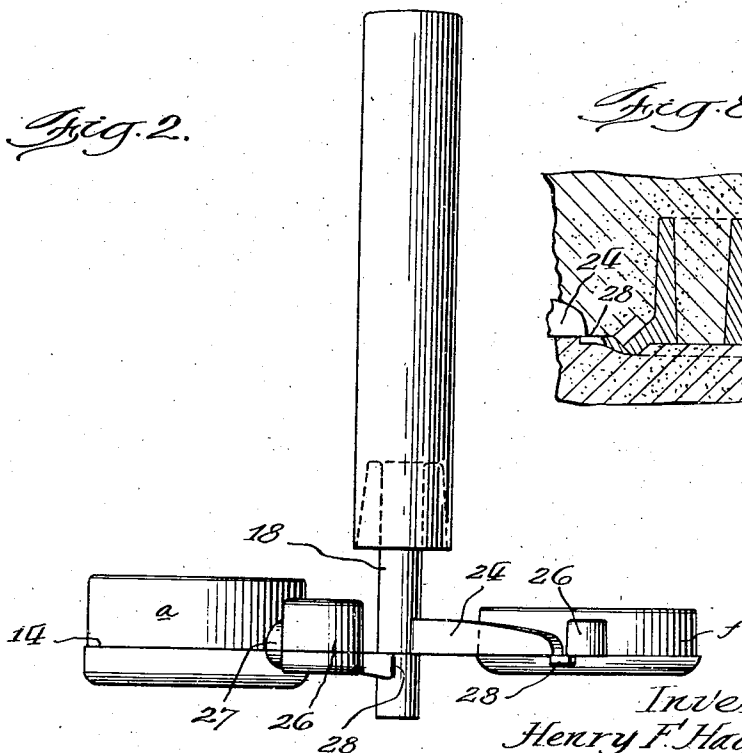
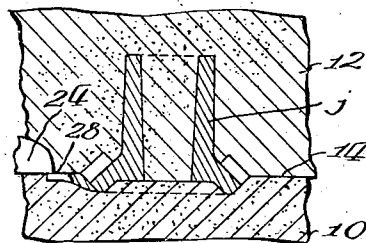


Fig. 8.



Inventor.
Henry F. Hagemeyer
By
Williams, Bradbury & Hinkle
Attys.

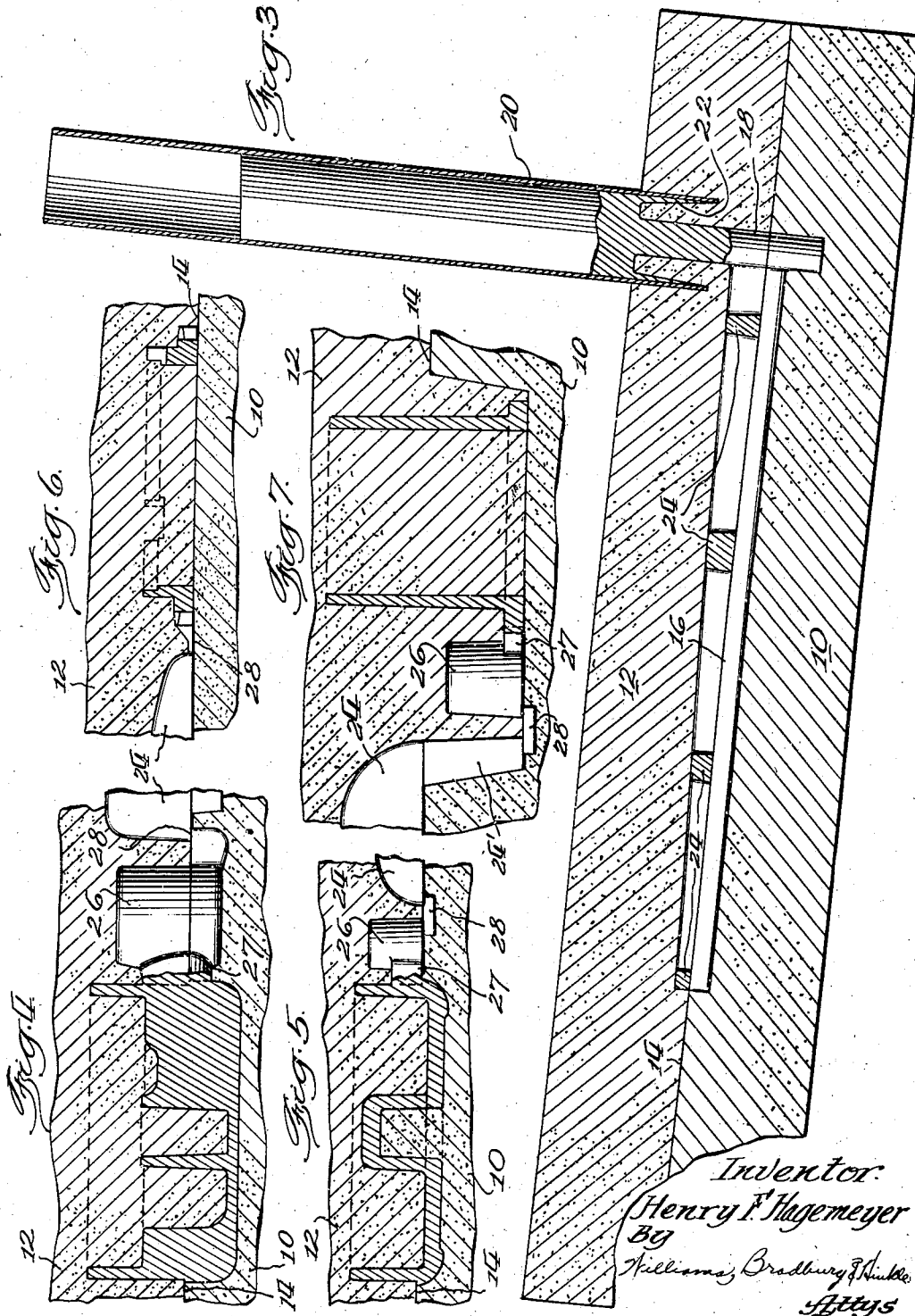
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UNITED STATES PATENT OFFICE

2,247,777

METHOD FOR FORMING CASTINGS

Henry F. Hagemeyer, Chicago, Ill., assignor to
Castings Patent Corporation, Chicago, Ill., a
corporation of Illinois

Original application January 15, 1940, Serial No.
313,872. Divided and this application April 6,
1940, Serial No. 328,214

7 Claims. (Cl. 22—200)

This invention relates generally to the art of forming castings and is more particularly concerned with a novel method for forming castings which results in the production of castings having a uniform high quality and in which porosity, lack of uniformity, the formation and entrainment of oxides and occluded gases, distortion, bad surface finish, and other well-known defects likely to be present in castings are largely eliminated. The present application is a division of my copending application Serial No. 313,872.

By casting processes as ordinarily practiced, several mold cavities are connected to a runner by feeders and the runner is in turn connected to a sprue or filling opening. The fused metal is then poured into the sprue and runs down the runner, through the feeders and into the mold cavities, or in the case of pressure castings is forced into the sprue. This rapid movement of the metal, together with the splashing and spraying about of the metal within the mold, causes oxides formed at the surface of the fused metal to be mixed with the metal and to be trapped therein when the metal hardens. Also, during the process of pouring the molten metal into the mold, frequently quantities of gases and air are trapped within the castings, thereby producing a spongy structure which weakens the resulting casting and also causes the rejection of castings that are intended to be fluid tight, such, for instance, as engine or compressor cylinder blocks and heads, valves, pipe fittings, and the like.

Another disadvantage frequently encountered in ordinary casting processes is that the metal in the runner and sprue solidifies after the metal in the mold impressions. The subsequent shrinkage of the runner, therefore, puts considerable stress on the castings, which frequently results in the completed castings having strains therein, or in the castings being distorted.

It is the principal object of the present invention to overcome the above generally recognized defects in castings.

A more specific object of the present invention is to form castings by causing the fused metal to flow into and within a mold in a novel manner that minimizes the formation of oxides and gases and prevents their occlusion, and that therefore gives the resulting casting a more homogeneous structure and a more uniform density.

A further object of the present invention is to form castings in a novel manner that prevents oxides formed at the surfaces of the fused metal from becoming entrained within the casting.

An additional object of my invention is to pro-

vide an improved method of molding that prevents the cooling and attendant shrinking of the castings and runner from causing distortions or strains in the castings.

A still further object of the present invention is to provide a novel method for forming castings that allows the runner to shrink away from the several castings as the runner cools without putting excessive strains on the castings.

A still further object of the present invention is to provide a novel method that permits the casting of metal at lower temperatures than those customarily used, and in which a definite but relatively low pressure is used to form the impression of the mold.

Another object of my invention is to provide a casting process that keeps the oxide film on the molten metal flowing into the mold in constant motion until it touches the mold surface and thereafter prevents the movement of any metal which has been brought into contact with the mold surface.

An additional object is to provide a novel casting process that permits the use of much smaller sprues and runners than customarily used.

Other objects and advantages of the present invention will become apparent from the following description and accompanying drawings, in which:

Fig. 1 is a plan view of several different types of castings shown joined to a runner and appearing as they would just after the metal has solidified. In the interest of clarity of illustration, the outline of the mold within which these castings were formed has been omitted;

Fig. 2 is an end elevational view taken in the direction of the arrows along the line 2—2 of Fig. 1;

Figs. 3, 4, 5, 6, 7 and 8 may be considered as sectional views taken in the direction of the arrows, respectively, along the lines 3—3, 4—4, 5—5, 6—6, 7—7, and 8—8 of Fig. 1. In these views, Figs. 3 to 8, the portions of the mold surrounding the respective sections are included in the views.

In the drawings in which similar characters of reference refer to similar parts throughout the several views, the two mold halves, which will be referred to as the drag 10 and cope 12, are preferably formed of a gypsum base compound in the manner as described in my copending application Serial No. 203,872, although it will be understood that the method comprising the present invention is adapted for use with molds composed of other

materials, such as sand, or, in the case of pressure castings, metal.

As is the usual practice, the cope and drag each have depressions formed therein, whereby when these two mold halves are placed together, the resulting cavities will be complementary to the part to be cast, it being understood that I use separately formed core parts inserted into the mold cavities wherever this becomes necessary or advisable. The practice of using cores and other separately formed mold parts is well understood and will not be described here, inasmuch as this invention does not contemplate any change in the use of these mold elements.

The essence of the molding method comprising my invention is to cause the metal flowing into the mold to form a globule around the point of entrance of the metal. This globule is then constantly and comparatively slowly expanded by additional metal running into the inside thereof, until the entire mold cavity is full. This I accomplish with as little turbulence in the metal as possible, and thus oxides formed at the surface of the globule remain on the surface and are not entrained in the molten metal. As the globule expands, these oxides are brought against the surface of the mold cavity. Whereupon the metal touching the wall becomes chilled somewhat and its viscosity thereby increased to a point where it remains in place against the wall of the mold and immobilizes the oxides, while the hotter and therefore more fluid metal in the interior of the globule flows through the shell of thickened metal to other portions of the impression. Thus, the surface film on the globule is in constant controlled motion until it touches the mold wall and thereafter cannot mix with the molten metal, nor can chunks of thickened metal come loose from the walls and re-enter the still flowing metal.

In order to promote the flow of metal in the mold in the manner as above described, I tilt the mold, so that the metal must run uphill along the feeders and in the casting impression, which it enters at its lowest point. Between the feeders and the mold cavity, a small orifice is provided through which the metal must run. This orifice slows the rate of flow of the metal and allows the formation and gradual expansion of a globule of metal within the mold cavity. Preferably the mold is so arranged that the metal flows into a casting impression at its lowest point, so that the globule around the inlet opening is formed as quickly as possible and splashing of the metal within the mold is prevented, although practical considerations affecting the layout of the mold may make it advisable to bring the metal into the casting impression slightly above the lowest point. If the metal enters the impression above the lowest point, it will be appreciated that a globule may not form around the inlet opening immediately, but will be formed as soon as the level of the molten metal in the casting impression rises to the level of the inlet opening. If the formation of this globule does not take too long, no serious effects will be noticed in the casting produced, since the metal flows slowly into the impression and this forms a pool, the level of which quickly rises to cover the inlet opening without causing the metal to be scattered in the impression.

It may be said that, as a rule, the mold should be laid out to bring the metal into the casting impression at the lowest point, but if this appears to be impractical, the metal should flow

into the impression as close to its lowest point as can be arranged, so that the quality of the castings will suffer as little as possible. It is also advisable to bring the metal into the impression at the thickest section of the casting to be produced, so that the temperature of the metal reaching the several portions of the casting impression will be more constant.

As will be explained more fully later, the metal is slowed in its flow into the casting impressions by a restriction placed in the path of flow of the metal rather than by having its rate of flow determined by the venting capacity of the mold. I prefer that the head behind the metal flowing into the mold should be sufficient so that a pressure of about two and one-half to three pounds per square inch will be brought to bear upon the metal at the top of the highest impression when the mold and sprue are full. It should be observed, however, that since the metal flows through a restriction before it reaches the impression and flows into the impression at a rate slower than the venting rate of the mold, the pressure within the impression will be very low until the impression is filled, whereupon the full head will immediately be brought into bear to form a sharp impression of the mold.

Since the metal is always caused to flow uphill, I form the major portion of the impression in the cope. This is contrary to usual casting practice, but works well with the present method. It is also usual casting practice to place the portion of the casting requiring the best finish in the drag, but with the present process the finish produced by all portions of the impression are equally good.

In the drawings, I have shown typical molded parts and the molds I prefer to use in carrying out my process. As shown in Fig. 3, the cope 12 is placed upon the drag 10 and the plane of juncture of these two mold halves will be referred to as the parting line 14. A runner cavity 16 extends substantially down the center of the mold and joins the sprue 18 at one end thereof. This sprue extends upwardly through the cope and is further extended above the top of the mold by an asbestos paper sleeve 20, the lower end of which sets in an annular slot 22 concentric with the sprue opening in the top of the cope. The height of the sleeve should be such that the hydrostatic head at the top of the highest casting impression will be from about two and one-half to three pounds when the sprue is reasonably full.

At intervals along the sides of the runner 16, branches or feeders 24 extend outwardly therefrom. These feeders 24 usually lead to a generally cylindrical cavity which I call a shrink bob cavity 26 and from these the metal flows into the mold impression through a neck 27. The purpose of this shrink bob cavity is to provide a reservoir of metal that solidifies after the casting proper, and thus provides a quantity of metal which can be drawn into the casting when shrinkage in this element takes place. By the use of this shrink bob, I effectively prevent the formation of voids in the castings due to shrinkage of the metal. It will be appreciated that the casting will be removed from the mold with the shrink bob attached thereto and that the shrink bob will ordinarily be removed from the casting before the casting is used.

Between the shrink bob 26 and the feeder 24, the metal is forced to flow through a very small orifice 28 which restricts the flow of metal into

the mold, while the interposition of the shrink bob between the orifice 28 and the casting impression permits the flow of metal to be slowed after passing through the orifice, and before it reaches the casting impression. Preferably the orifice and outlet of the shrink bob should not be in a straight line as the jet action produced by the orifice might carry through and produce turbulence or spreading out of the metal in the casting impression. I, therefore, prefer that the orifice and outlet of the shrink bob be at right angles to each other whenever this is possible. The metal, therefore, runs into the casting impression or cavity slowly and because of gravity and its surface tension, it forms a globule which is uniformly expanded until the impression is filled. If the part to be cast is a ring or of similar shape, the globule will divide and expand around both sides of the central core until the rounded forward faces of the two expanding streams touch, whereupon the oxides covering these forward faces will be pushed aside against the surface of the mold cavity as the two streams of metal join.

It has been found that if the part to be cast is quite small, the shrink bob may, in some instances, be dispensed with, in which event the feeder is connected directly to the casting impression by the small orifice. Such an arrangement is shown in Figs. 6 and 8.

In arranging the mold, care should be taken to see that the cross-sectional areas of the one or more runners are considerably greater than the total cross-sectional areas of the orifices leading therefrom, and that the cross-sectional area of the sprue is several times greater than the total of the similar areas of the runners attached thereto. This is done so that when the pouring operation is started, the sprue and then the runners will immediately fill and bring the full hydrostatic head in the sprue to bear to force the metal through the orifices. Since the runners and sprue are kept full during the pouring operation, the danger of entraining oxides and gases is greatly lessened.

For convenience in discussing the several castings attached to the runner in Fig. 1, those castings below the runner are lettered from *a* to *e* beginning at the sprue, while those above the runner are similarly lettered from *f* to *j*. Of these parts, those lettered *a*, *c* and *e* are alike and are alternated along the runner with parts *b*, *d* and *f*. These parts are positioned along the runner much in the manner that I use for regularly producing castings, while parts *g*, *h*, *i* and *j* are odd parts which are illustrated for the purpose of better disclosing the present invention. The parts *a*, *c* and *e*, as may be seen from Fig. 4, are of comparatively heavy section and it is for this reason that a comparatively large shrink bob 26 is used.

Although for practical considerations, I have not shown the metal as running into the absolute bottom of the mold impression in Fig. 4, it will be seen that when this mold is tilted into pouring position, as shown in Fig. 3, not much metal will need to flow into the impression before a globule is formed. This globule can be expanded without breaking, until the mold is full. The small orifice 28 through which the metal must run in passing from the feeder to the shrink bob is formed in this instance by overlapping slots in the cope and drag, and thus the orifice causes metal flowing therethrough to flow vertically, or, in other

words, at right angles to the outlet of the shrink bob.

In Fig. 5, which illustrates parts *b*, *d* and *f* in section, it will be seen that the mold is in general similar to that shown in Fig. 4. Since this part requires less metal than that shown in Fig. 4, however, the shrink bob 26, neck 27 and orifice 28 are all smaller than the similar parts in Fig. 4. In forming this mold, the feeder 24, shrink bob 26 and neck 27 are all formed by cavities in the cope only, while the orifice is produced by a cavity in the drag, although it will be appreciated that nothing in my process requires that these several elements be specifically so formed.

Fig. 6 illustrates a ring gear requiring a comparatively small amount of metal. For this reason the shrink bob has been omitted. Since the bottom surface of this ring gear is flat and since its total height is well within the limits of the cope alone, this part is formed by a cavity in the cope only.

The rectangular part illustrated in Fig. 7 is of considerable height and for this reason the bottom of the casting, together with the shrink bob 26 and neck 27, are all formed in the cope, but offset downwardly well below the normal parting line of the mold. As in the case of Fig. 5, the orifice is formed by a groove in the drag overlapping the cavities in the cope. The metal is delivered from the feeder 24 to the orifice 28 by a downwardly extending feeder extension 24'.

In Fig. 8 is shown a beveled pinion that is small enough to require no shrink bob. In forming this part, mold cavities are formed in both the cope and drag, while the neck leading from the orifice to the principal impression is wholly within the drag.

The above illustrations are given merely for the purpose of showing the adaptability of the process for use in forming different types of castings and should not be understood as limiting each of the particular parts to the particular mold arrangement shown. Each of the parts shown in Figs. 4 to 8 is illustrated somewhat smaller than full scale. It will be appreciated also that although I have shown a single runner in the drawings, I intend that more runners may be used if desired and that, if desired, a sprue of any suitable material of low heat conductivity may be used in place of the asbestos paper sleeve shown.

An additional utility of the small orifice 28, besides its control over the rate of flow of the metal into the molds, is that after the metal in the mold solidifies and the runner starts contracting, the metal will break or stretch across the thin section at the orifice. That is, the interposition of this easily fractured piece between the molded pieces and the runner protects the molded pieces from being distorted by limiting the amount of pull to which the molded pieces can be subjected to the amount of force which is necessary to stretch or break this small section. In carrying out this function of the orifice, I prefer that the smallest portion of the orifice should be located contiguous to the body of metal which solidifies last. With this arrangement, the separation of the castings from the runner will ordinarily occur while the metal at the orifice is still soft, and thus the stress on the castings is at a minimum. To reduce the pull necessary to bring about this separation even further, I prefer that the corners of the orifice where it joins the larger body of metal should be sharp and not

rounded, in order to give the section of metal at this point as little strength as possible. It has been found, for instance, that when a mold arrangement such as is shown in Fig. 1 is cast and allowed to cool and the mold material is washed or broken away from the metal, all of the cast pieces will be found separated from the runner with the occasional exception of parts close to the sprue, such for instance as those in the positions *a* and *f*.

The size of the orifice 28 used depends in each instance upon the venting capacity of the mold and should as a maximum be of such size that the factor limiting the rate of flow of metal into the mold is the size of the orifice rather than the venting capacity of the mold. The size of this orifice is not critical inasmuch as it may be considerably smaller than the maximum mentioned above. As a general rule, I have found that the cross-sectional area of the orifice should be approximately .0007 square inch for each ounce of weight of the casting to be produced when the molds are constructed in the manner described in my copending application previously referred to and the alloy is of the fluidity of yellow brass in the 60% copper-40% zinc group. Alloys of higher viscosity will require somewhat larger orifices.

Many factors, such as the hydrostatic head used, alloy being cast, volume of the mold; etc., influence the size of this orifice, but the figure given will serve as a starting point from which the best possible size must be determined by trial.

I have found that with this process a brass alloy having a point of fusion of about 1640° to 1670° F. and ordinarily poured at about 1950° F. is best poured at about 1750° to 1800° F.

Having described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. The method of producing metallic castings in a mold impression from fused metal which comprises manipulating the fused metal to form a globule in the mold impression, said globule being held together by gravity and the surface tension of the fused metal, continuously expanding the globule by gradually adding metal thereto at low velocity, the expansion of said globule being continued uninterruptedly until the mold impression is filled, and the step of continuously adding metal to the globule to expand the same being so conducted that disintegration of or turbulence in the globule is prevented.

2. The method of producing metallic castings in a porous mold impression from fused metal which comprises manipulating the fused metal to form a globule in the mold impression, said globule being held together by the surface tension and gravity of the fused metal, continuously expanding the globule by adding metal thereto at low velocity, the expansion of said globule being continued uninterruptedly until the mold impression is filled, and the step of continuously adding metal to the globule to expand the same being conducted with substantially no turbulence, so that disintegration of or turbulence in the globule is prevented, and metal on the surface of said globule once having touched the surface of said impression and having become chilled and thickened somewhat thereby, the continued expansion of said globule will not cause relative movement between the surface of the impression and the surface of the metal in contact therewith.

3. The method of producing metallic castings

in a mold impression from fused metal which comprises manipulating the fused metal to form a globule in the mold impression, said globule being held together by gravity and the surface tension of the fused metal, continuously expanding the globule by gradually adding fused metal thereto at low velocity, the expansion of said globule being continued until the mold impression is filled, the step of continuously adding metal to the globule to expand the same being so conducted that disintegration of the globule or turbulence therein is prevented, and the rate at which metal is added to the globule being less than the venting capacity of the mold.

4. The method of producing metallic castings in a mold impression which comprises filling the mold impression from a runner impression, interposing a small orifice between the mold impression and runner impression to produce a weak section between the useful casting and the runner, and breaking the said weak section by mutual contraction of the casting and runner to separate the useful casting from the runner before the runner and casting have completely cooled.

5. The method of producing metallic castings in a mold impression from fused metal which comprises manipulating the fused metal to form a globule in the mold impression, said globule being held together by gravity and the surface tension of the fused metal, continuously expanding the globule by gradually adding fused metal thereto at low velocity, the metal flowing to said globule being under a substantial head, but being restricted in entering the mold impression by a small orifice so that the flow into said mold will be at a rate slower than the venting capacity of the mold, whereby the metal in said mold impression will be surrounded by air at substantially atmospheric pressure while the mold is filling, but will be subjected to the full head of the metal to form a sharp impression immediately the mold impression is full.

6. The method of producing metallic castings in a mold impression which comprises filling the mold impression from a runner impression, interposing a restriction between the mold impression and the runner impression to reduce the rate of flow of the metal, introducing an enlargement between the restriction and the mold impression to permit the flowing metal to become quiet before flowing into the casting impression, and the whole being so conducted that the metal flows substantially continuously uphill to the casting impression and flows substantially continuously uphill within the casting impression.

7. The method of producing metallic castings in a mold impression which comprises filling the mold impression from a runner impression, interposing a restriction between the mold impression and the runner impression to reduce the rate of flow of the metal, introducing an enlargement between the restriction and the mold impression to permit the flowing metal to become quiet before flowing into the casting impression, and the whole being so conducted that the metal flows substantially continuously uphill to the casting impression and flows substantially continuously uphill within the casting impression, said casting impression being filled with metal at a temperature not substantially higher than 200° F. above its temperature of fusion.

HENRY F. HAGEMEYER.