United States Patent [19] [11] **3,752,212**
Thompson [45] **Aug. 14, 1973**

[54] **METHOD OF FORMING CASTINGS OF DIFFERENT METALS**

[75] Inventor: **Earl A. Thompson,** Bloomfield Hills, Mich.

[73] Assignee: **Earl A. Thompson Manufacturing Co.,** Ferndale, Mich.

[22] Filed: **July 20, 1970**

[21] Appl. No.: **56,740**

Related U.S. Application Data

[63] Continuation of Ser. No. 485,270, Sept. 7, 1965, abandoned.

[52] **U.S. Cl.** **164/93,** 164/96, 164/94, 164/133, 164/125, 164/363, 249/52, 249/107, 249/109, 249/110

[51] **Int. Cl.** **B22d 23/00**

[58] **Field of Search** .... 164/112, 91, 92, 164/98, 106, 96, 93, 94, 95, 99, 125, 126, 127, 129, 108, 130, 363; 123/188 A, 188 AA

[56] **References Cited**

UNITED STATES PATENTS

618,867	2/1899	Griffith	164/95
1,446,678	2/1923	Wilks	164/96
95,577	10/1869	Foster	164/96
547,009	10/1895	Hampton	164/96
945,019	1/1910	Connell	164/93
1,742,849	1/1930	Davidson	164/129
1,455,091	5/1923	Nichols	164/133
638,908	12/1899	Cosgrave	164/95
375,666	12/1887	Atha	164/94
3,412,721	11/1968	Thompson	164/96 X
3,395,747	8/1968	Thompson	164/106

FOREIGN PATENTS OR APPLICATIONS

23,622	10/1913	Great Britain	164/96
8,490	10/1913	Great Britain	164/96
20,895	12/1890	Great Britain	164/95
991,513	5/1965	Great Britain	164/95

OTHER PUBLICATIONS

Principals of Metal Casting, by Heine & Rosenthal, pp. 175 & 177, copyright 1955 by McGraw-Hill Co.
2,163,022, 20 June 1939, Campbell.

Primary Examiner—J. Spencer Overholser
Assistant Examiner—V. K. Rising
Attorney—Theodore L. Chisholm

[57] **ABSTRACT**

A second and different metal may be cast onto the solidified free surface of an otherwise still molten first cast metal which partially fills a mold cavity in such a way that said solidified surface forms a temporary barrier which remelts, autogenously uniting the metals into a composite cast product upon solidification. Vertical velocity in casting the upper metal should be minimized. Metal may be cooled in a lower gate to block flow therethrough to permit an upper gate in the same system to feed the mold.

7 Claims, 10 Drawing Figures

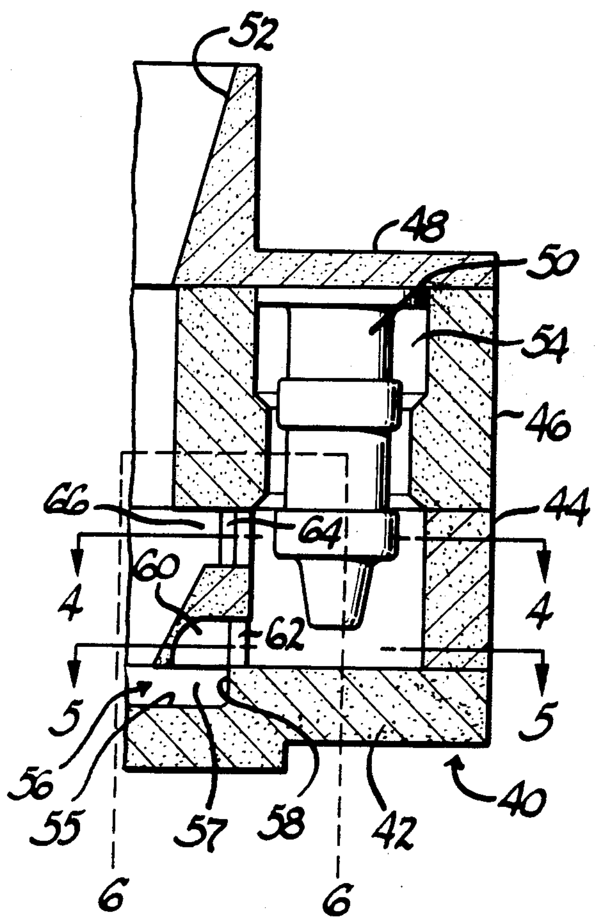


Fig. 1

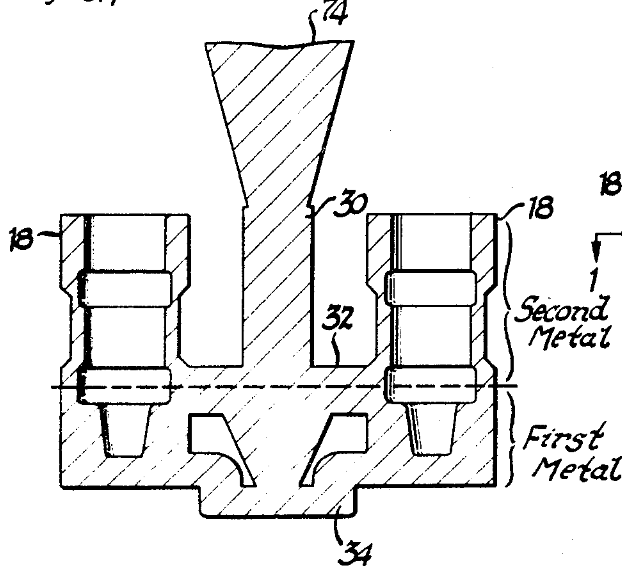


Fig. 2

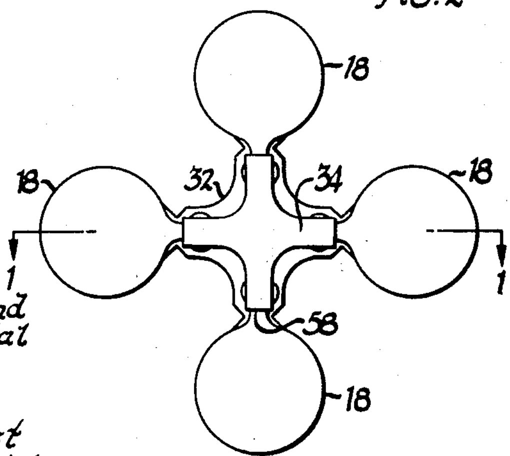


Fig. 3

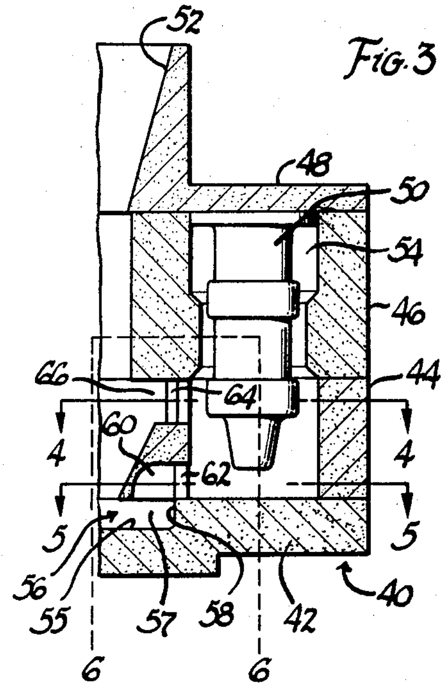


Fig. 4

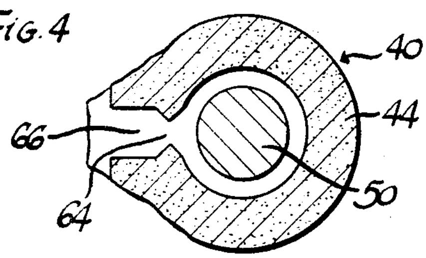
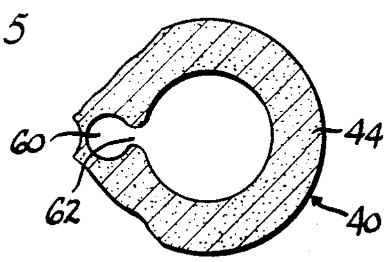


Fig. 5



Patented Aug. 14, 1973 3,752,212

2 Sheets-Sheet 2

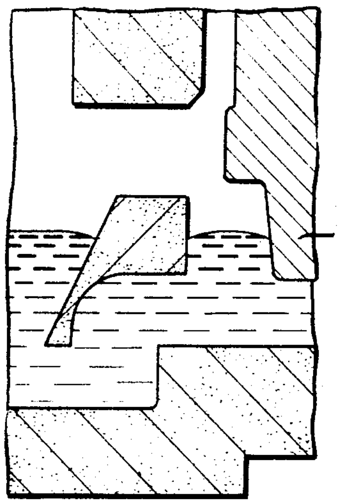


FIG. 6

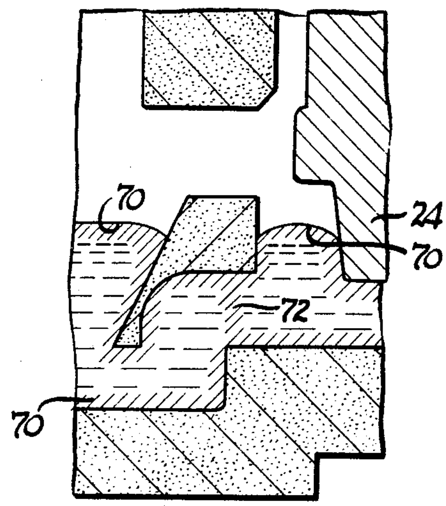


FIG. 7

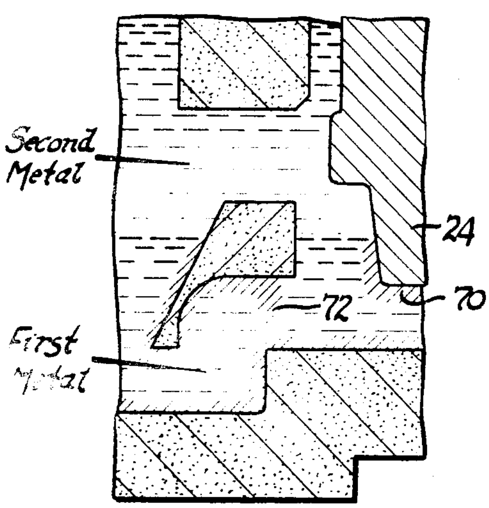


FIG. 8

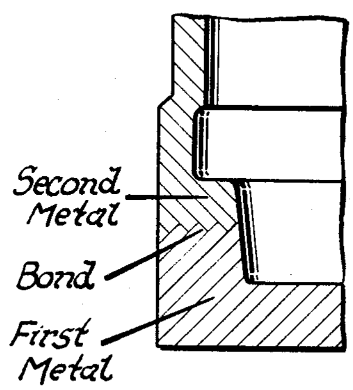


FIG. 9

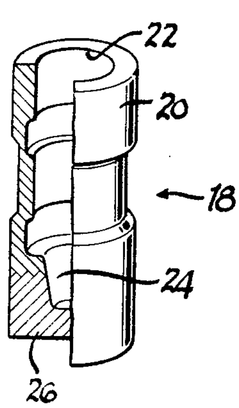


FIG. 10

METHOD OF FORMING CASTINGS OF DIFFERENT METALS

This application is a continuation of Ser. No. 485,270, filed Sept. 7, 1965, now abandoned.

This invention relates to the casting of metallic articles, particularly small articles. Some of the features of the invention are especially adapted to the casting of an article which has one part composed of one metal autogenously united to another part composed of a different metal.

Castings composed of separately poured different metals united at some kind of juncture zone have long been known. A mold is partly filled with molten metal to form one part of the casting, then the rest of the mold is filled with a different metal to form the other part of the casting. See for example the U.S. Pat. to Wilmington No. 82,466 Sept. 22, 1868. The metals are chosen for the suitability of their properties for the demand made on the particular parts. For example one part may be required to be very hard to resist wear, while another part need not be so hard, but must be freely machinable. See for example the U.S. Pats. to Foster No. 95,577 Oct. 15, 1869, Totten No. 399,295 March 12, 1889, Krepps No. 2,710,997 June 21, 1955.

The casting processes proposed for making such articles have been limited to two types. One is to pour the second molten metal into the mold before the first-poured metal hardens, as in the Wilmington patent. The other is to allow the first metal to solidify before pouring the second metal, supposing or hoping that the second metal will melt a portion of the first metal and so form a molten mixture of the two metals which will unite the two when they are cooled, as in Krepps. In the first proposed method the two molten metals can flow together and mix too much. This mixing may be quite irregular and provides a product which is undesirable in many respects. In particular this method places one metal in parts of the finished casting where that metal should not be. This method is particularly unacceptable in making small castings because space limitations make it extremely difficult or impossible to prevent the second metal from flowing into a part of the mold which should be occupied by the first metal exclusively. This prevents or destroys the desired qualities in that part of the casting which should be composed of the first metal alone.

It has been proposed to reduce the tendency to mix by careful direction of the stream of second metal, as in Japanese Pat. No. 2682 dated Feb. 19, 1896, but none of these theoretical proposals have been successful in practice in the production of small castings, especially those subject to severe and frequent stress.

In the second proposed method the second metal may not melt the first, and if it does the melting of the first metal by the second metal after the first metal has solidified is irregular, unreliable and cannot be controlled. It does not form a reliable or adequate joint in small castings subject to great or frequent stress.

I have previously proposed, as disclosed in detail in British Pat. No. 991,513, dated May 12, 1965 and in my U.S. Pat. No. 3,412,721, Nov. 26, 1968, to form such a two-metal casting by pouring a quantity of the first molten metal into the bottom of a mold, forming a temporary frozen skin on the exposed surface of the metal then while the metal below the skin remains molten pouring a second molten metal onto the skin. The

second metal is poured under such conditions that it melts the skin and so forms a blend of the two metals in the space occupied by the skin. This forms a superior joint when both metals cool. The skin prevents too much mixing of the two metals. This can be controlled easily, and it makes a very desirable joint.

Applying the skin process just described to otherwise customary casting techniques has proven advantages and is satisfactory within some inherent limitations. But there are disadvantages. Sometimes the first metal spatters and forms solid particles adhering to the wall of the mold in the space which should be occupied by the second metal alone. When using certain combinations of metals, for example a wear resisting hard alloy for the first metal and a machinable cast iron for the second metal, the particles of the spattered alloy adhering to the mold solidify before the second metal is poured. Subsequent casting of the second metal usually does not remelt these particles so that they remain as hard spots, or even form loose hard particles which are knocked out of the casting in subsequent machining. This makes flaws in the casting. Even if the second metal should re-melt these globules of the first metal, they remain as isolated hard spots in what should be machinable metal.

Another disadvantage of my previously proposed process is that the castings are made one at a time. Consequently another object of this invention is to provide an improved method of simultaneously making a number of such multiple-metal castings. This requires simultaneously pouring precisely the same quantity of metal into several molds without filling the mold, and maintaining that quantity of molten metal in the mold during subsequent pouring of a second molten metal on top of the first metal, which remains molten.

Therefore another object is to provide improved molds and improved methods of pouring which help me quickly and easily to measure precisely quantities of metal less than a mold full, and to preserve such quantities, for example by preventing, at the appropriate time, flow of the first molten metal from one mold to another after it has been poured and stabilized. This flow is prevented in order to prevent forcing of the first metal out of one mold into another due to head or pressure, of the second metal being poured. The achievement of these objects is especially important where only about a teaspoon full of the first metal is poured into each mold.

One of the objects of my invention is to prevent this undesirable result by providing an improved mold having a tortuous passage between the point of impact of the molten metal and the mold and that part of the mold cavity to which the first molten metal is to be delivered. This tortuous path may include a vertical wall at the ends of a chamber which first receives the molten first metal.

Another possible disadvantage in my previously proposed process is that it is possible, especially when pouring the second metal from a height, to break the skin on the first metal, producing a turbulent mixing of the two metals and an unacceptable distribution of the second metal into the first. Consequently another object is to improve the successive pouring of molten metals in order to control the juncture zone between the two metals and to prevent undesired mixing of the metals. More particularly it is an object to pour the second metal in such a way that it contacts the first metal without substantial vertical velocity.

Another object is to improve the mold and the casting process so that a multiple cavity mold may be used without wasteful runners. More particularly it is an object to design the product, molds and casting process so that the sprue, which inherently contains separate portions formed of the two metals, will contain the two metals in such proportions and such mass that the sprue can be used as the source of one of the metals alone, simply by adding ingredients and remelting. I proportion the mass of the castings being made, the mass of the sprues and the proportions of the two metals used so that the entire quantity of the sprues will be used as ingredients of one of the metals in the successive castings.

Other objects and advantages of the invention will be evident from the annexed description and claims and from the accompanying drawings, in which

FIG. 1 is a central vertical section through a sprue and a cluster of castings embodying one form of the invention. FIG. 1 is a section on line 1—1 of FIG. 2.

FIG. 2 is a bottom plan view of the structure shown in FIG. 1.

FIG. 3 is a vertical section of the right half of a mold in which the structure of FIG. 1 is cast.

FIG. 4 is a section of the mold on the line 4—4 of FIG. 3.

FIG. 5 is a section of the mold on the line 5—5 of FIG. 3.

FIG. 6 is an enlarged vertical section of a portion of a mold into which a first metal has been poured, this portion of the mold being that within the broken line 6—6 of FIG. 3.

FIG. 7 is a schematic section corresponding to FIG. 6 showing the way in which the first metal begins to harden or solidify after being poured.

FIG. 8 is a view corresponding to FIGS. 6 and 7 showing the second metal poured into the mold on top of the first metal.

FIG. 9 is a section of the casting formed in that part of the mold shown in 6, 7 and 8 showing diagrammatically the joint between the two metals. It shows the smooth casting after the gate metal has been removed.

FIG. 10 is a perspective view, partly cut away of a finished casting constructed according to the invention.

The invention will be described for illustration only as applied to a body for a valve tappet of known form such as is customarily used in automobile engines. Such a tappet 18 is illustrated in FIG. 10. It includes a thin walled tubular portion 20 having a bore 22 for a plunger and having a spring pocket 24 closed at the bottom by an end 26 which forms a cam follower. It is desirable that the tubular portion 20 be formed of readily machinable material such as gray cast iron and that the end 26 be formed of a hard, wear resistant material such as a hardenable white iron alloy, for example one containing chromium, molybdenum and nickel. The two kinds of metal are autogenously united in a single casting as shown in FIG. 9 at about the center of the height of the spring pocket where the thickened wall provides an adequate area for an extremely secure joint.

The invention includes making improved castings of the type described by an improved method in an improved mold.

FIGS. 1 and 2 show an intermediate casting as removed from the mold. It has a central sprue 30 joined to four symmetrically arranged tappet bodies 18 by four very short upper runners 32 and four very short lower runners 34.

FIG. 3 is a half section corresponding to FIG. 1 of the mold in which the casting of FIG. 1 is formed. The mold is symmetrical about the center line. The mold designated generally by 40 may be made of four horizontal sections stacked together and including a bottom section 42, a lower intermediate section 44, upper intermediate section 46 and a top 48 to which are attached cores 50. The parts of the mold when stacked together provide a sprue passage 52 and four mold cavities 54, each of which cavities when filled produces a tappet body casting 18.

The sprue passage 52 terminates at its lower end at a surface 55 which may cause spattering of metal being poured. The surface may be part of a chamber 56 which may be cruciform to define four connected passages 57 for the runners 34. These are as nearly identical as can be made practically, and terminate at their outer ends in substantially vertical walls 58. Identical vertical passages 60 connect the chamber 56 with each of a number of identical horizontal gates 62 through which metal is discharged into the mold cavity 54 at a level of the bottom 26 of the tappet casting. At a point above the gate 62 is a second gate 64 connected to the sprue passage 52 by a short passage 66 for the runner 32, conducting metal to a higher level in the mold cavity. As shown in FIG. 4 the gate 64 embodies a constriction or narrowing of the runner passage 66 and as shown in FIG. 5 the gate 62 embodies a constriction or narrowing of the passage 60. The purpose of these constrictions will be explained.

In making the castings in accordance with this invention I prefer to use shell molds of sand bonded with any suitable binder, for example molasses, which when heated, burns or gives off gas which consumes or expells all oxygen in the mold cavity so as to maintain a non-oxidizing atmosphere in the mold cavity. This prevents forming of scale on the top of the first metal.

I first pour the predetermined quantity of the hardenable white alloy iron into the sprue passage 52 sufficient to rise to about the middle of all of the spring pockets 24. This condition is shown in FIG. 6. The upper surface of the molten metal tends to assume a meniscus or arcuate shape due to its surface tension as indicated schematically in FIG. 6.

The passage from the lower end of the sprue passage 52 into the bottom of the mold cavity, formed by the runner passage 57, vertical passage 60 and gate 62 is a tortuous one. When molten metal is first poured into the sprue passage 52 it strikes the flat bottom of the chamber 56 and tends to spatter. Either the vertical walls 58 or the particular form of the tortuous passages 57 – 60 – 62 effectively prevent any spattering of the metal first poured into the mold cavity, especially into the upper part of the mold cavity 54. This tortuous passage is particularly effective because the gate 62 enters the bottom of the mold cavity and is fed from below.

The resistance to flow of each of the passages 57 – 60 – 62 is the same, as nearly as it is practical to make them. This is to insure that the same quantity of the white iron alloy will flow into each mold cavity, and that the upper surface of this metal will be at the desired point in each mold, so that the iron alloy will constitute the desired portion of each tappet body, but no more.

In order to insure this equal distribution of metal, in the event that the passages are not precisely identical the metal in the mold is maintained molten long enough after the pouring stops for the liquid to find the same hydrostatic level in all molds. Then as the first metal cools, it begins to harden. It hardens first at the surfaces of the mold and at its exposed upper surface as indicated at the hatch lines at **70** and **72** in FIG. **7.** A feature of this invention is the constriction of the gate **62** so that the amount of metal in the gate has such a narrow cross section that the metal solidified at the surface of the mold neck as indicated at the hatch lines **72** in FIG. **7** completely blocks the gate. If desired a chill may be inserted in the mold adjacent the neck to accelerate blocking. After the neck and upper surface of the first metal have hardened, and while the rest of the metal is molten, I pour into the sprue passage **52** a roughly predetermined quantity of the second metal sufficient to fill the rest of the mold cavity and to provide a riser **74** to prevent shrinkage. At the instant the second metal is poured the hardened upper surface of the first metal forms a non-liquid barrier which prevents the second metal from flowing into the first metal and mixing with it. The frozen neck at **72** prevents flow of the first metal in the gate under the head of the second metal, and thus preserves in the mold cavity the exact quantity of the first metal needed to make the composite casting. When the second metal is poured there is then in the mold a barrier or skin of hardened first metal separating a body of first molten metal from a body of second molten metal.

The melting point of the first metal and the temperature of the pouring of the second metal are so chosen that the second metal melts this skin. The pressure of the second metal may flatten the skin into a plane. The two molten metals which have been maintained quiet by the skin then mix one into the other in the space occupied by the skin and form a blend of metal the analysis of which progresses from the analysis of the first metal at the bottom of the blend to an analysis of the second metal at the top of the blend. This provides an autogenous joint between the two bodies of metal when they are cooled and provides a tappet body having a bond or joint between the two metals formed by the progressive blend of the two metals as indicated schematically in FIG. **9.**

The constricted neck or gate **62** not only serves to prevent flow of the first metal after the second metal is cast but its narrow circumferential dimension and the corresponding narrow circumferential dimension of the gate **64** provide weak spots in the casting shown in FIG. **1** which can readily be broken to separate the tappet castings **18** from the sprue **30.**

After the casting has solidified the mold is broken away from it and the sprue is broken away from the castings **18** in any suitable manner.

Referring to FIG. **1,** it will be observed that the sprue and its connected runners have a portion below the dotted line composed of the first metal poured and the remainder of the sprue and the upper runners are composed of the second metal.

One of the features of the invention is the selection of the analyses of the first and second metals, the proportioning of the masses of the sprue and runners to the mass of the four castings removed and the proportioning of the first metal to the second metal so that all of the back scrap consisting of the sprues and runners can be remelted and used again. For example the first metal, that is the hardenable white iron alloy, is poured in the proportionate amount shown in FIG. **1.** It may have the following ingredients in the percentages indicated:

Carbon **2.8 - 3.4**
Silicon **2.0 - 2.4**
Manganese **0.7 - 0.9**
Chromium **0.9 - 1.25**
Sulphur **0.1** max.
Molybdenum **0.4 - 0.7**
Nickel **0.4 - 0.7**
Phosphorous **0.2** max.
Balance iron

The gray iron second metal is poured in the proportionate amount shown in FIG. **1** and may have the following analysis:

Carbon **3.3 – 3.7**
Silicon **2.3 – 2.8**
Manganese **0.6 – 0.9**
Sulphur **0.15** max.
Phosphorous **0.2** max.
Balance iron

The first metal may be formed from the second metal solely by adding the appropriate amount of molybdenum and nickel and chromium.

In practice all of the back scrap consisting of the broken off sprues and runners is remelted. Due to the presence in this melt of both first and second metals the melt has a third analysis which is different from both first and second metals. The relative mass of metal in the four tappet body castings and in the back scrap is so related that after removal of the four tappet castings and after addition of the amount of chromium, molybdenum and nickel required to convert the third analysis into the first analysis the quantity of resulting molten metal is not greater than the original mass of the first metal cast as shown in FIG. **1.** Thus all of the back scrap can be used in the process and there is no waste.

The hardenable white allow iron of the composition herein disclosed may be poured into the mold at approximately 2,700°F. In the proportion shown in FIG. **1** to FIG. **5.** The skin **70** and the solid neck **72** will be formed in approximately twelve seconds after pouring. The gray iron can be poured at approximately 2,700°F. to 2,800°. The amount of skin formed, the latent heat of fusion of the alloy iron, the temperature of the second metal and the quantity of the second metal are all so proportioned and related that the second metal is stopped by the skin and does not penetrate and intermix with the molten first metal until after any turbulence in the second metal due to pouring has disappeared. The gate **64** discharges the second molten metal at the level of the frozen skin on the first molten metal and discharges it generally parallel to this skin without any vertical velocity. At the first instant of pouring the second metal and before the second metal has has time to flow through the upper gate there is a head of molten metal on the first metal which is molten except for the skin and the solidified portion in the gate **62.** Solid metal in the gate prevents flow of the first metal through the gate under this head. Thus there is for a time a solid skin formed on the first metal between two bodies of molten metal. The second metal then melts the skin and the two molten metals form a progressive blend of metals constituting the joint. Because the metals are quiet and not flowing or turbulent at the time the molten first metal comes in contact with the molten second metal the thickness throughout which this mixing takes place is small, being confined essentially to a space of the order of the volume formerly occupied by the skin.

It is to be understood that the foregoing description and drawings are for illustration only and that the invention may be embodied in other forms and practiced in various ways within the scope of the claims. In particular I have described gravity casting but certain features of the invention can be included in centrifugal casting. Consequently I have used the expression hydrostatic level to indicate the level at which liquid metal will be maintained whether by gravity or otherwise.

I claim as my invention:

1. The method of forming a casting having predetermined parts of different metals autogenously united which includes pouring a first molten metal having first properties into a cavity to fill part of the cavity only, cooling the exposed upper surface of the first metal while maintaining the first metal molten adjacent the surface to form from the first metal on the exposed upper surface thereof a horizontal barrier which includes solidified first metal on top of molten first metal and which prevents the flow of molten metal therethrough, confining the first molten metal in that space in the cavity determined by the barrier, pouring a second molten metal having second and different properties onto the barrier without significant vertical velocity so that there is now a horizontal barrier including solidified first metal between two masses of molten metal of different properties, melting the entire barrier in place to form a single mass of molten metal having well defined portions of different properties above and below the space determined by the metal melted from the barrier, and cooling said single mass of molten metal to form a casting having a well-defined part of the first metal autogenously united to a well-defined part of the second metal by a metal having a progressive blend of properties from the properties of the first metal to the properties of the second metal.

2. The method of forming a casting having predetermined parts of different metals autogenously united which includes pouring a first molten metal having first properties into a cavity through a gate below the top of the cavity to fill part of the cavity only and at least to a hydrostatic level sufficient to retain the gate filled, cooling the exposed upper surface of the first metal while maintaining the first metal molten adjacent the surface to form from the first metal on the exposed surface thereof a horizontal barrier which includes solidified first metal on top of molten first metal and which prevents the flow of molten metal therethrough, confining the first molten metal in that space in the cavity determined by the barrier, pouring a second molten metal having second and different properties onto the barrier without significant vertical velocity from a second gate above the hydrostatic level of the first gate and substantially at the level of the barrier so that there is now a barrier including solidified first metal between two masses of molten metal of different properties, melting the entire barrier in place to form a single mass of molten metal having well defined portions of different properties above and below the space determined by the metal melted from the barrier, and cooling said single mass of molten metal to form a casting having a well defined part of the first metal autogenously united to a well-defined part of the second metal by a metal having a progressive blend of properties from the properties of the first metal to the properties of the second metal.

3. The method of forming a casting having predetermined parts of different metals autogenously united which includes pouring a first molten metal having first properties into a cavity through a gate below the top of the cavity to fill part of the cavity only and at least to a hydrostatic level sufficient to keep the gate filled, cooling the exposed upper surface of the first metal while maintaining the first metal molten adjacent the surface to form from the first metal on the exposed surface thereof a horizontal barrier which includes solidified first metal on top of molten first metal and which prevents the flow of molten metal therethrough and while cooling the metal in the gate sufficiently to prevent flow therethrough, pouring a second molten metal having second and different properties onto the barrier without significant vertical velocity so that there is now a horizontal barrier between two masses of molten metal of different properties, melting the entire barrier in place to form a single mass of molten metal having well defined portions of different properties above and below the space determined by the metal melted from the barrier, and cooling said single mass of molten metal to form a casting having a well defined part of the first metal autogenously united to a well defined part of the second metal by a metal having a progressive blend of properties from the properties of the first metal to the properties of the second metal.

4. The method of forming a casting having portions of different metals autogenously united which includes pouring into a passage a first molten metal having first properties, conducting said metal from the passage into a cavity through a gate below the top of the cavity to fill part of the cavity only and at least to a hydrostatic level sufficient to keep the gate filled, cooling the gate sufficiently to prevent flow of molten metal therethrough, cooling the exposed upper surface of the first metal while maintaining the first metal molten adjacent the surface to form from the first metal a horizontal barrier which contains solidified first metal on top of molten first metal, pouring into said passage a second molten metal having second and different properties, conducting the second molten metal into the cavity and onto the barrier through a second gate at a higher hydrostatic level than the first gate and substantially at the level of the barrier, melting the entire barrier in place to form a single mass of molten metal having well defined portions of different properties above and below the space defined by the barrier so that there is now a single mass of molten metal having well defined portions of different characteristics, and cooling said single mass of molten metal to form a casting having a well defined part of the first metal autogenously united to a well defined part of the second metal.

5. A method of controlling the quantities of different metals in a plurality of castings each of which has portions of different metals autogenously united which method includes pouring a predetermined quantity of a first molten metal having first characteristics into a supply passage, simultaneously leading molten metal into a plurality of molds through a low gate for each

mold below the top of the mold to fill part of the mold only and at least to a hydrostatic level sufficient to keep the gate filled while maintaining molten metal in all molds, cooling the metal in the gates sufficiently to prevent flow therethrough while maintaining the first metal molten in the molds, pouring a second molten metal having second and different characteristics into the supply passage and through high gates onto the first metal while preventing flow of the second metal into the first metal so that there is in each mold a single mass of molten metal having portions of different characteristics, the portions of the first metal being substantially the same in all molds, and cooling all said single masses of molten metal to form castings each having a part of the first metal autogenously united to a part of the second metal.

6. A method of controlling the quantities of different metals in a plurality of castings each of which has portions of different metals autogenously united which method includes pouring a first molten metal having first characteristics into a supply passage, simultaneously leading molten metal from the passage into a plurality of molds through a gate for each mold below the top of the mold to fill part of the mold only and at least to a hydrostatic level sufficient to keep the gate filled while maintaining molten metal in all molds, stopping the pouring into the passage to permit the metal to reach the same hydrostatic level in all molds, cooling the metal in the gates sufficiently to prevent flow therethrough and preserve said level in all molds, while maintaining molten metal in the molds, pouring a second molten metal having second and different characteristics into the supply passage and through high gates onto the first metal while preventing flow of the second metal into the first so that there is now in each mold a single mass of molten metal having well-defined portions of different characteristics, the portions of the first metal being substantially the same in all molds, and cooling all said single masses of molten metal to form castings each having a well defined part of the first metal autogenously united to a well defined part of the second metal.

7. A method of controlling the quantities of different metals in a plurality of castings each of which has portions of different metals autogenously united which method includes pouring a predetermined quantity of a first molten metal having first characteristics into a supply passage, simultaneously leading molten metal from the passage into a plurality of molds through a low gate for each mold below the top of the mold to fill part of the mold only and at least to a hydrostatic level sufficient to keep the gate filled while maintaining molten metal in all molds, cooling the metal in the gates sufficiently to prevent flow therethrough while maintaining molten metal in the molds, pouring a second molten metal having second and different characteristics into the supply passage and through high gates onto the first metal while preventing flow of the second metal into the first so that there is now in each mold a single mass of molten metal having well defined portions of different characteristics, the portions of the first metal being substantially the same in all molds, and cooling all said single masses of molten metal to form castings each having a well defined part of the first metal autogenously united to a well defined part of the second metal.

* * * * *