Sept. 8, 1942. N. M. CAMPBELL ET AL 2,294,959

METAL CASTING

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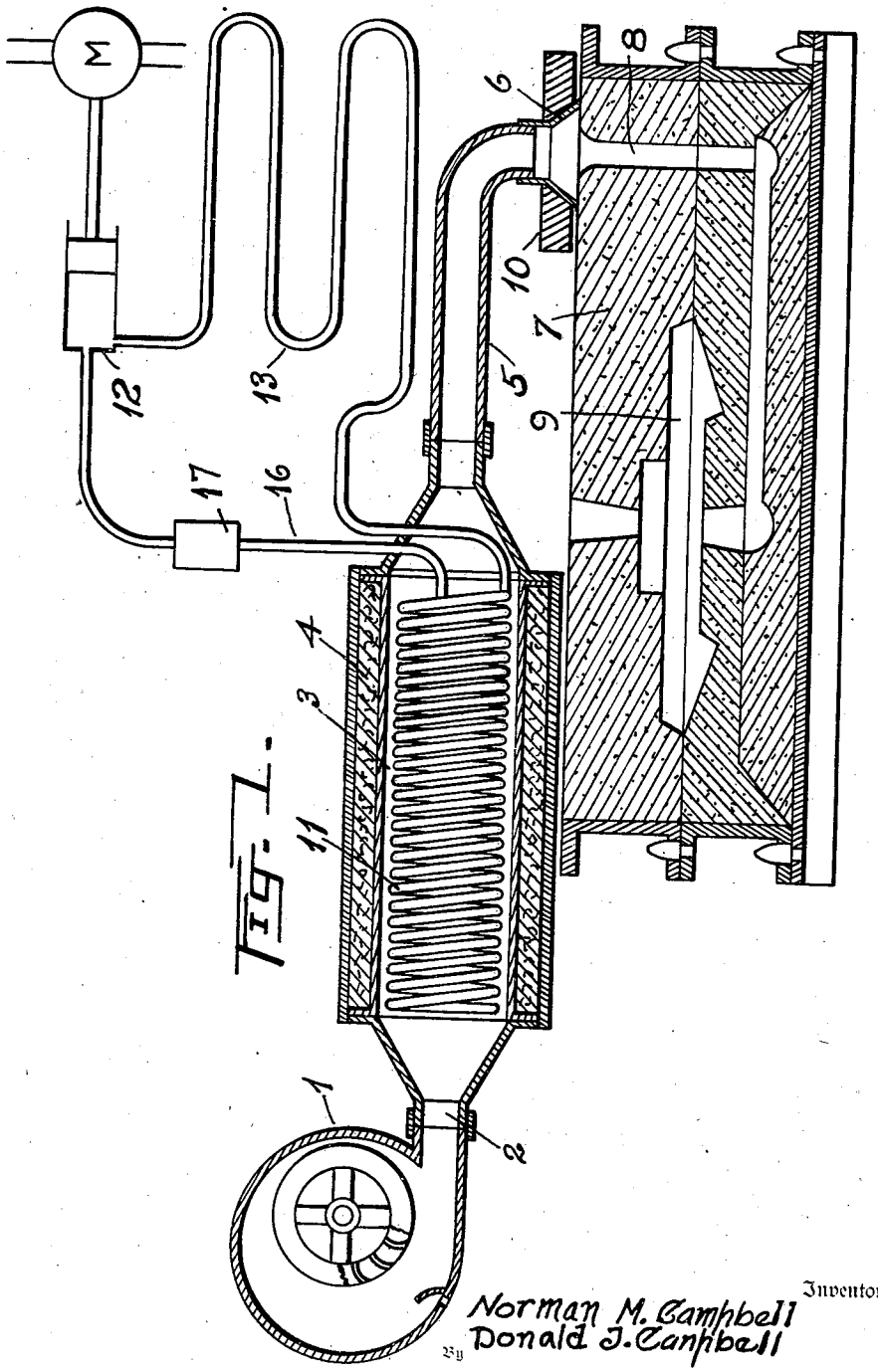


Fig. 1.

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Fig. 2.

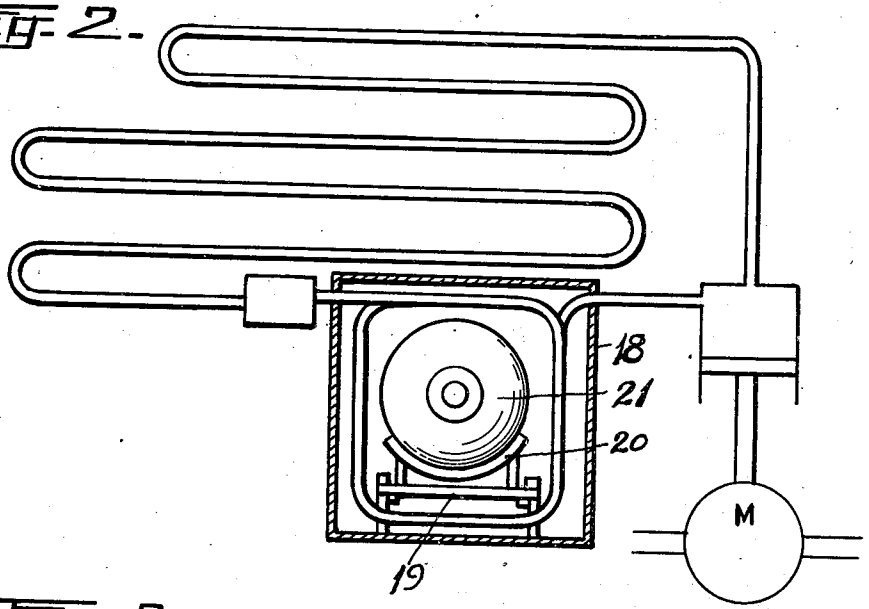


Fig. 3.

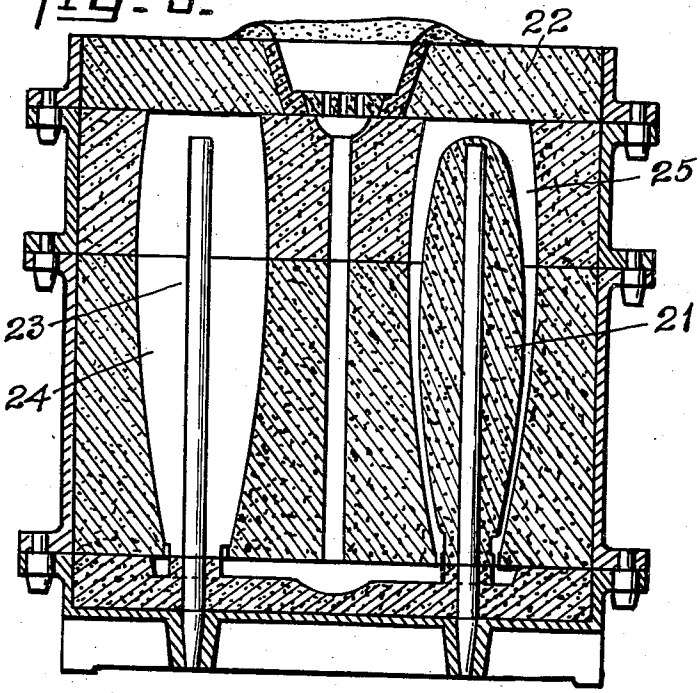
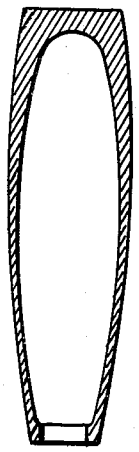


Fig. 4.



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METAL CASTING

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3 Claims. (Cl. 22—212)

The present invention relates to improvements in metal casting, and particularly to the casting of metal having high shrinkage characteristics such as steel, or castings of great bulk, or unsymmetrical shape; and the objects of improvement are, first, to provide a method by which castings free from internal defects can be economically produced from metal having high shrinkage characteristics; second, to provide a method whereby bulky metal castings can be produced that are free from shrinkage depressions on their exterior or voids within; third, to provide a method whereby metal castings produced thereby will have a finer grain structure than castings produced by usual foundry practice; fourth, to provide a method whereby castings of uniform grain structure will be produced; fifth, to provide a method whereby castings free from internal flaws of all kinds can be produced.

The above named objects and other objects that appear from a perusal of the method herein described, assisted by the devices diagrammatically illustrated, are attained by such devices shown in the accompanying drawings, in which:

Figure 1 is a part sectional view of the air cooling apparatus preferably employed to cool the mold in which is cast metal in accordance with my method of metal casting, the view being taken on a vertical plane through the axis of the cooling tunnel and the mold in which is shown a mold cavity adapted for casting a bevel gear blank, the refrigerating apparatus being shown diagrammatically.

Figure 2 is a part sectional view of the cooling tunnel adapted to cool the core of an artillery projectile which is alone supported on a cradle dryer within the cooling tunnel cooled by the refrigerating coils shown diagrammatically as also the apparatus.

Figure 3 is a cross-sectional view of a mold in which to cast a plurality of artillery projectile bodies, the view being taken on a vertical plane through two of the mold cavities, in one of which is shown the core whereby is formed the explosive charge cavity.

Figure 4 is a longitudinal cross-sectional view of a projectile body that my improved method of metal casting is particularly adapted to, and as would be produced in the mold shown in Figure 3.

Referring further to Figures 1, 2, and 3.

Figure 1 illustrates one method of cooling a mold, by circulating through the mold cavities refrigerated dry air cooled to a lower temperature, by the device shown diagrammatically as comprising a centrifugal air drier and fan 1, having its discharge 2 connected to the air cooling tunnel 3, surrounded by suitable temperature insulation 4, and having a flexible tubular air conductor 5 provided with a canvas-like funnel-shaped hood 6, held against the mold 7 over the gate riser 8 connected with the mold cavity 9, and held securely thereover by weight 10. Within the air cooling tunnel 3 is refrigerating coil 11 connected to the gas compressor 12 through condenser coils 13 at one of its ends, and its other end connected to the compressor 12 by tube 16 and liquid receiver 17. From the above description it will readily be understood that the air delivered to the mold will first be, to a great extent, dehydrated by the air drier and forced thereby through the tunnel 3, around the refrigerating coils 11 therein by which the air will be cooled to a low temperature, and by passing to and through the mold, will cool or refrigerate the mold to the required low temperature degree.

Figure 2 represents the cooling of a core as employed in casting artillery shell bodies. The apparatus comprises generally, the same refrigerating elements as that of Figure 1, such as the refrigerating coil 11, gas compressor 12, condenser coils 13, compressor connecting tube 16 and liquid receiver 17 it differing therefrom only in that the refrigerating coils are arranged within a rectangular cross-sectional housing 18, adjacent the walls thereof and in which is core supporting carriage 19 for supporting the core drier 20 on which rests core 21, which core is the same as the core illustrated in Figure 3, illustrating a mold 22 in which to cast artillery shell bodies, which is cooled by either the method shown in Figure 1, or by packing carbon dioxide, commonly referred to as dry ice. This dry ice is preferably formed to near the shape of the mold cavities on a hollow perforated mandrel 23 and inserted in the mold cavity 24. The mold cavity has therein the core 21, as shown in Fig. 2, being cooled by refrigeration.

Bulky castings produced by the usual foundry methods invariably have depressions in their top, which are caused by shrinkage of the metal during solidification of the metal within the casting after the outer shell portion has solidified. Castings of irregular shape, or those having a heavy portion adjacent a lighter portion, will usually have a ragged void within the casting at the heavier portion, or cracks extending inwardly from the junction of the light and heavy sec-

tions. In order to overcome these defects, several expedients have been employed, such as providing heavy metal chill blocks and inserting these chill blocks in the material forming the mold, adjacent the portion of the mold cavity in which the heavy portion of the casting is formed, the purpose being to bring about as near as possible, a uniform solidification of the casting and consequently, uniform shrinkage. Another method is to provide excessively large riser passages in which the metal is kept in a molten state by churning with a steel rod, thus feeding molten metal to the heavy portion of the casting to overcome shrinkage voids during solidification of the molten metal therein. A third method is to provide large riser passage and to apply pressure to the molten metal in the passage during solidification of the metal in the mold cavities.

The first method described requires that a large quantity of specially shaped chill blocks be maintained, with frequent renewals when lost or damaged, besides leaving objectionable marking on the casting. The second and third methods are objectionable on account of waste and cost, because of the heavy sprues and the labor required to prepare for casting and cutting the heavy sprues from the casting.

In the present improved method of metal casting, the mold, including cores, is cooled to a low temperature, in some cases, as when a very heavy casting is to be produced, to considerably below zero Fahrenheit, and in extreme cases as low as seventy or more below zero Fahrenheit. In the production of lighter castings, the mold can be considerably above zero, and even above thirty-two degrees Fahrenheit for the casting of very light section castings. Therefore, when the molten metal is poured into the mold cavity so cooled, it is caused to solidify quickly and sufficiently rapidly to prevent internal shrinkage. Such shrinkage as takes place is the normal linear shrinkage of the casting and therefore in the outer dimension of the casting only.

Having described the present invention, the rights it is desired to secure are disclosed in the claims hereinafter set forth. Therefore, we claim:

1. The method of casting steel consisting in providing a mold having a mold cavity and passages extending to said cavity, refrigerating air to a temperature of approximately zero degrees Fahrenheit, blowing the refrigerated air into the mold cavity until the mold has reached a temperature below thirty-two degrees Fahrenheit and while the mold temperature is below thirty-two degrees Fahrenheit, flowing molten steel into the mold cavity.

2. The method of casting steel consisting in providing a mold having a mold cavity and passages extending to the said cavity, refrigerating air to a temperature below thirty-two degrees Fahrenheit, passing said refrigerated air through said passages and mold cavity until the mold around the cavity is cooled to a temperature below thirty-two degrees Fahrenheit and while the mold around the cavity is below thirty-two degrees Fahrenheit, depositing in the mold cavity, molten steel.

3. The method of casting steel consisting in refrigerating air, forcing said refrigerated air into a mold cavity until the mold has reached a temperature below thirty-two degrees Fahrenheit and immediately thereafter depositing molten steel in the mold.

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