

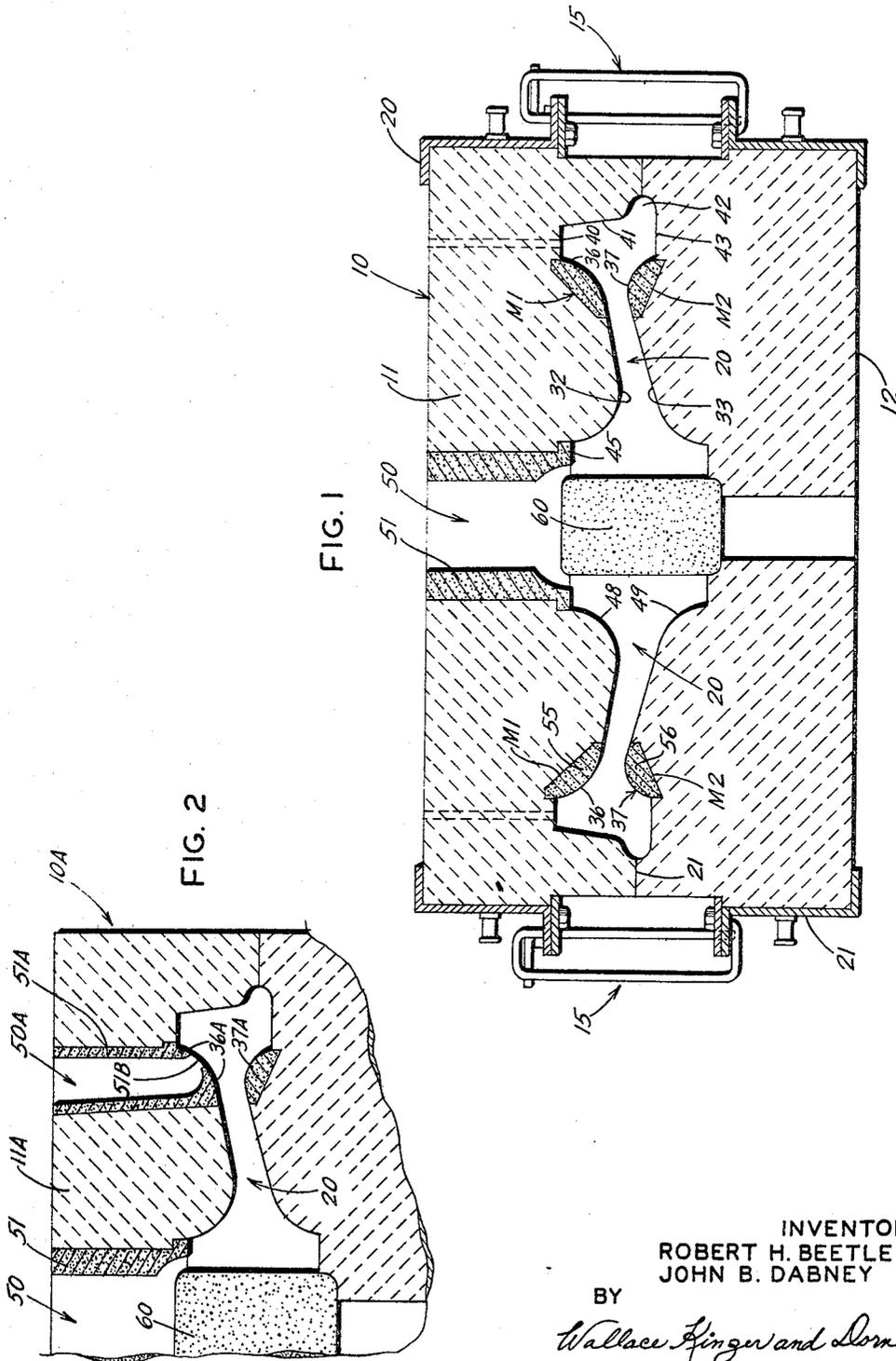
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PERMANENT MOLD FOR CASTING A WHEEL

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3,480,070

**PERMANENT MOLD FOR CASTING A WHEEL**  
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2 Claims

## ABSTRACT OF THE DISCLOSURE

A railroad wheel having an inner hub portion and an outer tread portion joined by a thinner plate is cast in a permanent mold having a yieldable and relatively thick lining at the fillets near the tread portion of the wheel. As the casting cools and contracts, the lining yields which allows wheels with fillets of sharp radii to be produced.

This invention relates to the production of railroad wheels which have a central hub portion and an outer tread portion joined by a so-called plate which is comparatively thin.

It has been proposed to cast railroad wheels in a permanent mold. U.S. Patent Nos. 2,779,075 and 2,819,501 are examples, but satisfactory production on a commercial scale is realized only by casting under pressure as shown by U.S. Patent Nos. 2,847,739 and 2,990,592.

A railroad wheel may weigh almost half a ton. It is perhaps one of the most difficult castings known because its use requires great precision, soundness and freedom from defects in the cast wheel which might otherwise contribute to a failed wheel on the train.

The geometry of the wheel is also important, and in fact the shape of the fillets at the tread end of the plate of the wheel is recognized as contributing to superior wheels and is important in wheels having a specialized purpose.

In the process of the above identified patents, the shape of the fillets is severely limited. A sharp radius is not attainable for the fillets. This is so for the reason that as the casting cools and solidifies, the permanent mold material (e.g. graphite) resists contraction of the fillets. Unless the fillet design is one of a large radius of curvature, the contraction of the casting will be so severely resisted by the corresponding mold surfaces as to create stressing within the casting giving rise to imperfections in the finished wheel. In fact, in U.S. Patent No. 2,819,501 means are of necessity provided to enable the cope (upper) portion of the mold to float upwards as the designated fillets contract against the corresponding graphite mold surfaces. In this way, by resort to mold accessories of a mechanical nature, the problem of the contracting and solidifying fillet is proposed to be handled. Even this result, however, cannot be realized with a sharply curved fillet, because a sharply curved or abrupt fillet will not apply the wedge or lever effect necessary to the lifting of the cope.

The objects of our invention are to enable virtually any contour to be realized at the fillets of a railroad wheel adjacent the tread of the wheel, and to accomplish this without having to resort to accessory equipment. These objects are realized by lining the fillet areas of the permanent mold with a temporary, yieldable or frangible mold material such as a bonded sand or a solidified ceramic slurry which, as the fillet part of the wheel contracts thereagainst, will yield or even crumble allowing contraction to continue unimpinged.

Thus, we achieve almost 100% flexibility in the contour of the critical fillet of a railroad car wheel, and we do not need to incorporate mechanical means in the mold equipment to allow the cope to float during cooling of the casting.

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Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawing which, by way of illustration, shows preferred embodiments of the present invention and the principle thereof and what is now considered to be the best mode contemplated for applying that principle. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

In the drawing:

FIG. 1 is a sectional view of a mold for a railroad car wheel in accordance with the present invention; and

FIG. 2 shows a typical modification of our invention.

The preferred embodiment of the present invention is illustrated in FIG. 1, embodied in a mold 10 for a railroad car wheel, the mold being inclusive of a top section or cope 11 formed from an annular block of graphite. The cope 11 is disposed on a lower annular graphite block 12 constituting the drag of the mold.

The cope 11 and the drag 12 may be clamped together by suitably spaced clamps 15 of any desired character, and in this connection the clamping structure herein illustrated corresponds to that disclosed in our U.S. Patent No. 3,302,919, granted Feb. 7, 1967.

The graphite mold material 11 and 12 constitutes a permanent mold material, but the principles of the present invention are equally applicable to other kinds of permanent mold material. In any event, the mold 10 is for the casting of a railroad car wheel, and the mold cavity 20, which spans both sides of the parting line 21 where the surfaces of the cope and drag abut, presents the contour of the railroad car wheel to be cast therein.

Thus, the mold cavity 20 presents opposed surfaces 32 and 33 which will correspond to the so-called plate of the wheel. These surfaces are of graphite, but preferably a typical mold wash is applied thereto as a thin coating prior to pouring the molten metal into the mold cavity. A mold wash may also be applied to any other surface of the mold which defines a contour of the wheel.

The mold cavity includes front and back rim fillet surfaces 36 and 37. These fillet surfaces are those that play a critical role under the present invention as will be described hereinafter.

In addition, the wheel to be cast has a front rim surface 40, a tread surface 41, a flange 42 and a so-called back rim 43. Of course it will be appreciated that the wheel is of 360° form, so that the surfaces thus far described are continuous about the entirety of the mold cavity 20.

The wheel to be cast also includes a hub 45 and corresponding front and back hub fillets 48 and 49.

The molten metal, a steel of suitable metallurgy, is admitted to the mold cavity through a central riser 50, and in this connection it will be observed that the riser opening 50, in the preferred embodiment of the invention, is located at the central portion or hub area of the mold, especially if the practices in our aforesaid patent are followed. The riser opening 50 is preferably lined with a replaceable ceramic core 51 which may be a conventional sand core or a more sophisticated solid body obtained from a suitable slurry of kyanite or the like as hereinafter specified. This is equally true of the hub core 60 which serves to define the hub opening of the wheel.

It will be apparent from FIG. 1 that the course of molten metal admitted into the riser is downward around the hub core 60 and thence radially outward through the plate area 32-33 of the cavity, past the fillet surfaces 36 and 37 that are adjacent the tread surface 41 of the wheel, and finally into contact with the tread surface 41 which, it will be observed, is presented by the permanent mold material which is graphite in this instance.

The graphite at the tread surface 41 serves as a chill, such that solidification of the molten metal proceeds radially inward from the tread surface 41 in the direction of the hub core 60. As the molten metal solidifies, it contracts against the fillet-defining surfaces 36 and 37, and in accordance with the present invention the fillet surfaces 36 and 37 are presented by separate liners 55 and 56 of any yieldable or impermanent mold material such as bonded sand as heretofore used in molds or a ceramic which will also yield or even crumble as the molten metal pushes thereagainst. The liners 55 and 56 are, of course, thick enough to yield or crumble as the solidifying metal exerts force.

By using yieldable or frangible liners 55 and 56, we can achieve virtually any contour we want for the fillets of the wheel which are adjacent the tread. Thus, because of their impermanent or yieldable nature, the liners 55 and 56, unlike the graphite material, offer no resistance to solidifying metal, and hence we are able to cast wheels with any desired radius of curvature at the fillet without having to incorporate in the mold any mechanical means which will enable the cope 11 as a whole to float so as to give way to the thrust of the rim fillets of the wheel as the casting solidifies in the direction of the hub core.

FIG. 2 is a half section similar to the mold apparatus illustrated in FIG. 1 but showing a typical modification of our invention. Thus, the mold 10A of FIG. 2 has additional riser openings 50A formed in the cope 11A. These riser openings 50A may be of any preferred number and themselves lined with a sleeve 51A in the nature of a sand core or the like similar to the lining 51 for the central riser 50. The sleeve 51A extends to the mold cavity 20 and the lower end of the sleeve is formed with an opening 51B allowing excess molten metal to rise upward therein so that additional molten metal is available within the riser 50A in the course of cooling and contraction of the casting in the mold cavity 20.

The lower end of the auxiliary riser sleeve 51A presents a contour 36A corresponding to the front fillet mold surface 36 of FIG. 1. In the cope of the mold of FIG. 2, the frangible or yieldable liner of the front fillet adjacent the tread of the wheel will be continuous about the entire circumference of the cope, with the exception of the openings 51B where the auxiliary risers 50A are located. Thus, in the cope of FIG. 2 the portion of the mold between the secondary or auxiliary risers, which may be of any desired number, will have a solid or uninterrupted extension corresponding to the liner 55 of FIG. 1.

The liner which presents the surface 37A, FIG. 2, will be altogether identical to the liner 56 presenting the surface 37 illustrated in FIG. 1, and the same advantageous results are realized with the mold 10A or above described in connection with the mold 10 of FIG. 1.

In the actual construction of the mold, the graphite blocks will be machined to enable the various cores and sleeves to be set therein. Similarly, the graphite blocks will be machined at the fillet areas M1 and M2 to enable the separate liners to be set therein, and which of course present outer or exposed faces that complete the contour of the wheel. In this regard, the cores or liners 55 and 56 may be secured adhesively in place, they may be formed by blowing sand into the machined cavities M1 and M2 while using a suitably shaped pattern, and of course in the instance of FIG. 2 the so-called front fillet liner 36A will be formed as an incident to formation of the riser sleeve 51A.

Referring to FIG. 1, the liners 55 and 56 may be formed by a sweeping operation as described in our aforesaid patent, or may be formed and positioned by a typical mold jolting operation particularly in the instance where the liners are of sand which may be thus mechanically bonded in place as described in our aforesaid patent.

If sand is used for the fillet liners, these may be typical core sands, and bonding agent such as a core paste, sodium silicate, a resin binder and so on can be used to hold the liner in place. In fact, adhesive bonding of the liner may be combined with mechanical bonding in a jolting operation as mentioned above. The sand grains themselves may be internally bonded by sodium silicate, resins, oil, clay or other sand core binders well known in the art.

As mentioned above, it is also possible to have the liners solidified from a ceramic slurry, particularly in the instance of preference for a precision finish in the cast wheel. Thus, the fillet liners 55 and 56, or those described in connection with FIG. 2, may conform to the following specification:

Colloidal silica (30% SiO <sub>2</sub> )	----- cc	2160
Citric acid (one molar solution)	-----cc	34
Kyanite (100 mesh or finer)	----- lbs.	16.5
Magnesium sulphate solution		
(600 gm./1000 cc. H <sub>2</sub> O)	-----cc	35

The above quantities are approximately figures and may be varied slightly depending upon humidity, temperature and other environmental conditions which would effect gelling of the slurry within a predetermined time.

The colloidal silica, citric acid and kyanite are mixed thoroughly, kyanite being added until the viscosity reaches approximately 82° Bé. The sulphate solution is added and mixed well. The slurry is then ready for use. The amount of sulphate solution controls the time in which the mix gels. The more sulphate solution added, the quicker the setting time. When the slurry is applied to a warm mold, the heat from the mold causes the mix to set more quickly. A setting time of about 15 minutes at room temperature produces a setting time of about 1 minute on a mold at 160° F., which is satisfactory for "sweeping" the ceramic slurry in place when affording ceramic liners 55 and 56.

The initial gelling of ceramic linings 55 and 56, which is in the form of a slurry when the lining is formed by the sweep method or by an injection method, is accelerated by the heat of the cope and the drag. On a production basis, the cope and drag will be at elevated temperatures because of the residual heat of previous casting operations. Where the cope and drag are being used initially, the cope and drag are preheated to approximately 150-180° F. to facilitate the gelling of the refractory ceramic linings 55 and 56.

After the linings 55 and 56 are gelled or solidified, the linings are cured. For example, the cope and drag may be brought together to form a complete mold and heated at a temperature and for a time sufficient to cure the linings 55 and 56 in an oven at about 400° F. for a period of several hours. Also, as much moisture as possible is driven from the mold during this backing operation. Shortly before the mold is to receive the molten metal, the mold is removed from the oven, vent holes (if used in the graphite blocks) are lined with sand, and a central opening may be formed in the vent holes. The hub core 60 is pasted in position, and the unlined areas of the mold cavity are preferably sprayed with a mold wash made of a mixture of zircon flour, bentonite and water. The mold wash is sprayed or brushed on to form a very light layer of about 1/64 of an inch or less in thickness. The function of the mold wash is to protect the graphite surfaces. The mold is then closed with the cope 11 superimposed on the drag 12 by the usual pins and holes on the respective flasks 20 and 31. Next the clamps 16 are applied, and the mold is tilted as described in our Patent No. 3,302,919.

Metal is poured into the mold through the central combined gate and riser means 50 to fill the entire mold cavity and the riser cavity. The pouring temperature and time of pour will depend upon the composition of the metal and the size and shape of the wheel.

As soon as the mold is filled, the mold is leveled, that is, untilted. After a skin is formed on the metal, the

clamp 16 are loosened and there may be some lifting of the cope 11 relative to the wheel casting as the latter solidifies. After the casting is cooled to a desired temperature, the cope 11 is lifted and the wheel casting is separated therefrom. The riser having been knocked off, the wheel casting is immersed in a soaking pit. The wheel casting is taken from the soaking pit and subjected to heat treatment.

The cope and drag have their casting cavities cleaned, particularly to remove any remaining portions of the linings 55 and 56 and the riser sleeve 51. The cope and drag are then ready to receive a new lining 55 and 56 and a new riser sleeve 51 for the next casting operation when using the mold of FIG. 1.

It will be seen from the foregoing that the liners 55 and 56, or their equivalent, in effect interpose a yieldable mold surface between the solidifying metal and the unyieldable permanent mold 11-12. The permanent mold material, however, is used to present an outer chill surface 41. The molten metal solidifies radially inward encountering the contours 36 and 37, which are enlarged in comparison to the inner plate portion of the casting. However, the liners 55 and 56 are purposely expendible, yieldable or even frangible and hence interpose no resistance to sharp radii of the solidifying casting.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

We claim:

1. In a permanent mold for casting a railroad car wheel having an inner hub and an outer tread joined by a plate, and in which the wheel has front and back rim fillets at the end of the plate adjacent the tread, a cavity in the mold conforming generally to the contour of the wheel including an enlarged hub area, a thinner plate area and an enlarged tread area, and with only the portion of the mold cavity which corresponds to said fillets being defined by surfaces of a separate liner, said liner being of a yieldable, impermanent mold material which will yield to the fillet metal contracting thereagainst.

2. A mold according to claim 1 in which the liner comprises sand and in which the permanent mold material is graphite.

#### References Cited

##### UNITED STATES PATENTS

3,302,919	2/1967	Beetle et al. ....	249—56
1,025,438	5/1912	West .....	164—356
1,161,034	11/1915	Davis .....	164—356
2,886,865	5/1959	Leisk .....	164—22
2,765,505	10/1956	Sylvester .....	164—27

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