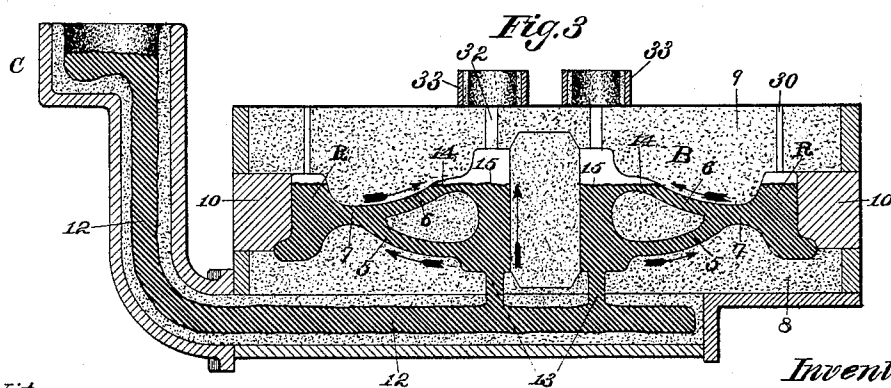
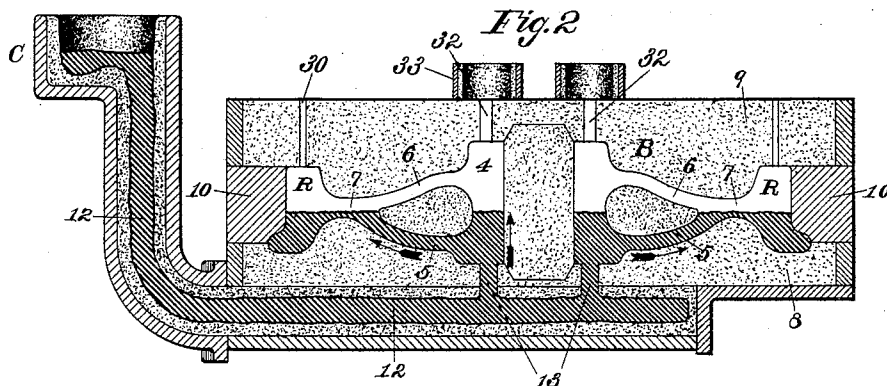
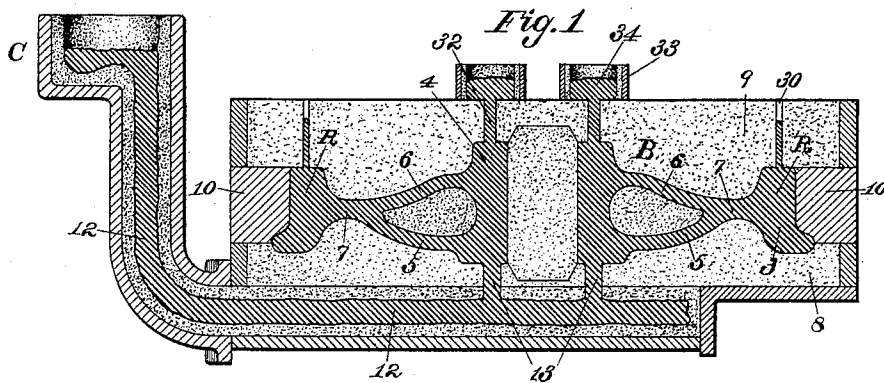


W. G. RICHARDS.
PROCESS OF CASTING STEEL WHEELS.

No. 451,575.

Patented May 5, 1891.



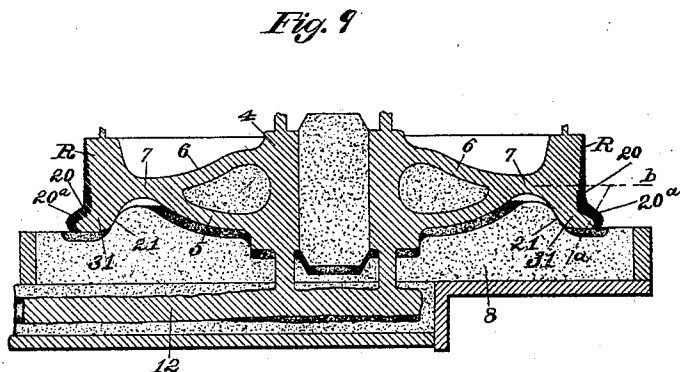
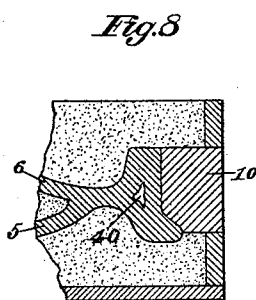
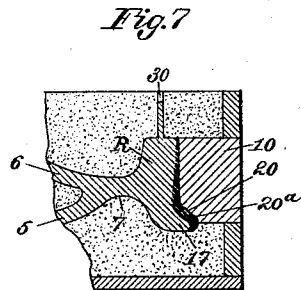
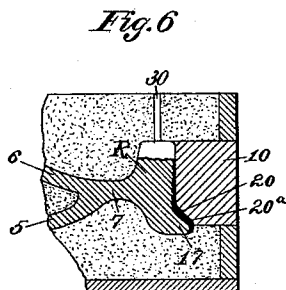
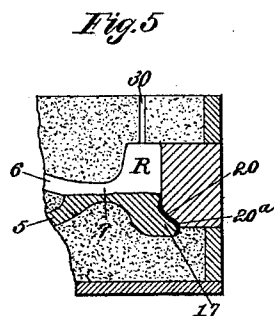
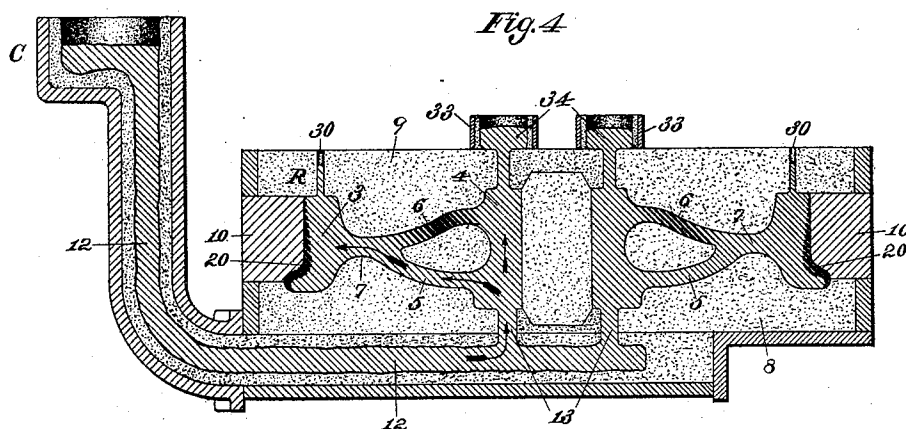
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By his Attorney,
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UNITED STATES PATENT OFFICE.

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PROCESS OF CASTING STEEL WHEELS.

SPECIFICATION forming part of Letters Patent No. 451,575, dated May 5, 1891.

Application filed February 11, 1890. Serial No. 340,075. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM G. RICHARDS, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in the Manufacture of Steel Car-Wheels, of which the following is a specification.

This invention relates to the manufacture of steel wheels by the art of casting; and it consists in certain processes hereinafter set forth, whose object is the production of hub-and-tire wheels of steel and of superior quality.

In the accompanying drawings illustrating my invention, Figure 1 shows a vertical section through a mold having a double-plate wheel therein. Figs. 2 and 3 show the said mold at successive stages of the filling of the same. Fig. 4 is a view similar to Fig. 1 for illustrating certain features of the action of the metal in the mold. Figs. 5, 6, and 7 are diagrammatic views illustrating certain changes occurring in the wheel during the filling of the mold. Fig. 8 is a section of the rim, showing certain defects to be avoided therein. Fig. 9 is a view illustrating the utility and operation of certain features of my improvements.

Similar characters designate like parts in all the figures.

It will be remembered that, owing to the difference in its melting temperature and to its different manner of shrinking, it has hitherto been impracticable to form steel by the art of casting into some of those forms in which steel castings are most desirable.

My improvement has for its object to furnish means for overcoming the difficulties heretofore existing in the manufacture of car-wheels of solid steel.

The wheel B (shown in the mold in Fig. 1) is a car-wheel of the double-plate variety, having the tire R, the hub 4, the back plate 5, the front plate 6, and the single plate 7, which may be considered as a continuation of the two plates 5 and 6 for joining these two plates and the tire 3. It is found to be essential to the successful use of steel wheels in railway service that the entire wheel, but more especially the hub thereof, shall be substantially sound throughout and free of any porosity and of shrinkage or other internal pipes or cavities; and to secure this essen-

tial result I have discovered by the aid of much practical investigation and experiment that, among other things, the wheel should be poured with the least possible agitation of the inflowing metal and with the maintenance for relatively the longest possible time of the high temperature and perfect fluidity of the heavy mass of metal constituting the hub. It is also necessary for the making of a sound all-steel car-wheel to effectively "feed" the "pipe-forming" regions of the mold up to the moment when general con- gelation sets in.

It is well understood by those acquainted with this art that the functions of a car-wheel are many and diverse, one of the most essential being that the hub shall safely resist the enormous bursting strains caused by the forcing in of the axle under the hydraulic press, which strains, in the case of steel wheels, result from a pressure of about thirty to fifty tons longitudinally of the axle. This requirement necessitates an excessively strong hub, which in turn requires a thick hub of sound metal; but an extra thick body of metal at the hub is in itself a detriment to the wheel in other respects, since it introduces variations in the shrinkages and increases the naturally great tendency to the forming of internal shrinkage cavities and pipes. To overcome these obstacles, while retaining a relatively thick hub, to maintain as long as possible the highest degree of heat and fluidity in the hub, and to fill the mold with the least agitation of the inflowing metal, are therefore among the chief objects of my present improvements.

The mold, consisting of the novel 8, the chill 10, and the cope 9, is set in a substantially horizontal position. A pouring-head C is provided at one side of the mold and at a higher level, as shown. From the head C the runner-channel 12 extends downward and underneath the mold to the center thereof and connects with the hub by suitable connecting-channels 13. A number of small vents 30, large enough for the molten steel to overflow through them, are formed in the mold over the rim-space, and several larger vents 32 are formed over the hub-space, and which are or may be surrounded by the rings 33 for catching any metal, as 34, Fig. 1, that may rise through said vents during the last part of

the pouring operation. In the process of casting the wheel the molten steel is steadily poured into the head C, flows rapidly through the channel or runner 12, and enters the mold through the channels 13 at the lower end of the hub 4. This is shown in Fig. 2, which represents the mold beginning to fill. At this stage of the process the metal is flowing outward through the lower plate 5, as indicated by the arrow. As the process proceeds the metal fills the lower-plate space, enters the rim-space, and returns through the upper-plate space, as in Fig. 3, toward the upper end of the hub. Here the metal at 14 in said upper-plate space meets the metal rising at 15 in the hub-space and is united by admixture. Following this the metal continues to rise in the hub, thus furnishing more metal and more heat to the thickest portion of the wheel, and thereby feeding both the lower and the upper plates during the early period of their shrinkage, and during this latter portion of the operation all the metal of the hub (except, possibly, a very thin surface scale) ascends together, thereby bringing to the junction of the lower plate and the hub a fresh supply of relatively uncooled metal at the very latest moment of the process, which fresh supply forms a new admixture with the metal of the inner edge of the plate, and thus continues to the latest possible moment the conditions most favorable to the proper shrinkage and final cooling of the wheel. By pouring this form of wheel from below, as set forth, the highly-heated and fresh metal is utilized most effectively for reheating the metal already in the hub, owing to the ascendant power of the heat itself under such circumstances. By this means both the temperature and fluidity of the entire hub are unified and are maintained throughout at the highest possible point until the pouring operation is entirely completed. By this means, also, the tire during its early cooling stages is most evenly and effectively "fed" through the plate, the fluidity of the plate is better maintained, and at the close of the pouring operation the hub itself is left in the most favorable condition for continuing said "feeding" and for its own shrinkage. As soon as the upper-plate space is filled the metal therein almost instantly "sets" or congeals, as indicated by the darker shading at 6, Fig. 4, while the inflowing metal passes on, one part through the lower plate and through the middle of the rim-space to the overflow-passages 30, and another part up through the hub-space to the overflow-passage 32. The continued supply of metal being thus diverted through two channels, the metal in the upper-plate space becomes neutral between the two currents, and thus rapidly congeals and passes through its sudden-shrinkage stage or period simultaneously with the solidifying of the resistance-ring hereinafter described.

When the metal begins to fill the rim-space

3, as in Fig. 2, the first effect of the chill 10 is to rapidly abstract heat from the upper surface 20 of the flange 17, as in Fig. 5. This reduces a layer of said metal to a temperature where it regains its cohesion and strength. As the mold continues filling, this cohesive surface layer widens and thickens, as indicated at 20 in Figs. 6 and 7, so that by the time the mold is filled said cohesive layer constitutes a surface ring of relatively great strength, which ring, being flanged by the portion 20 on the lower edge thereof, is thereby given the cross-sectional form of an angle-iron, (as between lines *a b*, Fig. 9,) and thus greatly strengthened in its resisting-power. Owing to this outer resistance-ring, created thus early in the operation of filling the mold, and to the substantially twofold shrinkage peculiar to steel when being made into castings, the earlier shrinkage of the interior parts of the wheel-casting is strongly opposed by said ring, thus creating two tendencies: first, to draw the interior metal outwardly by attraction of cohesion at the expense of the vertical thickness, and, second, to form interior shrinkage cavities or pipes. To secure a sound wheel, it is necessary to favor the first and to resist the second of said tendencies, this being done in my improved process as follows:

Reference has been made to the ascendant power of heat, whereby at the end of the pouring, the heat of the hub-metal is unified or equalized. This ascendancy, however, operates in the plates and earlier in the said operation with a different effect, which is indicated in Fig. 4 by the darker shading at 6. The cope 9 being freely vented and also absorbent of heat, the metal of the upper plate 6 becomes stagnant or non-flowing earlier than the metal of the lower plate 5 and also before the metal of the rim at 3 has become set or much shrunken. This leaves the metal of the lower plate 5 still fluid and with an outwardly-flowing movement into the single-plate space 7, and through space 7 into said rim-space, whereby said rim is effectually fed until the very latest moment of the pouring, and a sound rim thus obtained. While this feeding of the rim is going on the outward movement of the lower-plate metal delays the setting thereof, and at the same time said movement is forcibly promoted by the pressure of the inflowing metal, which pressure is due to the height of the pouring-head C. On the complete filling of the lower-plate space and the stagnating or setting of the metal therein the inflowing from below of the hot metal still continues to effect the aforesaid reheating of the hub metal and the readmixture thereof with the plate-junctures, whereby the fluidity of the entire hub is maintained for the longest possible time, and the feeding of the now rapidly-shrinking lower plate is longest continued.

It will be observed that the resistance-ring is formed prior to the setting in of the pipe-

forming stress, said stress existing simultaneously with the congelation. That prior formation is insured by flowing metal through the lower-plate space and the upper part of the rim-space to and out of the rim-vents until the resistance-rim is set. After this said rim resists the suction due to said stress and holds the tread in shape during the continuance of said stress. This continued outflowing of the metal delays internal congelation at the pipe-forming point 40, while the chill abstracts heat from the outer surface of the rim to form said "resistance-ring" and also during congelation of the upper plate.

By the old methods of making this class of wheels there was a great tendency to form a shrinkage space or pipe, as 40, Fig. 8, within the rim of the wheel, which tendency is substantially overcome by the more efficient feeding of the rim due to my improvements.

Another valuable result obtained by making the wheel-castings with the flange below the chill is that by this means the inner (upper) surface of said flange is more effectually cooled and toughened and shrunk to a very large degree before any shrinkage strains are thrown thereon by the other parts of the castings, so that said flange-face is obtained free of checks and defects due to shrinkage strains, thus adding materially to the durability and value of the wheel.

After the mold is wholly filled and after the same has stood for a very brief time, determined experimentally, the cope and chill are lifted off, leaving the wheel lying on the nowel, as in Fig. 9. At this time the casting is rapidly reducing in diameter, thereby bringing a severe strain onto the mold at 21 and a corresponding bursting strain within the lower part 31 of the rim R; but, owing to the aforesaid early chilling of the upper surface of the flange and the adjoining outer part of the tread, there has been formed a strong band 20, having the cross-sectional form of an angle-bar between the lines *a b*, Fig. 9, located in the best position for holding together the weaker metal at 31 and resisting the said bursting strains. By means of these features existing at the most critical movement of the shrinkage, instead of checking or distorting the tire, the whole wheel is lifted by its shrinkage, being slid upon the rounded part 21 of the mold, as shown in Fig. 9. By means of this early forming of the angle-shaped resistance-ring 20, in connection with the prolongation of the fluidity of the lower plate and hub, the critical shrinkage period is passed without damage to the wheel-casting. By this process of underpouring a chill-rim mold for a double-plate wheel very important practical advantages are secured, with a resulting product not to my knowledge heretofore obtained. By this process the rim-metal does not flow into the rim-space first through the lower plate and then through the upper plate, as by the old methods, but, on the contrary, flows altogether through the lower-plate

space without any change of direction and without any interruption from the beginning of the pouring to the end of the feeding of the rim. By this process also the feeding of the rim and of the plate 7 is continued after the upper plate is materially set and shrunk, so that the tendency of said plate 6 to "strain" at its juncture with the plate 7 is so materially reduced as to become safe and unobjectionable. Furthermore, by this process the natural prolongation of the fluidity of the lower plate is taken advantage of for the feeding of the rim, whereby the fluidity of said lower plate is itself still further prolonged and the effectiveness of said feeding still further increased. Again, by reason of the various and peculiar operations going on, as herein set forth, within the mold during the filling thereof, there is obtained at the end of the pouring operation the greatest practicable degree of variation between the condition of the metal in the extreme outer portion of the wheel-casting, which is against the chill, and the condition of the extreme inner portion of said casting constituting the hub, and, contrary to the usual opinion and contrary to the experience in making iron double-plate car-wheels, I find this difference to be highly important and indispensable to the attainment of the best results. By this process the last of the sudden-shrinkage strains are brought within the curved plate 5 and the hub, which are of a nature to most readily be reshaped by said strains for the relief thereof, this relief being largely due to a reshaping of the hub due to the prolonged fluidity thereof, and it will be obvious that the normal tendency of the hub to shrink (by reduction of its diameter) away from the plate 5 will be made up by the expansion of the hub by the axle when this is forced thereinto by the hydraulic press.

Having thus described my invention, I claim—

1. The process herein described for making plate and rim steel wheels, which consists in filling the mold from below, the rim-space being filled through the plate-space, and overflowing the rim during the solidifying of the tread-surface.

2. The process herein described for making double-plate steel wheels, which consists in filling the mold from below, the rim being filled through the plate-space, and overflowing the rim during the solidifying of the tread-surface and simultaneously with the congelation of the upper plate.

3. The process herein described for making double-plate steel wheels, which consists in filling the mold from below and simultaneously overflowing the rim and hub during the solidifying of the tread-surface and the congelation of the upper plate.

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