June 18, 1940. S. W. RANDOLPH 2,205,154

HOT METAL CAR

Filed Nov. 22, 1938 4 Sheets-Sheet 1

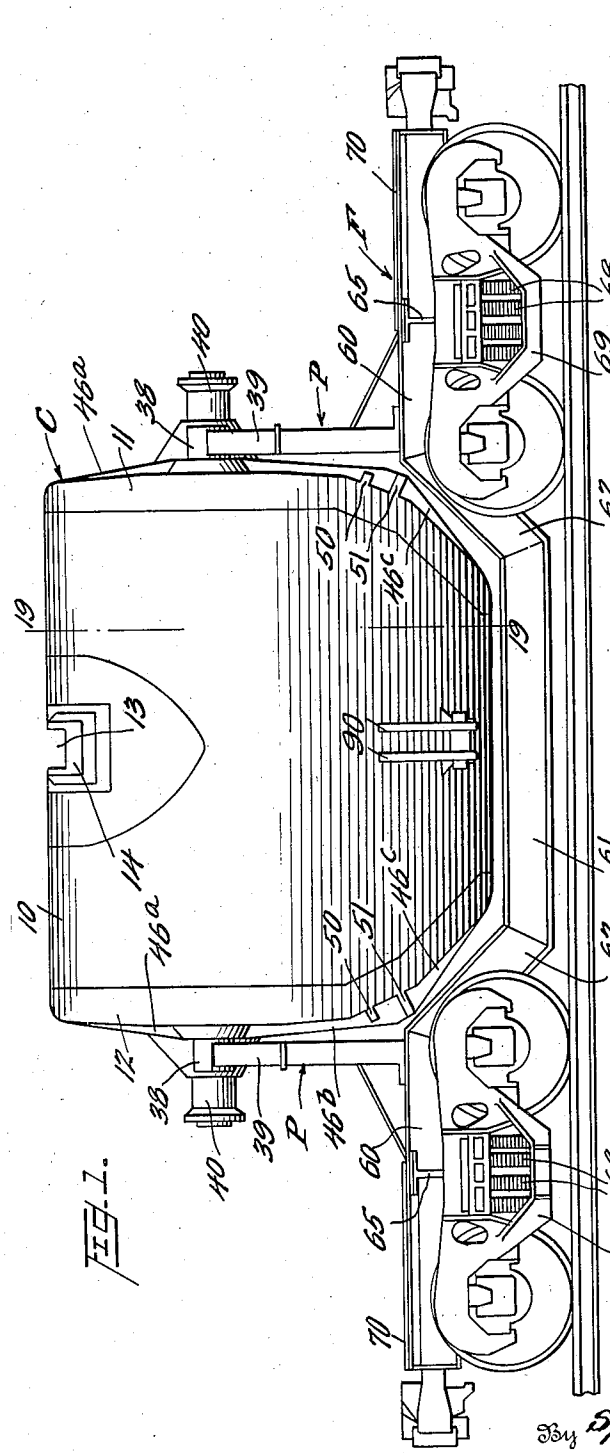

FIG. 1.

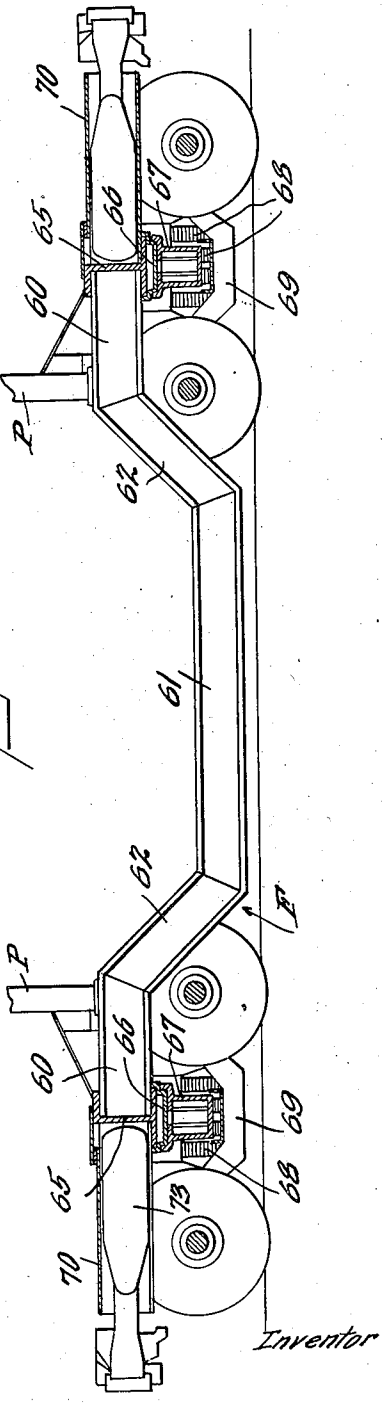

FIG. 2.

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Watson, Cole, Grindle & Watson Attorneys

June 18, 1940. S. W. RANDOLPH 2,205,154

HOT METAL CAR

Filed Nov. 22, 1938 4 Sheets-Sheet 2

FIG. 3.

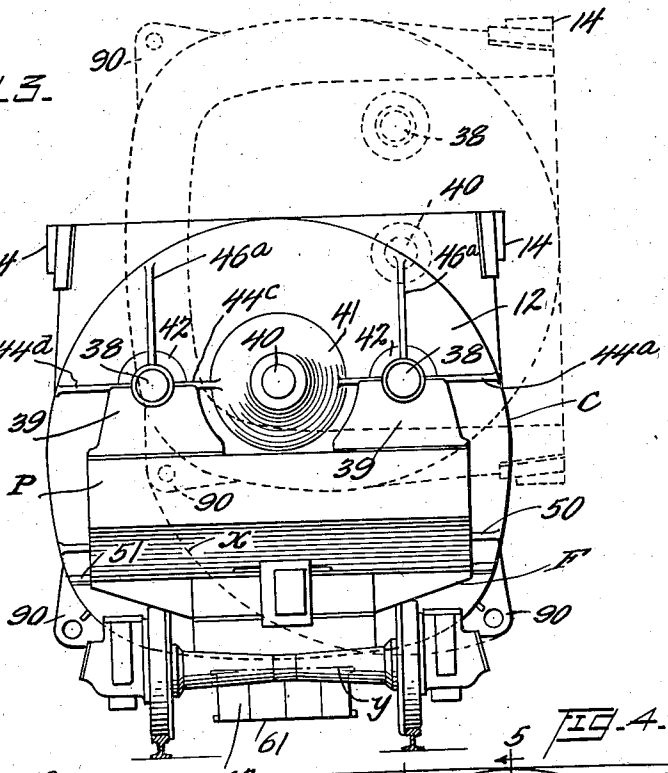


FIG. 6.

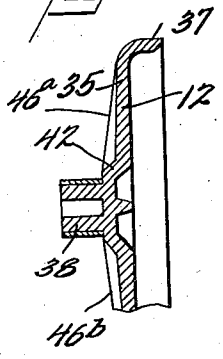


FIG. 4.

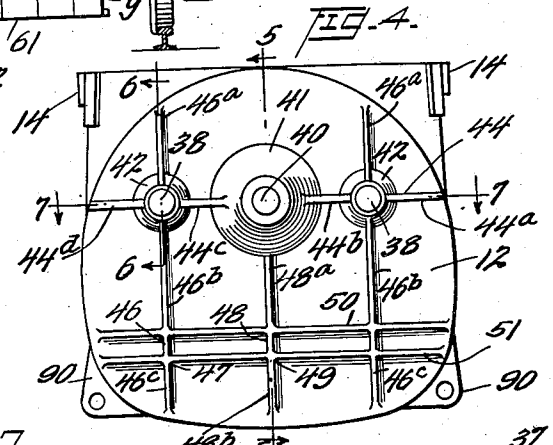


FIG. 5.

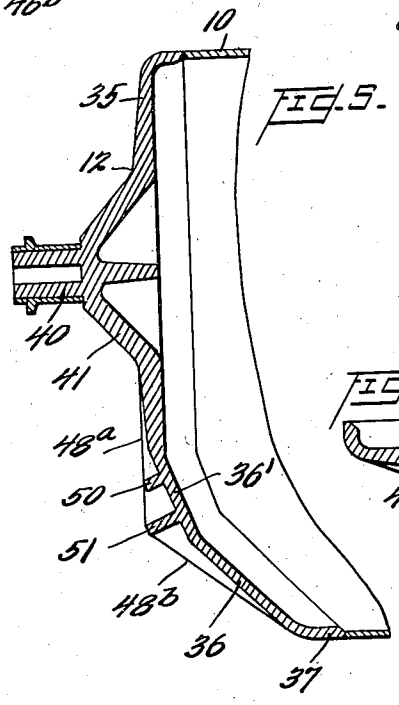
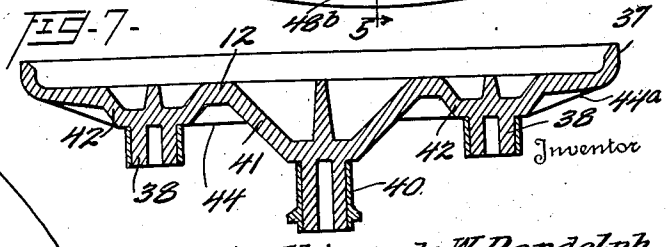


FIG. 7.



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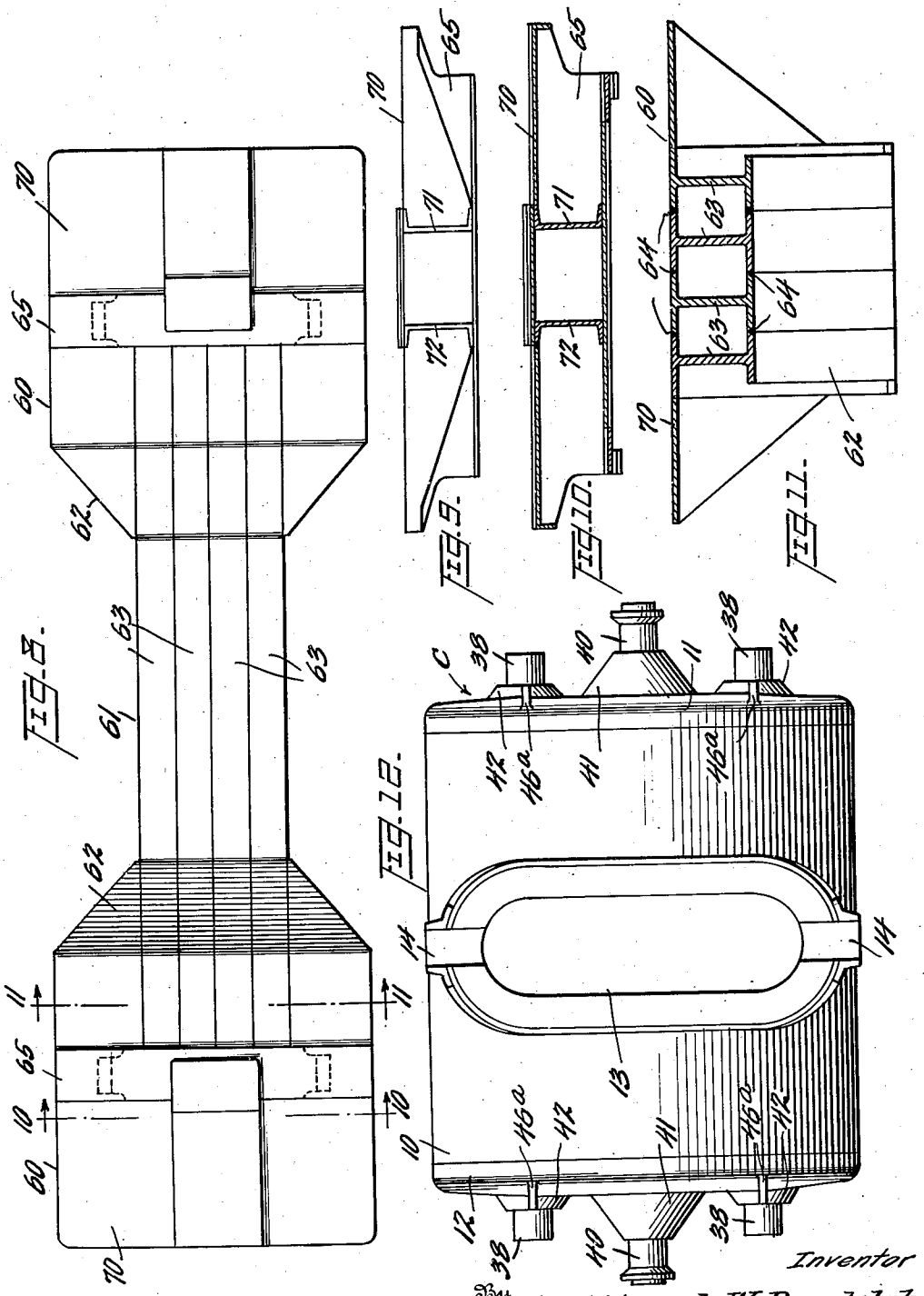
June 18, 1940. S. W. RANDOLPH 2,205,154

HOT METAL CAR

Filed Nov. 22, 1938 4 Sheets-Sheet 3



June 18, 1940. S. W. RANDOLPH 2,205,154

HOT METAL CAR

Filed Nov. 22, 1938 4 Sheets-Sheet 4

FIG. 13.

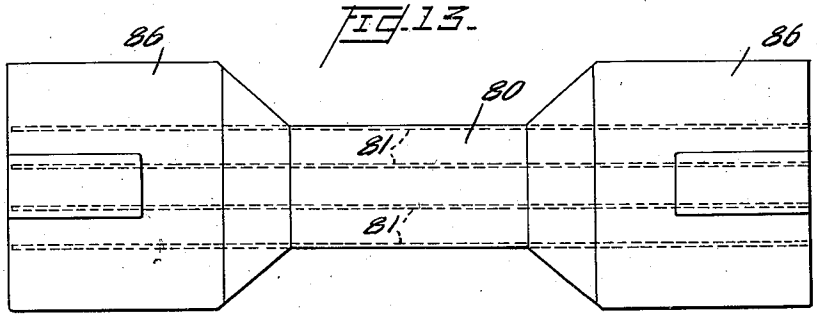


FIG. 14.

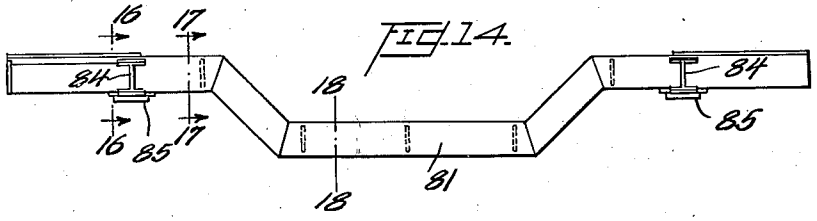


FIG. 15.

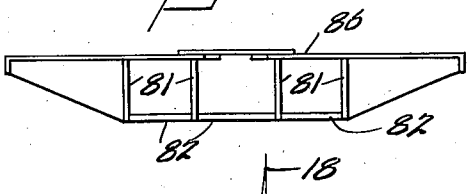


FIG. 16.

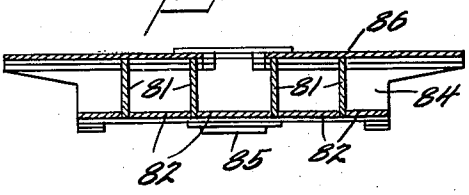


FIG. 19.

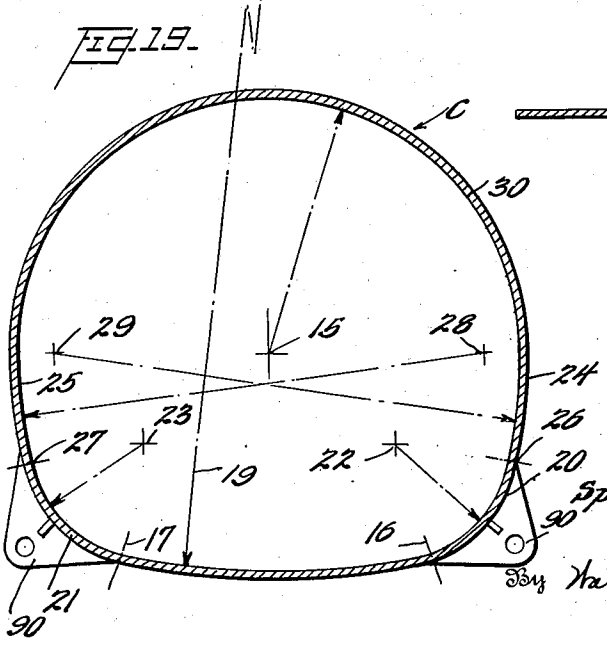


FIG. 17.

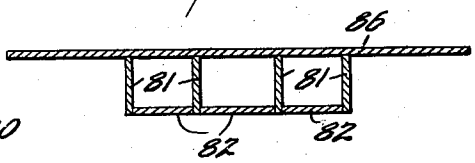
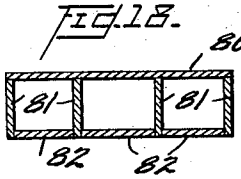


FIG. 18.



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Patented June 18, 1940 2,205,154

UNITED STATES PATENT OFFICE

2,205,154

HOT METAL CAR

Spottiswoode W. Randolph, Baltimore, Md., assignor to Koppers Company, Baltimore, Md., a corporation of Maryland

Application November 22, 1938, Serial No. 241,861

7 Claims. (Cl. 266—39)

The present invention relates to apparatus for the transportation of molten materials, such apparatus being principally utilized in and around steel plants for the transportation of molten iron and steel, and being commonly called "hot metal cars."

Stated generally, the purpose of the invention is to provide an apparatus of this type and comprising a container or ladle mounted on a frame supported on wheeled trucks, the ladle of which has a large carrying capacity for a given height, length and width, and may be fabricated at relatively small cost. It will be understood that hot metal cars are commonly used in the transportation of molten materials for substantial distances over railroads, and hence must meet all requirements imposed by the railroads, particularly those of maximum height and width. The hot metal car which comprises the subject matter of the present invention is of the type which includes an underframe beneath the container, the ends of this frame being mounted on wheeled trucks, and is of the crane dump type, carrying means for facilitating the ready attachment of a crane hook to effect tilting of the container. The container or ladle is of the enclosed type, being substantially tubular with its axis horizontally disposed, the container ends being formed as substantially flat members with trunnions integral therewith or rigidly secured thereto.

In order to obtain maximum carrying capacity for a given height and width of container body, while at the same time not relinquishing the advantage obtained when the body is formed of cylindrically curved sheets or plates, this body is formed in transverse section in a novel manner, its upper portion being substantially cylindrical and its lower portion being non-cylindrical but comprising a plurality of substantially cylindrical sections. Thus, the central part of the lower portion of the container, which immediately overlies the longitudinally extending sill or underframe of the car is upwardly concave and uniformly curved in transverse section, but about an axis substantially above the axis of curvature of the upper or cylindrical portion of the container. Hence the lower part of the container, while cylindrical, forms portion of a cylinder of substantially greater radius than the upper portion, and rather closely approaches, in shape, a flat plate. The lateral margins of this under-portion of the container body merge with cylindrical sections of substantially smaller radius, and these sections in turn are connected to the upper cylindrical portion of the ladle by sections of larger radius, the general effect being to provide a container, all portions of the body of which are curved in transverse section, but the lower portion of which may be said to be flattened and extended laterally. A container of this type has a large cubic content for a given length and height, while at the same time may be freely rocked about the customary trunnions, to either side, to effect discharge of its molten contents, without interference between the chain hook attachment bracket which must necessarily be provided, and the underframe or sill of the car.

The ends of the car underframe are pivotally mounted on wheeled supporting trucks and its mid-portion is disposed at a lower level than its ends, the undersurface of the mid-portion being spaced as closely as is permissible to the trackway construction. This mid-portion of the underframe is likewise relatively wide, measured transversely of the car, and of relatively small height, measured vertically, so that its upper surface is likewise relatively close to the trackway, while at the same time meeting all strength requirements. The ladle or container directly overlies this mid-portion of the underframe, the longitudinal axes of both ladle and underframe preferably being disposed in the same vertical plane. The flattened bottom of the ladle in turn is disposed just above the upper surface of the underframe, the clearance between these two surfaces being only sufficiently great to permit free tilting of the container about one of its trunnion axes when molten metal is to be discharged, without interference between either crane hook lug, mounted upon the container body and any portion of the underframe. By designing both the underframe and container body in the distinctive manner just above described, it is possible to make use of a centrally located underframe in a hot metal car of limited overall height and width and the container of which has the largest cross-sectional area possible for one of tubular shape and fabricated of cylindrically shaped members.

The tubular container body is provided with end closures formed by casting, or fabricated from rolled steel members and these end closures are of novel form and construction. The lower portion of each end closure is downwardly and inwardly inclined, while the upper portion is substantially flat and vertically disposed, the upper portion carrying the spaced trunnions by means of which each end of the container is supported upon suitable pedestals rigidly mounted upon the car frame. Each container end is provided with a novel arrangement of reinforcing and stiffening ribs, so disposed as to transfer in large part the forces applied to the trunnions by the pedestals, due to the weight of the container and contents, to the tubular container shell or body, the lower portion of which is thereby placed in tension. These reinforcing ribs likewise stiffen the container ends and prevent distortion of these ends due to internal pressure of the molten material within the container. The container body, being

of the tubular type, may be fabricated easily and conveniently of stiff sheets or boiler plate.

The car underframe is of novel character, as will hereinafter be pointed out, and the invention includes other novel features not heretofore specifically referred to. Obviously minor changes may be made in the design and construction of the car in adapting the same to special requirements, and without departure from the teachings of the invention, as will be apparent to one skilled in the art.

In the drawings, one embodiment of the invention is illustrated by way of example.

Figure 1 shows the improved hot metal car, in its entirety, in side elevation;

Figure 2 is a vertical axial section through the frame of the car;

Figure 3 is an end view of the car, the container being shown in its normal section in full lines, and in dumping position in dotted lines;

Figure 4 is an end elevation of the container body by itself, no portions of the car being shown;

Figure 5 is a section on line 5—5 of Figure 4;

Figure 6 is a section on line 6—6 of Figure 4;

Figure 7 is a section on line 7—7 of Figure 4;

Figure 8 is a top plan view of the car frame;

Figure 9 is an end view of the same;

Figures 10 and 11 are sections on lines 10—10 and 11—11 respectively of Figure 8;

Figure 12 is a top plan view of the container body;

Figure 13 is a top plan view of a modified form of car frame;

Figure 14 is a side elevation of this type of car frame partially broken away;

Figure 15 is an end view of the same;

Figures 16, 17, and 18 are sections on lines 16—16, 17—17, and 18—18 respectively of Figure 14; and

Figure 19 is a transverse section through the container taken on the line 19—19 of Figure 1.

The container is generally indicated at C in the drawings and the car frame at F. Mounted upon the upper surface of the frame and projecting upwardly therefrom are the spaced pedestals P upon which the container is supported for lateral rocking movement about either of two parallel axes, as is customary. The container body is indicated at 10 and the container ends at 11 and 12 respectively. The body is provided with a pouring aperture 13, shown most clearly in Figure 12, this aperture being transversely elongated, in the form of the container shown, and having at its ends the pouring lips 14. If desired, two spaced pouring spouts may be utilized in place of that illustrated.

The body 10 may be generally described as a horizontally extending tubular member fabricated of boiler plate or stiff metallic sheets. It will, of course, be suitably lined with refractory material, as is customary, although no attempt has been made to illustrate such material in the drawings. Its cross-sectional shape can be more clearly perceived from an inspection of Figure 19. The upper portion of this body is in the form of a half-cylinder, the central axis of this portion passing through point 15. The central part of the lower portion of the container body, that is, the part which extends from the point 16 to the point 17 (Figure 19) is likewise cylindrical, but the axis of this cylindrical part is positioned substantially above the axis 15 of the upper portion of the ladle body passing through the point 18, this axis being, in fact, located a substantial distance above the top of the ladle body, so that the radius of curvature, which will be hereinafter designated 19, is relatively long and this part therefore being only slightly curved, as shown, in fact approaching flatness.

Along longitudinally extending substantially vertical planes parallel to the axis 15 and passing through the points 16 and 17, the margins of the container bottom merge with the adjacent margins of the more sharply curved portions of the container body indicated by the numerals 20 and 21 respectively, the axes of curvature of these two portions passing through the points 22 and 23 respectively, the radii of curvature beng equal and relatively short. The upper margins of the ladle body portions 20 and 21 respectively in turn merge with the lower margins of cylindrically curved portions 24 and 25 of this body, the horizontal planes of junction between these parts passing approximately through the points indicated at 26 and 27, and the horizontal axes about which these parts are curved passing through points 28 and 29. The upper margins of sections 24 and 25 of the ladle body merge with the lower margins of the upper cylindrical portion thereof, which cylindrical portion is generally indicated by the numeral 30.

It will thus be perceived that, in transverse section, the container body has a cylindrical upper portion and a flattened and laterally extended lower portion and the cross sectional area thereof is as large as possible for a given height and width, while at the same time the body is smoothly curved at all points around its periphery, thus facilitating the application of a suitable refractory lining and minimizing manufacturing costs. The container body may be fabricated in one or more pieces as desired.

As has previously been explained, the container ends 11 and 12 are cast or built up members and are of slightly heavier section than the body portion 10. They are identical in construction, each having a substantially flat upper portion 35 disposed in a vertical plane, a downwardly and inwardly inclined lower portion 36, and a portion 36' intermediate these upper and lower portions, portions 36 and 36' also being flat. Each container end is provided with a peripheral flange 37 to which the adjacent end of the container body 10 is attached by welding, as indicated in Figure 5, or by means of rivets, and is provided with two transversely spaced carrying or supporting trunnions 38, which trunnions are mounted in bearings formed in blocks 39 carried by pedestals P, the axes of the trunnions 38 at one end of the container being aligned with the axes of the corresponding trunnions at the opposite end of the container, as is customary practice, and the container being tiltable about either pair of aligned axes as desired.

Each container end likewise carries a lifting trunnion 40 centrally positioned intermediate trunnions 38 and adapted to be engaged by a crane hook when it is desired that the container body as an entirety be lifted from the car. As may be readily seen in Figures 5 and 6 of the drawings, each lifting trunnion 40 is rigidly mounted upon the outer end of a frusto-conical portion 41 of the container end, and each carrying trunnion 38 is mounted upon the outer end of a frusto-conical portion 42 of the container end.

Extending transversely across each end member, and located in the horizontal plane of the three trunnion axes, is a horizontal rib 44, which is in reality formed in four portions, 44*a*, 44*b*, 44*c*, and 44*d*, respectively, the base of each por-

tion being integral with the container end. The outer ends of the outermost rib portions 44a and 44d are located approximately at the edge of the associated container end member, and the inner ends of these portions merge with the frusto-conical raised elements 42 which carry the trunnions 38, previously described. The outer ends of the intermediate rib portions 44b and 44c merge with these frusto-conical elements 42 and the inner ends of these rib portions with the frusto-conical element 41 which carries the lifting trunnion 40. The function of rib 44 will be hereinafter described.

Associated with each trunnion 38 is a vertically extending rib, integral with the end member, such rib being indicated at 46. That portion 46a of each rib which is positioned above the associated trunnion 38 has its upper end approximately located at the upper edge of the end member, and its lower end merging with the frusto-conical element 42 upon which the trunnion 38 is mounted. The portion 46b of each rib 46 which directly underlies each trunnion 38 extends from the frusto-conical element 42 downwardly to a point 47. A further portion 46c projects downwardly from the point 47 to approximately the bottom edge of the end member. An intermediate rib 48 has a portion 48a, the upper end of which merges with the frusto-conical element 41 upon which the lifting trunnion 40 is mounted and extends downwardly to a point 49. The lower portion 48b of this rib projects downwardly from the point 49 approximately to the lower edge of the inclined surface 36 of the head or end member.

Parallel horizontally extending ribs are indicated at 50 and 51 respectively, each of these ribs intersecting and being integral with each of the vertically extending ribs 46 and the vertical rib 48. Ribs 50 and 51 extend from edge to edge of the end member and, as can be seen most clearly from an inspection of Figure 5, are disposed normally to the section 36' of the associated head which lies intermediate the upper vertically disposed portion 35 and the lower inclined section 36, section 36' being more steeply inclined to the vertical than the section 36 and comprising a transition section intermediate sections 35 and 36.

Rib portions 46b of ribs 46 and rib portion 48a of rib 48 serve largely as levers for transferring a substantial portion of the force or load applied to the trunnions 38 to the lower portion of the end member and are effective as far down as the points 47. They therefore function to transmit forces from the trunnions 38 to the transversely extending ribs 50 and 51, thus not only distributing the bending forces applied to the trunnions over a substantial area of the end member of the container, but likewise functioning to transmit such forces to the outer edges of the end member through ribs 50 and 51, and hence to the ends of the intermediate tubular section 10 of the container. Therefore, when the container is charged and is supported upon trunnions 38 in its normal position, the bending forces developed and which have a tendency to rock the trunnions 38 upwardly and tear them from the end member, are transmitted downwardly and thence laterally to the margins of the end members. As these margins are securely attached to the ends of the tubular body 10 of the ladle, the lower portion of this tubular body is in tension, which is desirable.

The portions 46c of ribs 46 which project downwardly from the points 47 serve as stiffening ribs for that portion of the container end which lies below the horizontal rib 51 and resist deformation of this portion of the container end due to pressure of the molten material within the container. The portion 48a of rib 48 likewise functions to transmit downwardly to ribs 50 and 51, and hence to the container shell 10, forces resulting from the application of lifting forces to the trunnions 40 and the portion 48b projecting downwardly below transverse rib 51 serves as a stiffening member for the inclined section 36 of the container end. The portions 46a of rib 46 which project upwardly from trunnions 38 likewise comprise stiffening members and the rib 44 as an entirety comprises a stiffening member, the end portions 44a and 44d thereof also functioning to transmit bending forces from those trunnions which are active in supporting half of the weight of the ladle and contents, when the ladle is being tilted to the flange 37 of the head. The ribs are comparatively heavy in section so that each is well able to act as a lever in the manner specified and to also serve as a stiffening member, rendering the container end rigid and stiff against the internal pressure of the molten steel or iron when the ladle is fully charged.

The longitudinally extending frame or sill of the car may be farbricated in various ways insofar as its details of construction are concerned, but in every case it will have substantially the same external appearance, including two horizontally disposed end portions generally indicated at 60, a horizontally disposed central portion indicated at 61, at a lower level, and two downwardly and inwardly inclined portions 62, the upper end of each such portion merging with or being rigidly connected to an end portion 60, and the lower end of each inclined portion being rigidly secured to or merging with the central portion 61 of the frame. This central portion 61 is preferably dropped as far as possible toward the trackway construction in order that the vertical dimension of the container body may be as large as possible within the permissible limit of overall height of the car as an entirety.

In the form of frame which is illustrated in Figures 8 to 11 inclusive, the principal elements comprise a plurality of H-sections or beams 63 arranged in parallelism, the abutting edges of the flanges of such beams being welded together, as indicated at 64, to unite the several beams into one rigid structure. The ends of the frame thus formed abut against transversely extending H-sections 65 and are welded thereto, H-beam 65 being provided with a king pin 66 centrally thereof and extending downwardly into a recess formed in the upper surface of truck bolster 67, which bolster is supported by means of springs 68 on the side frame members 69 of a suitable railway truck, for instance the four-wheel truck shown in the drawings. Outwardly of the transversely extending H-beam 65 the frame is provided with suitable structural members for supporting a platform 70, which members may vary as desired in detail. Preferably, however, this platform supporting structure includes two outwardly facing channel members 71 and 72, spaced apart sufficiently far to provide a pocket for the reception of the draft mechanism 73 of a standard coupling unit.

The form of underframe illustrated in Figures 13 to 18 inclusive comprises essentially a box girder built up of relatively heavy plates by welding. To the top plate 80 of this frame are welded

four vertically disposed parallel webs 81. Horizontal plates 82 are welded in position intermediate the lower margins of the vertical plates 81, as indicated in Figures 17 and 18, thus completing a strong and rigid box structure, well able to withstand draft forces and bending strains. The built-up box structure just described has its ends secured as by welding to transversely extending H-sections 84 provided with king pins 85 respectively adapted to enter recesses in the bolsters of spaced supporting trucks. Beyond each H-section 84 the box girder construction is continued as indicated in Figures 15 and 16, and a plate 86 is mounted upon each projecting end to form a platform for the convenience of the operator, and for supporting brake applying mechanism. Likewise, in this form of frame, the space between the inner vertical plate 81 comprises a pocket for the reception of a standard coupling device.

A hot metal car constructed in the manner described and illustrated is relatively small in size for its capacity. By shaping the ladle or container in the manner described, its transverse section is made as large as possible for a container the body of which is, broadly speaking, cylindrical and which forms portion of a car the overall height of which is strictly limited. The shell of the container is curved, in transverse section, at all points and may be built up of a number of sections each being shaped as portion of a cylinder or at least having a generally cylindrical shape. It will be appreciated that, when a container is thus formed of easily fabricated shapes, its cost is minimized. The container body shown may be fabricated of a single sheet, the margins of which are welded together, or of as many as six sheets, the adjacent margins of which are connected by welds.

The chain hook lugs 90 will clear the underframe without difficulty when the ladle is tilted, as indicated in Figure 3. In this figure the path of movement of the lug which is lifted is indicated by the dotted line X, and the outline of the central section at Y, in chain lines, thus showing that the extreme outer end of the chain lug will not strike the underframe at any time.

As has previously been explained, the use of a central longitudinally extending underframe in a hot metal car of this type is made possible by designing the underframe and ladle body with special regard to each other. The underframe is centrally dropped and laterally flattened and the lower portion of the container is flattened as described. Without abandonment of the use of transversely curved sections in the fabrication of the container body, it is nevertheless possible to have a container which is very large in transverse section and likewise the underframe may be fabricated as a single unitary structure, straight in a longitudinal vertical plane and located directly beneath the container axis and between the truck wheels. This design of container and underframe likewise satisfies all clearance requirements of the railroads and is one of great practical importance in the art.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A container for use on hot metal cars comprising a tubular body and end members, the end members being provided with supporting trunnions, the tubular body being self-sustaining when the container is suspended by its trunnions and comprising a plurality of substantially cylindrical sections the adjacent margins of which smoothly merge with each other, the entire upper half of the container comprising a single half cylinder, and the lower half thereof comprising five cylindrical sections the axes of which are parallel and the radii of curvature of which are such that the lower half of the container has a central or bottom portion of large radius and side portions of smaller radius.

2. A ladle comprising a horizontally extending body and closure members rigidly attached to the ends thereof, each such member having a vertically disposed upper portion provided with trunnions and a downwardly and inwardly inclined lower portion, a horizontal rib integral with said member and disposed at the bottom of the vertical portion, and a vertical rib connecting each trunnion to said horizontal rib.

3. A ladle comprising a horizontally extending body and closure members rigidly attached to the ends thereof, each such member having a vertically disposed upper portion provided with trunnions and a downwardly and inwardly inclined lower portion, a horizontal rib at the base of said vertical portion, the ends of which are positioned adjacent the edges of said portion, and a vertical rib connecting each trunnion and the horizontal rib.

4. The combination set forth in claim 3 in which the vertical ribs extend downwardly beyond the horizontal rib and comprise stiffening ribs for the inclined portion of the closure member.

5. The combination set forth in claim 3 in which the vertical ribs project upwardly above the trunnions and comprise stiffening members for the upper portions of said closure member.

6. The combination set forth in claim 3 in which the trunnions are horizontally spaced from each other and a second horizontal rib has a mid-portion connecting the trunnions and end portions connecting the trunnions and the outer edges of the closure member respectively.

7. A hot metal car comprising a wheeled underframe and a container tiltably mounted thereon, the underframe including a central longitudinally extending sill the ends of which are mounted upon wheeled trucks, said sill having spaced trunnion receiving pedestals mounted thereon and extending upwardly therefrom, and said container including a tubular body and end members, the end members being provided with supporting trunnions, the tubular body being self-sustaining when the container is suspended by its trunnions and comprising a plurality of substantially cylindrical sections the adjacent margins of which smoothly merge with each other, the entire upper half of the container being substantially semicylindrical and the lower half comprising five cylindrical sections the axes of which are parallel and the radii of curvature of which are such that the lower half of the container has a central or bottom section, normally directly overlying the central sill of the underframe, which is of large radius, and side sections of substantially smaller radius merging with said central section.

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