Jan. 19, 1937. L. E. ALLEN 2,067,883

LADLE STRUCTURE

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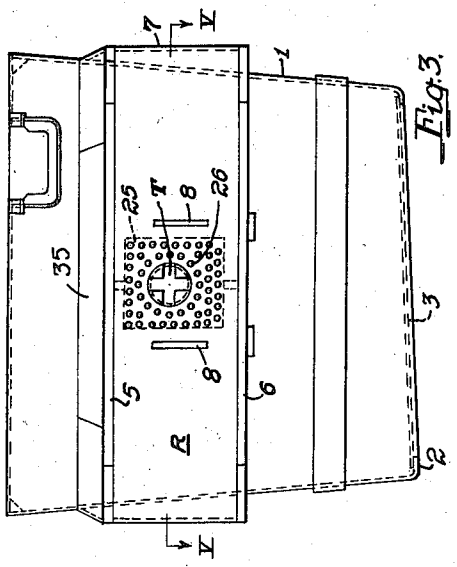


Fig. 3.

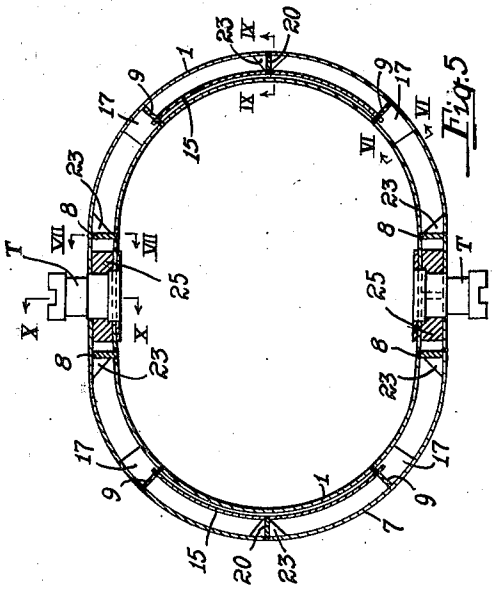


Fig. 5.

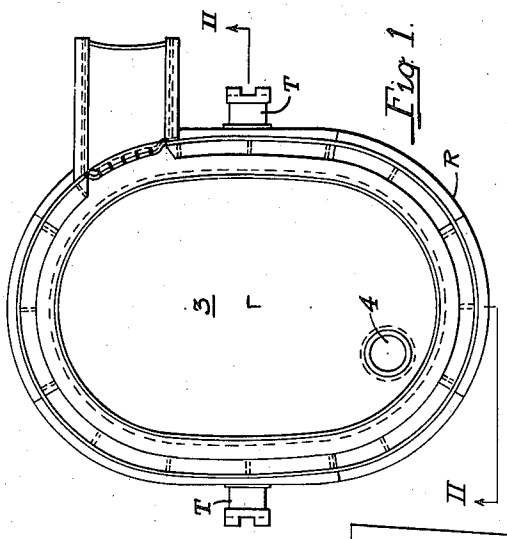


Fig. 1.

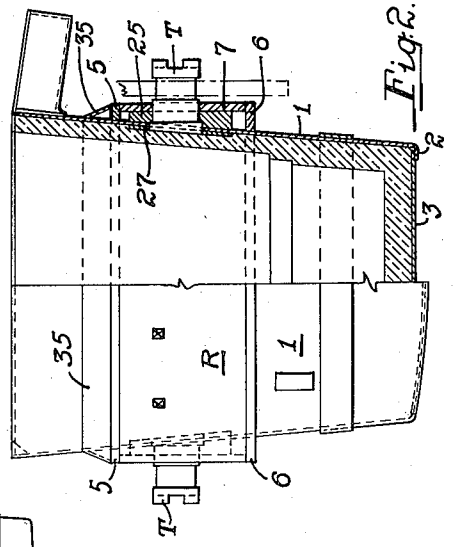


Fig. 2.

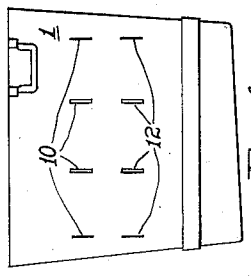


Fig. 4.

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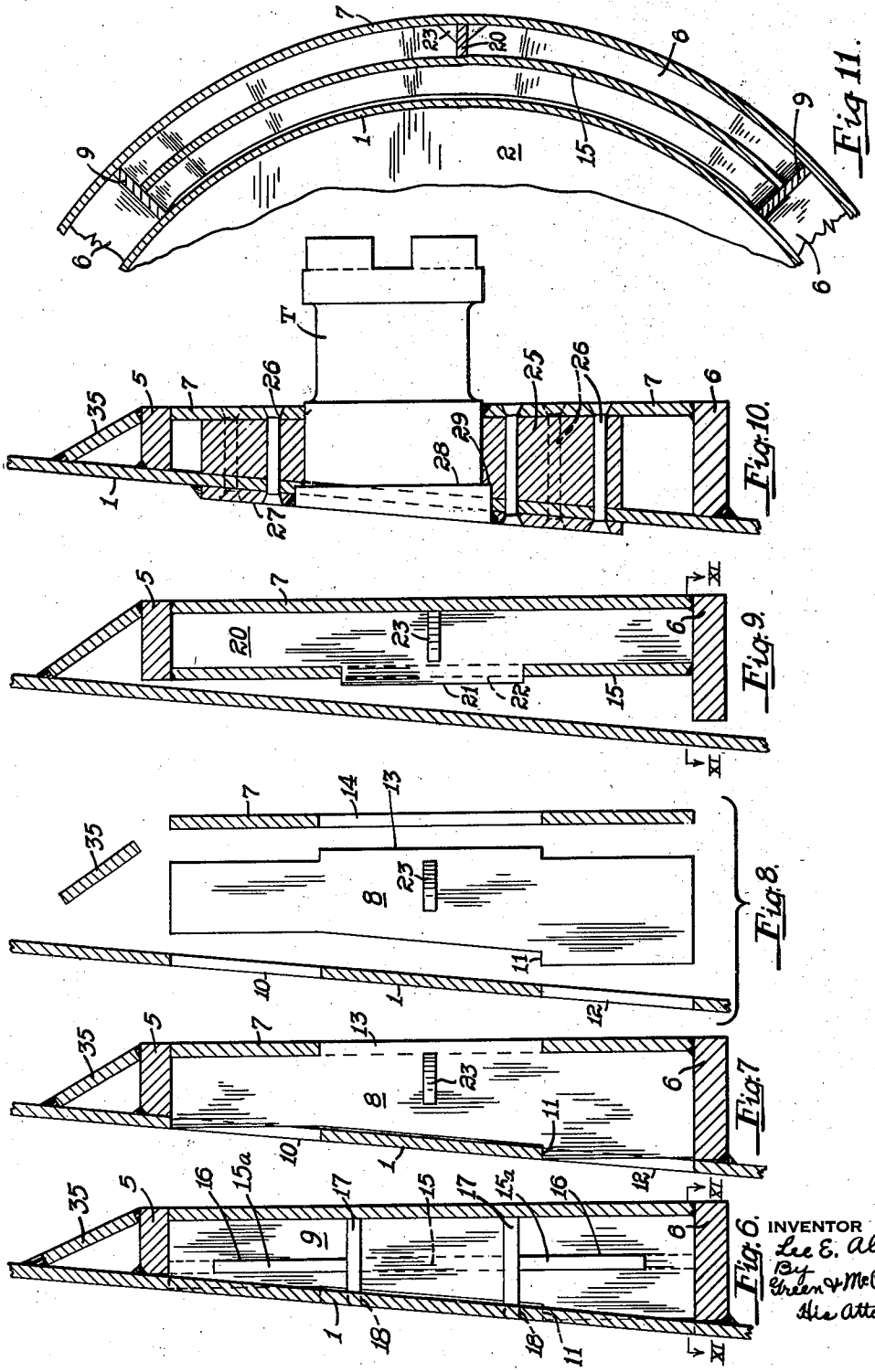
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LADLE STRUCTURE

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LADLE STRUCTURE

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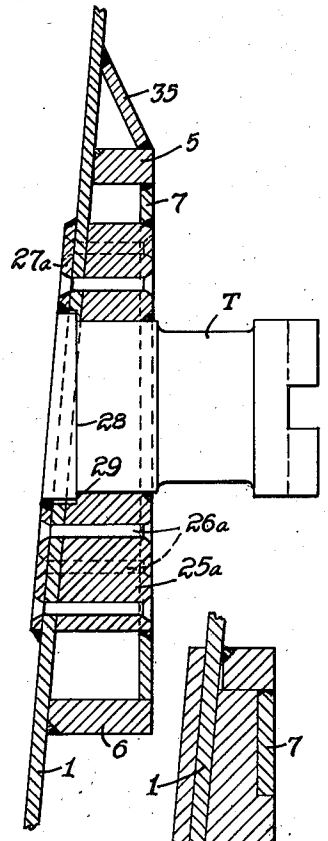


Fig. 12.

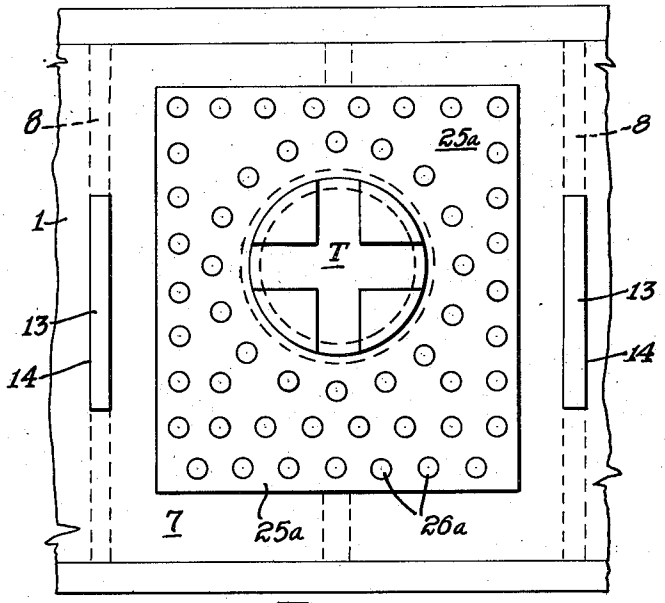


Fig. 13.

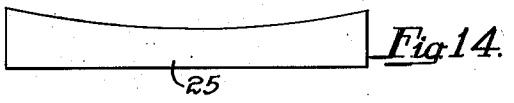


Fig. 14.

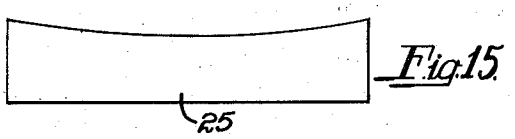


Fig. 15.

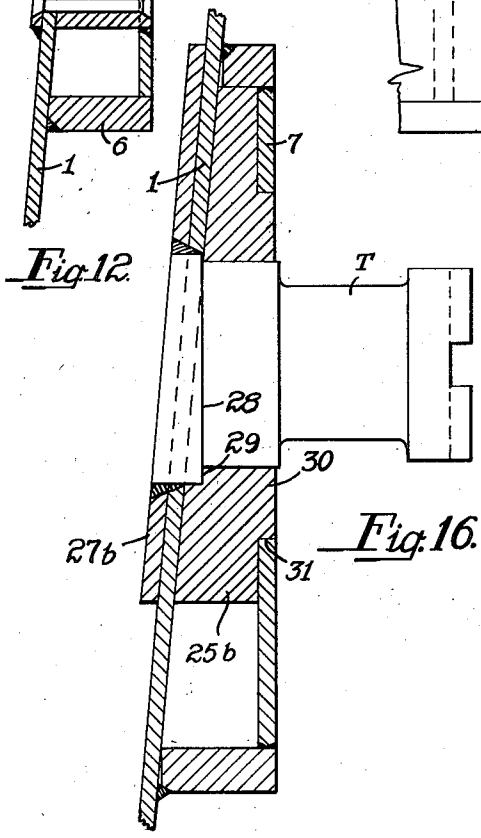


Fig. 16.

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UNITED STATES PATENT OFFICE

2,067,883

LADLE STRUCTURE

Lee E. Allen, New Castle, Pa., assignor to Pennsylvania Engineering Works, a corporation of Pennsylvania

Application February 18, 1936, Serial No. 64,503

8 Claims. (Cl. 22—84)

This invention relates to ladles for handling materials such as molten steel and the like, and more particularly to a ladle structure in which the shell is fabricated entirely from plates welded together into an integral whole.

The primary purpose of my invention is to provide a ladle shell fabricated from plates welded together which will have more than the necessary strength to support the load it is designed to carry and at the same time be materially lighter in weight (i. e., of substantially less dead weight) than the conventional riveted ladle shell having cast steel trunnions.

One object of my invention is to provide a ladle shell structure fabricated entirely of plates welded together in which the plates are so assembled that metal-to-metal bearings are maintained therebetween at all critical points of the structure such as between the floor and the side wall of the shell; between the trunnion ring and the wall of the shell and between the trunnions and their supporting blocks whereby the ladle may be lifted with safety regardless of the security of the welds between the plates.

Another object of my invention is to provide a ladle shell fabricated from plates in which a portion of the wall of the shell is utilized as part of the trunnion ring whereby a trunnion ring of substantially box section is secured.

Another object of my invention is to provide a trunnion ring for a ladle shell in which a metal-to-metal bearing is maintained between the shell and the ring so that it is impossible for the ladle to slip through the ring even though the weld between the ring and the shell is insecure.

A further object is to provide a ladle shell having a trunnion ring mounted thereon in such a manner that the shell, which is always of higher temperature than the trunnion ring when the ladle is in use, may expand freely relative to the ring.

A still further object is to provide a trunnion mounting in which the trunnions are installed after the shell has been completely fabricated and in which means are provided for preventing the trunnion from being pulled through its supporting block.

These and other objects which will hereinafter be made apparent to those skilled in this particular art are accomplished by means of my invention, one embodiment of which is described in the following specification and illustrated in the accompanying drawings, wherein:

Figure 1 is a top plan view of a ladle made in accordance with my invention;

Fig. 2 is a view partially in end elevation and section taken on the line II—II of Fig. 1;

Fig. 3 is a view in side elevation of the ladle;

Fig. 4 is a view on reduced scale in side elevation of the ladle with the trunnion ring removed;

Fig. 5 is a sectional view on line V—V of Fig. 3;

Fig. 6 is an enlarged sectional view taken on line VI—VI of Fig. 5;

Fig. 7 is an enlarged sectional view taken on line VII—VII of Fig. 5;

Fig. 8 is an exploded view similar to Fig. 7, showing the shape and relation of the parts;

Fig. 9 is an enlarged sectional view taken on line IX—IX of Fig. 5;

Fig. 10 is an enlarged sectional view taken on line X—X of Fig. 5;

Fig. 11 is an enlarged sectional view taken on line XI—XI of Fig. 9;

Fig. 12 is an enlarged sectional view similar to Fig. 10, and showing another exemplification of my invention;

Fig. 13 is a view in elevation of the trunnion illustrated in Fig. 12;

Fig. 14 is a top plan view of the trunnion block shown in Figs. 10, 12, and 13;

Fig. 15 is a bottom plan of the trunnion block; and

Fig. 16 is an enlarged sectional view illustrating another modification of trunnion mounting.

Referring to the drawings in detail, a ladle constructed in accordance with my invention is illustrated having a metallic shell 1 which is formed of a series of plates arranged vertically with their adjacent edges either lap or butt welded together to form an integral unit. Surrounding the shell 1 intermediate the top and bottom thereof, is a trunnion ring R carrying the usual trunnions T which are adapted to be engaged by the hooks of a suitable crane when it is desired to lift and move the ladle. The lower edges of the shell plates 1 are inturned to provide flanges 2 which support a floor or bottom 3 having the usual pour opening 4. The floor 3 is also fabricated from plates welded together and is supported on and welded to the flange 2 both inside and outside of the shell, so that the load is supported directly on the flanges 2 and not on the welds.

The trunnion ring R is built up of plates and comprises an upper annular plate member 5 and a lower annular plate member 6, both of which are of relatively heavy section in comparison with the section of the plates forming the shell 1 and a vertical plate 7 which joins the members 5 and 6. The ring R surrounds the shell 1 intermediate

the top and bottom thereof and the members 5 adn 6 are welded to the shell on opposite sides thereof in the vicinity of the trunnions T and form outwardly projecting flanges on the shell and the plate member 7, which is continuous except for the lap welding on the vertical seams of adjacent plates, is welded, top and bottom, to the outer edges of these flange members 5 and 6.

In order to utilize a portion of the shell 1 as a part of the trunnion ring R and to provide a metal-to-metal bearing between the shell and the ring, ribs 8 and 9 are positioned at spaced intervals between the shell 1 and the plate 7 and have their ends welded to the flanges 5 and 6. The upper edges of the ribs 8—9 project beyond the inner periphery of the annular plate member 5 and extend through slots 10 in the shell 1 which are of such length that the upper ends of the ribs are in abutting relation with the upper ends of such slots. (Figs. 6—7—8.) To further increase the metal-to-metal joint between the ribs 8 and 9 and the shell 1, the inner faces of the ribs are also provided with intermediate shoulders 11, which project through slots 12 in the shell 1 which are so spaced relative to the slots 10 that the shoulders 11 as well as the upper edges of the ribs 8 and 9 are in direct bearing contact with the shell.

So that the shearing stress on the trunnions T will be transmitted from the plate 7 to the wall of the shell 1, the outer surfaces of the ribs 8 are provided with outwardly projecting lugs or tenons 13 which extend through and are welded in slots or mortises 14 formed in the plate 7.

From the foregoing it is apparent that by having the ribs 8—9 mortised between the plate 7 and shell 1 a trunnion ring is provided which is substantially of box-like cross section, and that the lifting forces applied to the trunnions T will be transmitted directly to the shell, due to the metal-to-metal bearings secured by mortising the ribs 8 and 9 in the shell 1 and plate 7 and, therefore, it is impossible for the shell to slip through the ring even though the welds between the flange members 5 and 6 and the shell 1 are insecure. The utilization of the shell as a portion of the trunnion ring is made possible because in practice the shell plates are always much heavier than the actual figured requirements and consequently this additional thickness can be used without impairing the life of the shell.

The flange members 5 and 6, which are secured to the wall of the shell in the vicinity adjacent the trunnions T, are not attached to the shell at the portions thereof which are at right angles to the trunnions but are spaced therefrom to permit the shell, which is always at a higher temperature than the trunnion ring when the ladle is in use, to expand and contract freely relative to the ring (Fig. 11).

In order, however, to maintain the box-like section of the trunnion ring R at the points where the members 5 and 6 are spaced from the shell 1, a separate vertical plate 15 is inserted between the outer plate 7 and the wall of the shell 1 at each side of the ladle (Figs. 6 and 11). The ends of the plate 15 are forked as at 15*a* and extend through vertically spaced slots 16 in the ribs 9 to provide a mortise joint therebetween and as a result, the plates 15 carry a portion of the load in shear at these portions of the ladle. Sideward displacement of the ribs 9 is prevented by spaced members 17 having their inner ends mounted in slots 18 in the shell 1 and which abut against the ribs 9 and the member 7 to which they are welded.

The plates 15 are further strengthened and connected to the plate 7 by means of ribs 20 which are positioned therebetween and have their ends abutting against and welded to the members 5 and 6 (Fig. 9). Each of the ribs 20 is also provided with a projecting tenon 21 which extends through a mortise 22 in the plate 15 and thus provides a metal-to-metal bearing between the two plates 7 and 15 which also tends to transmit the shearing force from the plate 7 to the plates 15. The ribs 8—8, 20—20 are reinforced by triangularly shaped members 23 which are welded to the ribs 8—8, 20—20 and to the plate 7.

From the foregoing description it is apparent that in a ladle shell constructed in accordance with my invention, a metal-to-metal bearing is provided between all of the sections of the shell which are subjected to critical forces and as a result a lifting force can be applied to the trunnions T to lift the loaded ladle without danger of the ladle 1 slipping through the trunnion ring R although the welds may not be secure since the metal-to-metal contacts between the ribs 8 and 9 and their shoulders 11 with the ends of the slots 10—12 in the wall of the shell 1 are sufficient to carry the load in safety.

The trunnions T which are preferably made of forged steel are also mounted in the trunnion ring R in such a way that a metal-to-metal bearing is also maintained between the shell and the trunnion so that the ladle is safe for handling even though the fit of the trunnion in its supporting block is loose or insecure.

In mounting the trunnions T on the shell 1, a forged steel trunnion block 25 is positioned between the plate 7 and the wall of the shell 1. The inner surface of the block is shaped to correspond to the outer surface of the shell 1 and the block is secured in place by rivets 26 which extend through the plate 7 and through a reinforcing plate 27 mounted on the inner surface of the shell 1.

In the fabricating of my ladle, the block 25 is first positioned between the plate 7 and the shell 1 and after the ladle has been completely fabricated, a hole is bored in the block 25 for receiving the trunnion T which is either pressed or shrunk into the bore of the trunnion block. A shoulder 28 is formed on the inner end of the trunnion T which is adapted to engage when installed a shoulder 29 on the trunnion block 25. These coacting shoulders 28—29 serve the dual purpose of properly positioning the trunnions T during the pressing or shrinking of the trunnions in the trunnion block 25, and also prevent the trunnion from being pulled out of the block when a lifting force is applied thereto, although the fit between the trunnion and the opening in the block 25 is insecure.

In Figs. 12 and 13, I have shown another exemplification of trunnion mounting in which the trunnions are mounted in a trunnion block 25*a* that abuts against the shell 1 and extends through an opening in the plate 7 and has its outer face flush with the outer surface of the plate 7. The block 25*a* is welded to the plate 7 adjacent the opening therein and is secured to the shell 1 by rivets 26*a* which extend through the block 25*a* and a reinforcing plate 27*b* on the inner surface of the shell.

In Fig. 16, another form of trunnion mounting is disclosed in which the trunnion T is supported

in a trunnion block 25b that is positioned between the plate 7 and the shell 1 and has a portion 30 thereof projecting through an opening 31 in the plate 7 to which it is welded. The inner end of the trunnion T is welded to the shell 1 and to a reinforcing plate 27b.

In each trunnion mounting, however, it is to be noted that the functions and purposes of the coacting shoulders 28 and 29 on the trunnion and trunnion block are retained so that the trunnion is prevented from being pulled out of the trunnion block.

In the trunnion mounting shown in Fig. 12, the shear from the load on the trunnion T is taken on the outside trunnion plate 7 through the weld between the trunnion plate and the trunnion block 25a, whereas in Fig. 16, the shear from the load on trunnion T is taken on the outside trunnion plate T through the coaction of the projecting portion 30 and the slot 31.

The principal advantage of the trunnion mounting of the character illustrated in Figs. 12 and 16 is that the shrink fit between the trunnion T and the bore in the block 25a and 25b can be more readily obtained since heat can be applied directly to the trunnion blocks 25a—25b, whereas in the construction shown in Fig. 10, the application of heat to the trunnion block 25 is indirect.

In order to protect the flange member 5 of the trunnion ring R from spilled slag and metal and also to reinforce the shell 1, a plate 35 is secured between the shell 1 and the outer edge of the member 5. The plate 35 is inclined and prevents slag or metal from accumulating on the top of the trunnion band.

From the foregoing description it is apparent that a ladle shell constructed in accordance with my invention is not only much lighter in weight than the conventional riveted ladle with the cast steel trunnions (as much as 15 tons in ladles of large sizes), but also it is much safer than such a ladle from an operating standpoint since a metal-to-metal bearing is maintained between the parts of the ladle at all critical points and as a result the ladle may be operated with safety even though the welds between the plates making up the shell and the trunnion ring are not secure.

Further a greater degree of safety is obtained with the use of a forged steel trunnion and a separate forged steel trunnion block than can be obtained with the customary cast steel trunnion which is ordinarily cast integral with a pad, which is adapted to be riveted to the ladle shell, because, when making the trunnion and trunnion block separately and of forged steel, solid metal is always obtained between the two elements, whereas in a casting, and particularly where the casting changes from a heavy section to a lighter section, defects are likely to occur which are not obvious and cannot be found by surface inspection.

Another advantage of inserting the trunnion after the ladle has been completely fabricated is that the ladle can be shipped without the trunnions. This is very important since the present day ladles are of such size that it is impossible to secure the proper shipping clearance when the trunnions are in place on the ladle. By making the trunnions separate from the trunnion block this disadvantage is overcome since the trunnions can be readily shrunk or pressed into the bore of the trunnion block after the shell has been delivered to its destination.

What I claim as new and desire to secure by Letters Patent is:

1. A ladle, a shell composed of a series of plates welded together, a series of plates welded together to form a flanged ring surrounding said shell plates with the flanges thereof abutting against said shell, to form therewith a trunnion ring of substantially hollow box shape in section and members extending between the flanges of said ring and mortised to said ring and said shell.

2. The combination with a ladle shell, a trunnion ring of substantially box-like section surrounding said shell, and a plurality of ribs carried by said ring and having portions thereof mortised in said shell and in said ring to form a metal-to-metal bearing surface therebetween.

3. In combination with a ladle shell, a trunnion ring of substantially box shape in section comprising a pair of vertically spaced annular members surrounding said shell and having opposed sections thereof secured to said shell, and the sections thereof intermediate the secured sections spaced from said shell, and an annular plate spaced from said shell and secured top and bottom to the edge of each of said annular members.

4. In combination with a ladle shell, a trunnion ring of substantially box shape in section comprising a pair of vertically spaced annular members surrounding said shell and each having sections thereof on opposite sides secured to said shell, the portions of said members intermediate the secured sections being spaced from said shell, an annular plate spaced from said shell and secured top and bottom to the edge of each of said members, and intermediate plates disposed between said shell and said plate where said members are spaced from said shell.

5. In combination with a ladle shell, a trunnion ring comprising a pair of vertically spaced annular members surrounding said shell and secured to said shell on opposite sides thereof, the portions of said members intermediate the secured portions being spaced from said shell, a plate spanning the space between said members and secured to the edges of each of said members, members mortised to said shell and to said plate to provide a trunnion ring of substantially box-like section, and means for maintaining the box-like section of said trunnion ring at the points where said members are spaced from the wall of said shell.

6. In a ladle, a shell, an annular plate surrounding said shell and spaced from the side thereof, trunnion blocks positioned between said plate and said shell on opposite sides thereof and each having a bore therein, and a trunnion mounted in the bore of each of said blocks, having a shoulder on the inner end abutting against said trunnion block for preventing the trunnion from being pulled through said block.

7. In a ladle, a shell, an annular trunnion plate surrounding said shell and spaced therefrom, a forged steel trunnion block secured to said shell and projecting through openings in said trunnion plate, each said block having a bore therein, the inner end of which is of larger diameter than the remaining portion of the bore, and a forged steel trunnion mounted in the bore of said block and having an enlarged shoulder on the inner end adapted to be received in the enlarged portion of said bore.

8. The combination comprising a metallic ladle shell, a pair of vertically spaced annular members surrounding said shell and each having sections thereof on opposite sides secured to said shell, the portions of said members intermediate the secured sections being spaced from said shell, an annular plate spaced from said shell and secured top and bottom to said annular members, intermediate plates disposed between said shell and said first mentioned plate at the points where said members are spaced from said shell and spaced vertically extending ribs positioned between and having their edges mortised into said first mentioned plate and into said shell.

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