July 26, 1949. K. MARSH 2,477,136

FURNACE STRUCTURE

Filed May 10, 1946 5 Sheets-Sheet 1

Fig. 1

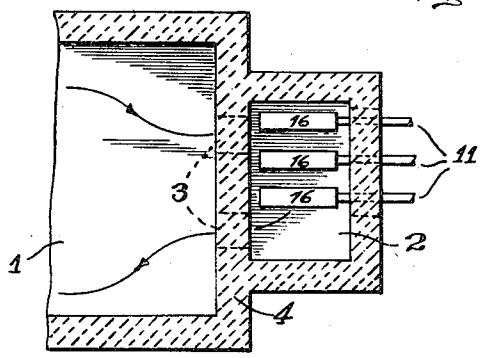
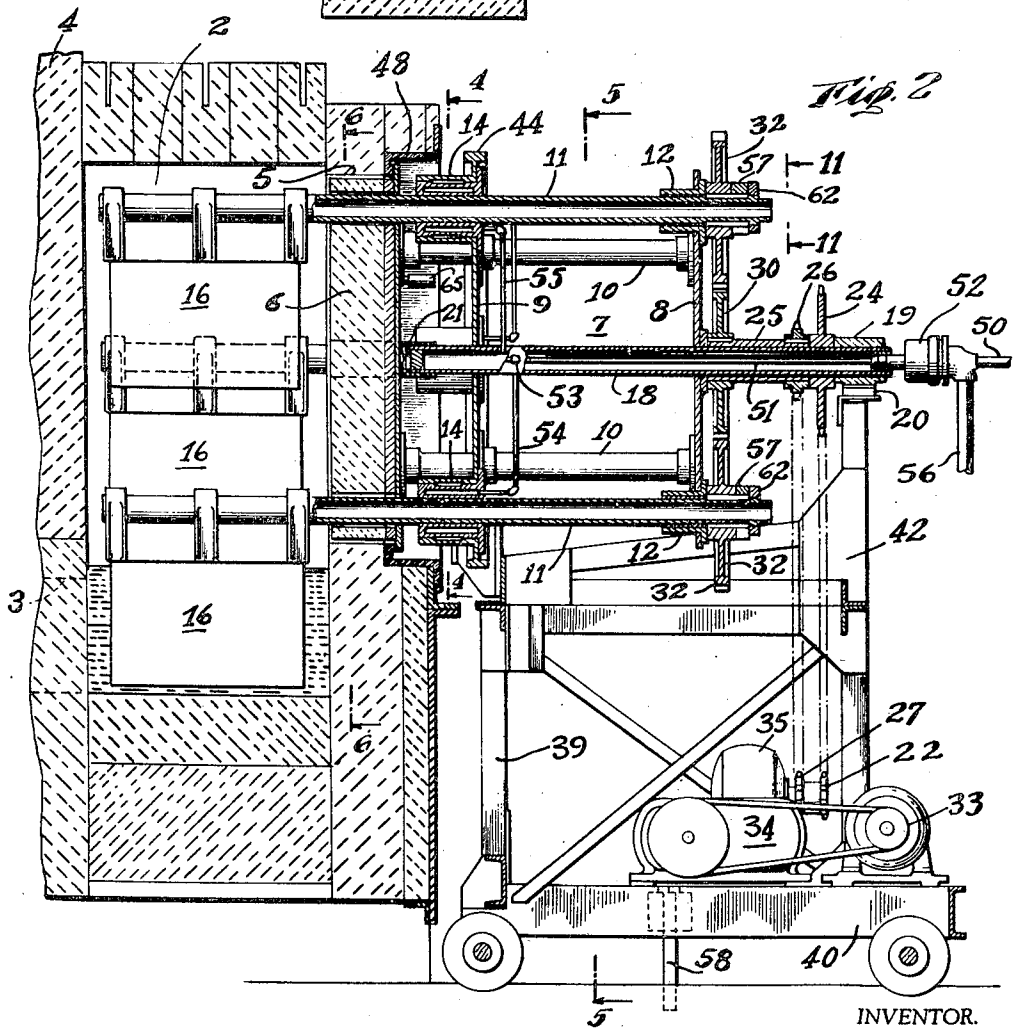


Fig. 2



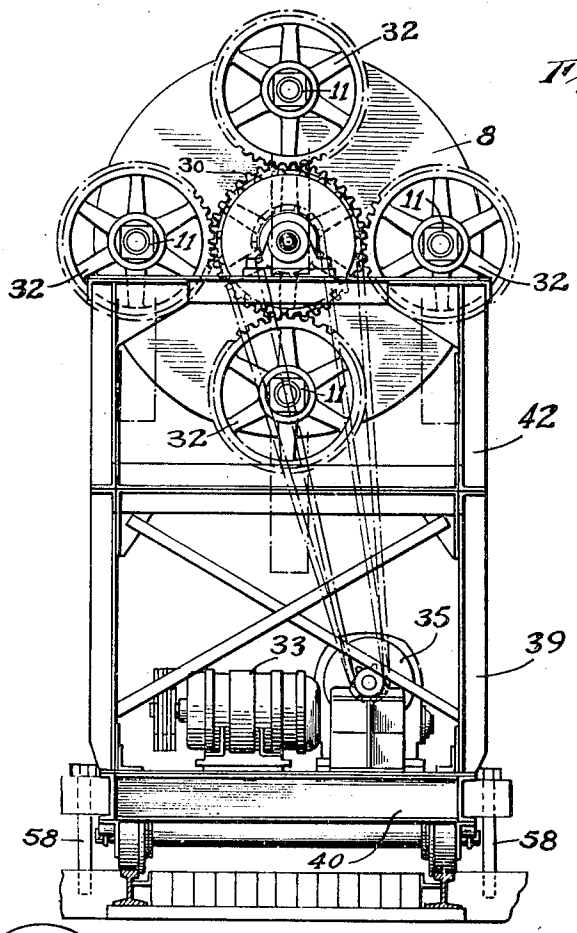
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July 26, 1949. K. MARSH 2,477,136

FURNACE STRUCTURE

Filed May 10, 1946 5 Sheets-Sheet 2

Fig. 3



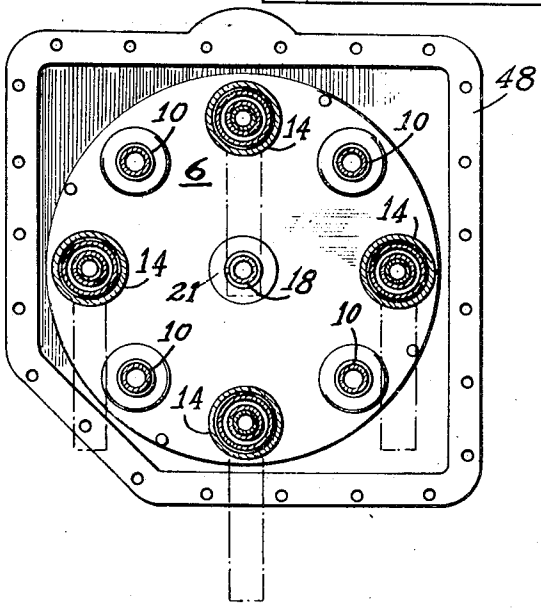
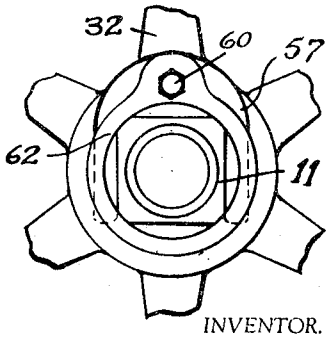


Fig. 4

Fig. 11



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July 26, 1949. K. MARSH 2,477,136

FURNACE STRUCTURE

Filed May 10, 1946 5 Sheets-Sheet 3

Fig. 5

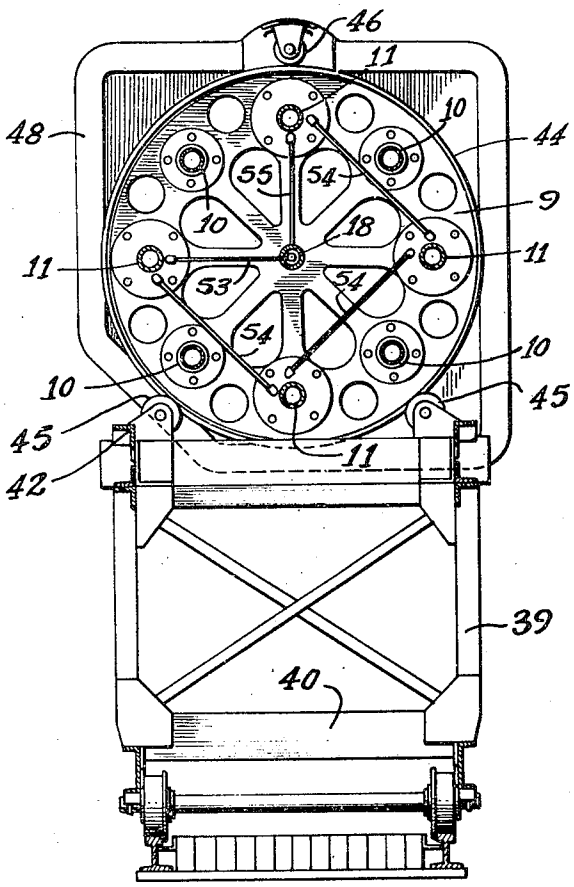


Fig. 6

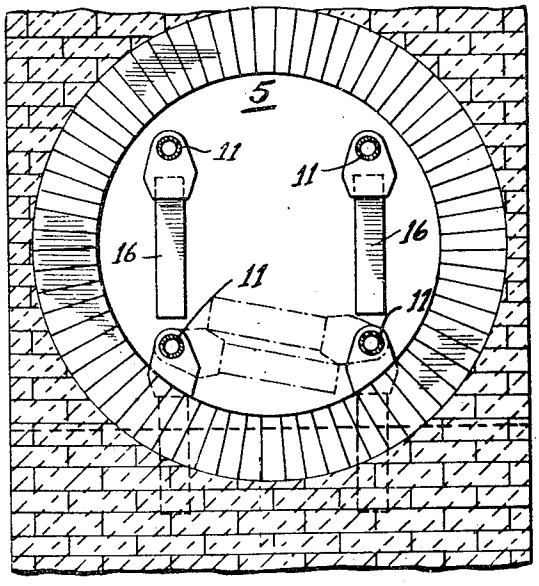
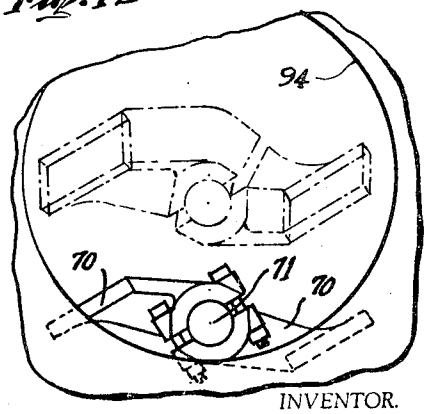


Fig. 12



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July 26, 1949. K. MARSH 2,477,136

FURNACE STRUCTURE

Filed May 10, 1946 5 Sheets-Sheet 4

Fig. 7

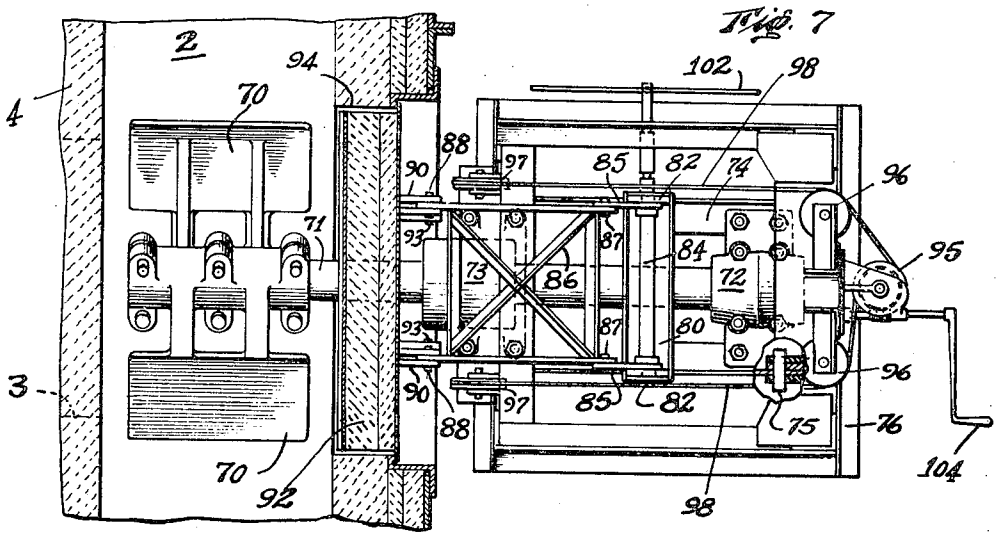
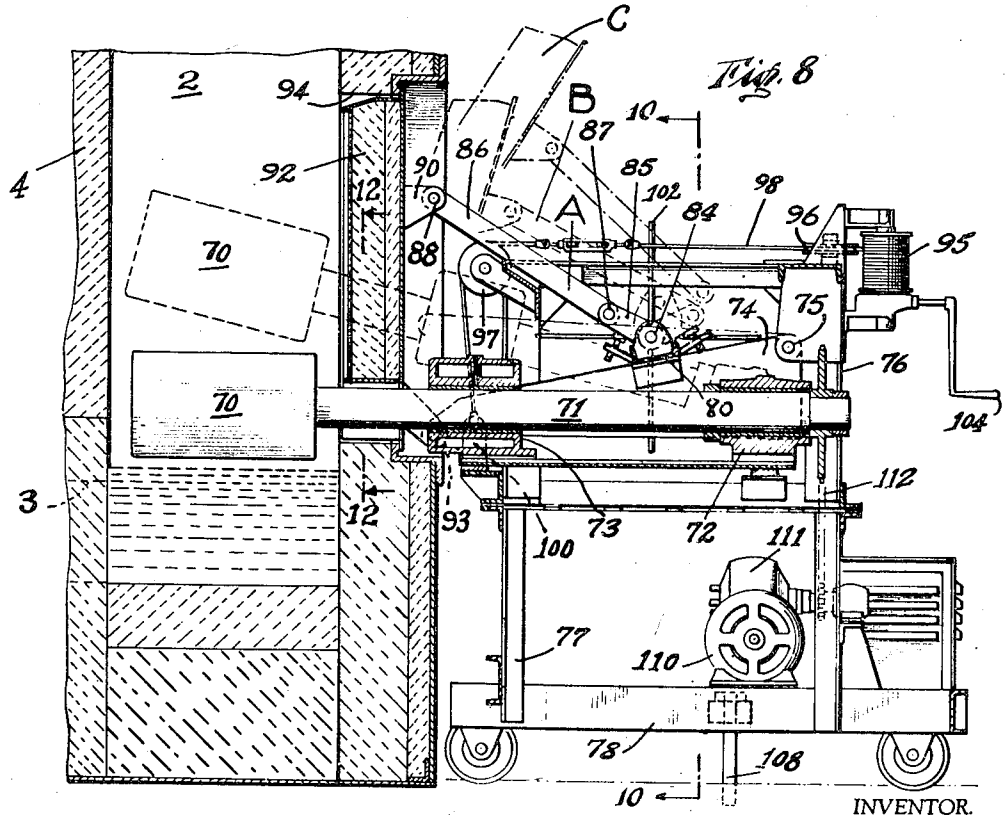


Fig. 8



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July 26, 1949. K. MARSH 2,477,136

FURNACE STRUCTURE

Filed May 10, 1946 5 Sheets-Sheet 5

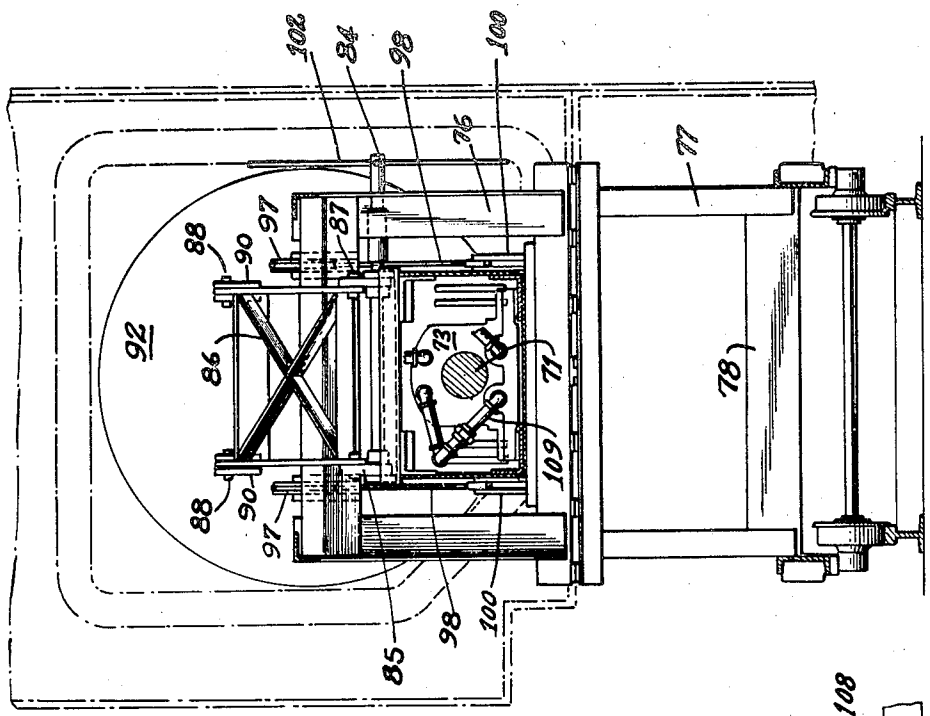


Fig. 10

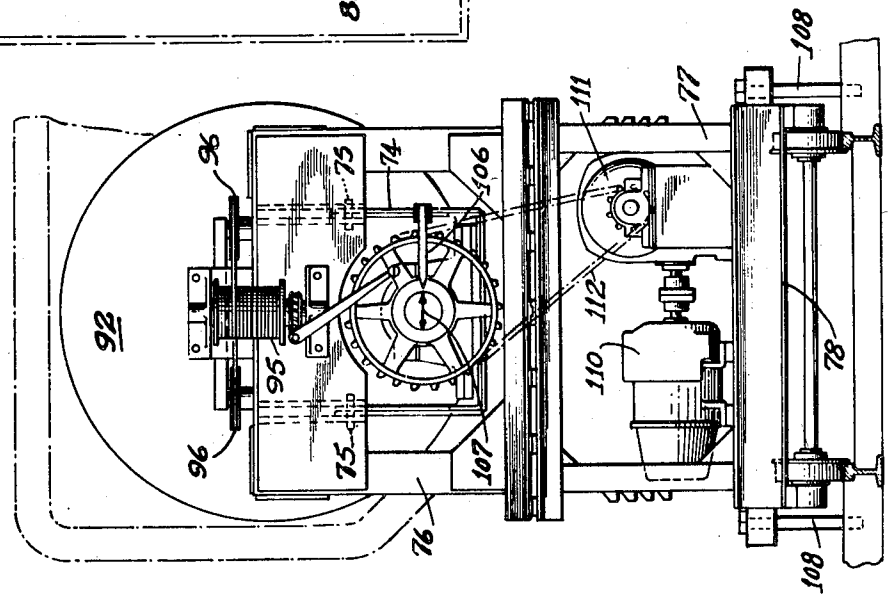


Fig. 9

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2,477,136

UNITED STATES PATENT OFFICE

2,477,136

FURNACE STRUCTURE

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Application May 10, 1946, Serial No. 668,905

12 Claims. (Cl. 266—33)

1

This invention relates in general to new and improved furnace structures and in particular to metal melting furnaces provided with mechanical means for submerging relatively light weight, normally floatable metal beneath the surface of molten metal in a furnace hearth and maintaining circulatory flow of the molten metal to insure uniform temperature and density of the melt.

Although the furnace structures of the invention are broadly applicable to adaptation in melting, remelting, reclamation, and preparation of various types of metals and alloys thereof, they have found their greatest use in the treatment of light metals and their alloys, wherein scrap metal, such as borings, turnings, foil scrap, and the like, form a substantial portion of a furnace charge in the preparation and composition of a molten metal charge. Metals and alloys, then, having low specific gravities and normally readily oxidizable, such as aluminum, magnesium and alloys thereof, as compared to ferrous metals, have been successfully handled by the furnace structures contemplated by this invention.

Normally employed apparatus and methods for melting and remelting readily oxidizable and low specific gravity metals are not commercially satisfactory when applied to aluminum or other light metals since such known apparatus and methods involve charging scrap metal onto the surface of a molten metal hearth in considerable quantity and thereafter endeavoring to submerge the scrap by means of a rabble, stirring or puddling apparatus, while exposing considerable metal surface to the detrimental action of oxidation at the relatively high operating temperatures of the furnace. Furthermore, considerable quantities of scrap of low specific gravity are lost through oxidation during exposure to the furnace temperatures before the same can be submerged beneath the molten metal surface with many of the known mechanisms now employed for this general purpose.

In the improved furnace structures of the present invention, means have been provided that lend themselves to adaptation and association with typical furnace hearth structures in a manner to permit the charging of low specific gravity scrap, such as turnings, borings, foil scrap, and the like, with a minimum amount of exposure to the main body of molten metal within a furnace, and with a minimum exposure to the atmosphere, whereby the scrap is quickly submerged beneath the molten metal and thereafter circulated uniformally through the main body of molten metal in a furnace hearth.

2

Accordingly, one object of the invention is to provide furnace structures for efficiently melting metals having a percentage of scrap introduced in the charge to the furnace.

It is another object to provide furnace structures capable of receiving metal scrap, submerging the scrap below the surface of the molten metal bath within the hearths of the same with a minimum amount of exposure to oxidizing elements.

Another object is to provide furnace door mechanisms and metal submerging devices in association therewith that permit ready adaptation to known types of furnace structures with a minimum amount of redesign.

Another object is to provide mechanical means for presenting furnace closing members into and out of sealed relationship with apertures or openings through furnace walls.

A further object is to provide mechanical metal submerging mechanisms in cooperative association with furnace door structures for the purpose of submerging scrap metal beneath the surface of molten metal in furnace hearths.

An object of the mechanisms of this invention is to provide means for opening, closing, charging and submerging scrap fed to metal melting furnaces, the charge being thoroughly circulated through the main body of molten metal within the furnace with minimum exposure to oxidation.

Other objects will be distinctly apparent and pointed out in the following description when considered in the light of the drawings attached hereto and forming a part hereof, in which:

Figure 1 represents a sectional plan view of a schematic furnace structure which lends itself to the incorporation and association of the mechanisms of this invention;

Figure 2 represents a side elevation, in partial section, of a furnace door structure and metal submerging and agitating mechanism associated with a metal melting furnace;

Figure 3 represents an end elevational view of the mechanism illustrated in Figure 2, as viewed from the right;

Figure 4 represents a sectional view taken along the line 4—4 of Figure 2;

Figure 5 represents a sectional view taken along the line 5—5 of Figure 2;

Figure 6 represents a sectional view, with parts removed, taken along the line 6—6 of Figure 2;

Figure 7 represents a top plan view in partial section of a modified form of furnace door structure and metal submerging and agitating mecha-

nisms, in association with a portion of a metal melting furnace;

Figure 8 represents a side elevational view, in partial section, of the mechanism illustrated in Figure 7;

Figure 9 represents an end elevational view of the mechanism illustrated in Figure 8, as viewed from the right;

Figure 10 represents a sectional view taken along the line 10—10 of Figure 8;

Figure 11 represents a fragmentary end elevation taken in the direction of the arrows 11—11, Figure 2; and

Figure 12 represents a fragmentary end elevation (with the furnace door member removed) taken in the direction of the arrows 12—12, Figure 8.

For purposes of so describing the furnace structures and devices associated therewith that those skilled in the art may practice the invention, it has been elected to describe the same in the adaptation to the treatment of metals and metal alloys broadly. However, it is to be understood that the mechanisms and structures of the invention have been employed successfully in the handling of metals of low specific gravity, such as aluminum and its alloys, where the problem of reclaiming light weight, normally floatable scrap is a prime desideratum.

Referring in general to the structures contemplated within the scope of this invention, it will be found that a furnace door or aperture-closing member is provided on a mobile or movable means, such as a truck or the like, for movement towards and away from an entrance in a furnace wall to substantially seal the same. Associated with the door member and mobile means is mechanism for agitating molten metal within the furnace, the agitating means being also adapted to submerge scrap metal charged into the furnace in proximity to the agitating means and circulate the molten metal within the furnace hearth. It will thus be understood that the metal agitating, submerging and/or circulating means is mounted in a unitary manner in association with a closure member or door for a furnace wall aperture, and that the whole is adapted to be translated towards and away from the aperture leading into the furnace.

More specifically, and with reference to the drawings, Figures 1 through 6 and 11 illustrate one embodiment of a mechanism that falls within the scope of the present invention, whereas Figures 7 through 10 and 12 illustrate a modification which incorporates the same inventive concept.

Referring first to the mechanism shown in Figures 1 through 6 and 11, reference numeral 1 designates a furnace hearth and 2 represents a forehearth within which the molten metal agitating members are normally located during an operating cycle. Suitable apertures 3 through a dividing wall 4 between the main and forehearths provide means for obtaining circulation of the molten metal between both hearths.

Forehearth 2 is provided in one of its walls with an entrance or aperture 5 for introduction of the metal agitating means. This aperture is preferably circular and is equipped with a furnace door or closure therefor 6, of usual steel and fire brick construction, adapted to substantially seal the aperture 5 when in closed position, as shown in Figure 2.

Door member 6 is constructed as an associated element of a rotatably mounted cage mechanism

7. This cage mechanism comprises spaced diaphragm members 8 and 9 secured to, and held in spaced relationship upon, flanged members 10 in the form of steel tubing to reduce the overall weight of the structure. Members 10 extend through the diaphragm 9 and present additional flanged ends which are secured, as by bolts or the like, to the exterior steel face of the furnace door member 6. It will be apparent then, that the cage 7 comprising end diaphragms 8 and 9 held in spaced relationship through the medium of flanged spacers 10, as well as the furnace door 6, constitute a unitary structure which is readily constructed from structural steel materials.

Cage 7 supports a plurality of tubular shafts 11 suitably journalled in bearings 12, secured to diaphragm 8, and water cooled bearings 14, secured to diaphragm 9. Shafts 11 also extend through diaphragm 9 and furnace door 6, and each supports a molten metal agitating member 16 secured, or otherwise dependently supported, at the outboard end thereof.

The cage 7, together with its associated door member 6, is supported upon a central tubular shaft 18 which is journalled at its extreme right, as seen in Figure 2, within a bearing 19, carried at 20 by a frame work to be hereinafter described. The opposite end of shaft 18 is positioned within a central cup bearing 21 secured to the face of the door 6, and the shaft is welded, or otherwise rigidly attached to diaphragms 8 and 9 where it passes through the same. It will be seen, then, that rotation of shaft 18 will cause rotation of the cage member 7 and door 6.

A simple drive mechanism is provided for rotating the cage 7 in the form of a chain drive connecting the sprocket 22 with a sprocket 24 fixed on shaft 18. A further chain and gear drive is provided for shafts 11 and associated metal agitating paddle members 16. This latter drive comprises a sleeve 25 rotatably mounted upon shaft 18, a sprocket 26 being key-connected thereto. Sprocket 26 is chain connected to sprocket 27, and a sun gear 30 is key-connected to the sleeve 25. Planetary gears 32 keyed to the ends of shafts 11 adjacent diaphragm 8 mesh with sun gear 30 to constitute a planetary transmission for driving shafts 11.

By proper selection of tooth relationship between the aforedescribed gears and chain drives, correct rotation of the various elements of the molten metal agitating paddles will be obtained. For example, sprockets 22 and 27 have been purposely selected with an equal number of teeth since they are driven at the same speed from motor 33 through gear reducers 34 and 35. Sprockets 24 and 26 have likewise been selected with a definite tooth relationship, in this case 2:1. The sun and planetary gears 30 and 32 have the same number of teeth. It will be understood from this drive arrangement that rotation of the cage 7, in a clockwise direction, will impart counterclockwise directional rotation to shafts 11 and planetary gears 32, which, in effect, retains or maintains paddles 16 in a vertical position at all times during rotation of cage 7, as viewed in full lines in Figures 2 and 6. This disposition of the paddles 16 causes each paddle to dip into the molten metal vertically, along its bottom edge, and further presents maximum surface contact between the paddles and the metal bath during rotation of cage 7, which results in maximum metal flow between the main and forehearths of the furnace to which this modification of the invention has been adapted.

The unitary cage, furnace door and paddle arrangement is preferably supported upon a movable truck unit which comprises a lower frame work 39 supported upon the bed 40 of a suitable truck. The bed 40 also serves to support the electric motor 33 and gear reducers 34 and 35. An upper deck or super structure 42 is secured to frame work 39, and provides a support for the end bearing 19 of shaft 18, as at 20. To impart stability to the cage 7 and its associated elements, and insure alignment of the cage with the furnace aperture 5, diaphragm 9 is equipped with a flange 44 which serves as a peripheral track engaging flanged rollers 45 rotatably mounted in brackets secured to the super structure 42, as best illustrated in Figure 5. A third roller 46, unflanged, is rotatably secured to the face of the furnace door frame 48 and bears upon the track or flange 44 to serve as a hold down roller. In view of the fact that the door 6 rotates against door 48, one or more spring pressed, carbon stick lubricators 65 are provided to extend through door 6 into contact with frame 48.

It will be understood that the paddle members 16 are subjected to the temperature of the molten metal within forehearth 2 in the normal operation of the apparatus thus far described. In view of this fact, paddle members 16 are preferably constructed from ceramic material or suitable high temperature resistant iron or steel. Shafts 11 are also preferably constructed from high temperature resistant steel, and, in addition, bearings 14 are water cooled. Water or other suitable coolant is introduced through centrally disposed pipes 50 and 51, a rotary type pressure joint 52 being provided adjacent the outboard end of shaft 18. A conduit or pipe member 53 connects pipe 51 to one of the interiorly channeled bearings 14 (Figures 2 and 5) and further pipe members 54 complete circulation of the coolant to the interior of remaining bearings 14, a pipe 55 returning the coolant to the interior of hollow shaft 18 where it is conducted to a sewer or sump by way of the rotary pressure joint 52 and pipe 56.

In the operation of the apparatus thus far described, the lowermost paddles 16, as illustrated in Figure 6, must of necessity be rotated into the position illustrated in broken line construction to permit entrance to and withdrawal from the furnace aperture 5. This is accomplished by removing the U-shaped keepers 57 (Figures 2 and 11), which may be keyed to shafts 11. Removal of the two lowermost keepers 57 permits sliding of planetary gears 32 to the right, as seen in Figure 2, to occupy the space vacated by removal of keepers 57. Application of a suitable spanner or wrench to the squared ends of the two lowermost shafts 11 permits rotation of these shafts and their attached paddle members 16 into the broken line position shown in Figure 6. Gears 32 are thereafter slid laterally to the left (Figure 2) into mesh with sun gear 30, which action will retain the lowermost paddle members in raised position to permit their withdrawal from, or entrance into, the furnace aperture. Translation of the entire metal agitating mechanism and its associated door 6 into and out of operative position with respect to the furnace hearth 2 is accomplished through the medium of the aforedescribed movable truck supporting the same. In this connection, retainer pins 58 are provided to maintain the truck in furnace sealing relationship.

In the preferred construction, keepers 57 are

secured against accidental displacement by means of a bolt 60 (Figure 11) extending through collars 62 into threaded engagement with keepers 57. In this connection, the collars 62 are secured in any suitable manner to the ends of shafts 11, as by means of tapered pins, or the like.

In the modification of the invention disclosed in Figures 7 through 10 and 12, a twin bladed paddle member 70 is secured to a shaft 71 rotatably mounted for extension into the forehearth 2 of a furnace structure similar to that previously described and schematically illustrated as Figure 1. The shaft 71 is supported in bearings 72 and 73, which in turn are bolted or otherwise secured to a door closure and bearing support frame member 74.

The frame member 74 is substantially U-shaped in cross section and has been readily fabricated from structural steel shapes and plate. This frame member 74 is pivotally attached, at the upper open ends of its U-shaped side walls, at 75, to a frame structure 76, forming a super structure secured to a lower frame structure 77, mounted upon the bed plate or base 78, of a suitable truck. A toggle lever support, in the form of a structural channel 80, is mounted adjacent the upper edges of the side plates forming U-frame 74, channel 80 being substantially midway along the length of frame 74. Bearing lugs or brackets 82, secured to either end of channel member 80, serve to receive and support a toggle shaft 84 upon which toggle levers 85 are keyed. An X-braced toggle link frame 86 is pin connected at 87 to the aforementioned toggle levers 85, and it is also pin connected at 88 to perforated lugs 90 secured to the exterior steel plate face of a furnace door or closure member 92. Door 92 is also attached by suitable pin connections 93 (Figure 8) to the base of U-frame member 74.

In order that the metal agitating paddles 70 will clear furnace aperture 94 during their introduction and removal, frame 74 supporting the same is provided with means for oscillatably raising and lowering the same about its pivot pins 75. This raising and lowering means comprises a worm and worm wheel driven drum 95, together with cable directing pulleys 96 and 97, rotatably secured to frame 76. Cables 98, supported on drum 95 and directed over pulleys 96 and 97, are attached to lugs 100 which extend upwardly from the frame 74 adjacent the furnace door 92.

In the operation of the modification or embodiment of the invention described immediately above, it is first necessary to raise the paddle members 70 from the full line to the broken line position in order to introduce or withdraw the same through the furnace aperture 94, as illustrated to best advantage in Figures 8 and 12. This is accomplished by rotation of toggle shaft 84 through the medium of operating handle or wheel 102, secured to an outboard end of shaft 84. Rotation of shaft 84 in a clockwise direction, as viewed in Figure 8, breaks the toggle joint at 87, causing toggle levers 85 and X-braced linkage 86 to move from position A to position B. It will be appreciated that movement from position A to B pivots door member 92 about its pin connections 93 towards the right. Rotation of drum 95 through the medium of crank 104 oscillates frame member 74 together with its supported shaft 71, paddles 70 and door 92 into position C, in which position it is now possible to translate the furnace door and paddle mechanism away from normal operating posi-

tion with respect to the furnace hearth. To aid in positioning paddles 70 for introduction into or withdrawal from the furnace aperture 94, a pointer or indicator 106 (Figure 9) is secured to frame 74, and an arrow 107 is scribed across the end of shaft 71. Alignment of indicator 106 and scribed arrow 107 insures paddles 70 to be in the position indicated at Figure 12. In this connection, pins 108 are employed for retaining the mobile truck and its associated elements in substantial furnace sealing relationship.

As in the case of the first described embodiment of the invention, paddles 70 are constructed from ceramic or high temperature resistant iron or steel. Furthermore, the bearing 73 is preferably water cooled, suitable piping 109, provided with flexible couplings to a source of water supply and drainage, being required for this purpose. A drive for shaft 71, and its attached paddles 70, is supplied in the form of a motor 110, speed reducer 111 and sprocket and chain drive 112.

It will be manifest to those skilled in the art that both mechanisms of the invention provide a furnace aperture closing member or door in association with metal agitating means which are supported for translation towards and away from the forehearth of a furnace for the purpose of introducing or removing the paddle members from operational contact with molten metal within the forehearth. It will also be appreciated that the unitary structures hereinabove described incorporate driving means for the paddle members, and in each case, the paddle members have been selected to present a normally flat surface in contact with the upper surface of a molten metal bath. This feature provides efficient submersion of scrap metal, such as borings, turnings and foil scrap, which have been charged in any suitable manner into the forehearth. It should be further appreciated that agitation of the molten metal within the forehearth transmits a circulatory flow of the molten metal between the main hearth and forehearth of furnace structures incorporating the mechanisms of this invention.

Although specific types of mechanisms have been selected for the purposes of illustrating the invention, it is to be understood that the invention is not to be limited thereto, except as defined in the appended claims.

What is claimed is:

1. In a furnace structure, an opening into a wall thereof, a closure member for said opening, translatable means for movably supporting and translating said closure member into and out of substantial sealing of said opening, means associated with said closure member and extending into said furnace, said last-mentioned means being mounted on and movable with said translatable means and being adapted to agitate molten metal within said furnace, and positive retainer means associated with said translatable means for maintaining the same and its supported closure member in substantial furnace-sealing relationship.

2. A furnace structure comprising an entrance thereto, a door member, a movable truck member aligned with said entrance and disposed exteriorly thereto, said door member being supported on said truck member, molten metal agitating means associated with said door member, said agitating means being supported on said movable truck member, means for driving said agitating means carried by said truck member, said truck member and its supported door member, agitating means and driving means being translatable into and out of substantial door-sealing arrangement with said furnace entrance, said agitating means, in substantial door-sealing arrangement, being adapted to agitate molten metal within said furnace, and positive retainer means associated with said movable truck member for maintaining the same and its supported door member in substantial door-sealing arrangement.

3. A movable truck member positioned exteriorly to and in alignment with a furnace opening, a furnace door member supported on said truck member, a metal agitating paddle member mounted on said truck member and extending through said door member to position said paddle member on the furnace side of said door member, a driving means carried by said truck member in rotational driving connection to said paddle member, said truck member being adapted to be moved into and out of substantial sealing relationship with said furnace entrance to dispose the paddle member in position to agitate and circulate molten metal within the furnace, and positive retainer means associated with said movable truck member for maintaining the same and its supported furnace door in substantial furnace-sealing relationship.

4. A mechanism for submerging scrap metal of relatively low specific gravity beneath the surface of a molten metal bath, said mechanism comprising a paddle member adapted to present a relatively flat face against the top surface of the molten metal bath to depress scrap floating thereon, means for imparting movement to said paddle relative to the molten metal bath, said paddle being supported in extending relationship from a movable truck member for movement into and out of an aperture in a furnace structure retaining the molten metal bath, and said truck member supporting a furnace door member movable therewith and adapted to substantially seal said furnace aperture during a scrap depressing operation.

5. A molten metal circulating mechanism comprising a rotatable cage member, a furnace closing member secured to said cage and rotatable therewith, a plurality of shafts rotatably supported in said cage and extending through said closing member, paddles secured to said shafts beyond said closing member, means for driving said cage, means for driving said paddle supporting shafts, and a translatable truck for supporting the cage, furnace closing member and driving means, whereby the circulating mechanism is translatable towards and away from a molten metal containing furnace hearth into operative and nonoperative positions for the paddle.

6. A molten metal circulating and scrap submerging mechanism comprising a rotatable cage member, a furnace door member secured to said cage and rotatable therewith, a plurality of shafts rotatably mounted in said cage and extending through the door member, paddles secured to the shaft ends extending through said door member, means for driving said cage in a selected direction of rotation, means for driving said shafts in the opposite direction, said driving means incorporating a planetary gear transmission system to maintain the paddles in fixed relative rotational position with respect to rotation of the cage, and a movable truck for supporting the cage and related elements, whereby the circulating and scrap submerging mecha-

nism may be translated into and out of association with a furnace aperture into operative and nonoperative positions.

7. A molten metal stirring apparatus for a melting furnace comprising a frame movable towards and away from a furnace wall, an opening in said wall above the molten metal level in said furnace, a door carried by said frame for substantially sealing said opening, means disposed adjacent the inner side of said door adapted for movement through the molten metal to effect circulation thereof, said last-mentioned means being supported on said frame and movable therewith, power mechanism carried by said frame and operatively connected through said door to said circulating means for actuating the same, and positive retainer means associated with said movable frame structure for maintaining the same and its supported door in substantial furnace-sealing position.

8. Apparatus for submerging metal scrap of low specific gravity below the surface of a molten metal bath within a furnace hearth, said apparatus comprising a movable frame structure, a door carried by said frame structure and movable therewith, a paddle member disposed on the furnace side of said door, said paddle being supported on and movable with said frame structure and having a relatively flat surface adapted to enter the molten metal and submerge scrap floating on the surface thereof, a power mechanism carried by said frame structure in driving organization with said paddle to move the same through said molten metal, said frame structure being movable into position with respect to said furnace hearth to present the paddle into position to submerge the metal scrap and present the door in substantially furnace-sealing position, and positive retainer means associated with the movable frame structure for maintaining the same and its supported door in substantial furnace-sealing position.

9. In a mechanism of the class described, a movable frame structure adapted to be positioned in and retracted from proximity to an aperture in a furnace wall, a door for substantially sealing the furnace aperture carried by said frame structure, a molten metal stirring means disposed on the furnace side of said door, means extending through said furnace door for supporting said stirring means on the frame structure, power means on the frame structure for imparting rotational movement to said stirring means, movement of said frame structure to the furnace wall being adapted to position said stirring means within said furnace and to simultaneously substantially seal the furnace aperture with the furnace door, and positive retainer means associated with the movable frame structure for maintaining the same and its supported door in substantial furnace-sealing relationship.

10. A mechanism of the class described comprising a movable frame structure adapted to be moved towards and away from an aperture in a furnace wall, an oscillatable frame member pivotally attached to and supported on said movable frame structure, a furnace door pin-connected to an end of the oscillatable frame member at a point remote from the pivotal connection, a toggle link connected at one end to the furnace door and at its other end to a toggle lever carried by and fixed to a shaft rotatably supported upon the oscillatable frame member intermediate the pin and pivotal connections, a molten metal stirring means supported on said oscillatable frame member and having a portion thereof extending through the furnace door, means for imparting movement to the toggle lever shaft to impart movement through the toggle lever and link to oscillate the furnace door about its pin-connection, and means for oscillating the oscillatable frame structure to raise said door and molten metal stirring means into a position to permit withdrawal of the movable frame structure and its supported elements from aperture-sealing and molten metal stirring relationship with respect to the furnace aperture.

11. A mechanism of the class described comprising a movable frame structure adapted to be moved towards and away from an aperture in a furnace wall, an oscillatable frame member pivotally attached to and supported on said movable frame structure, a furnace door pin-connected to an end of the oscillatable frame member at a point remote from its pivotal connection, a toggle link connected at one end to the furnace door and at its other end to a toggle lever carried by and fixed to a shaft rotatably supported upon the oscillatable frame member intermediate the pin and pivotal connections, means for imparting movement to the toggle lever shaft to impart movement to the toggle lever and link to oscillate the furnace door about its pin-connection, and means for oscillating the oscillatable frame member to raise said furnace door.

12. In a furnace structure, a door opening into said furnace, a closure member for said door opening, translatable structure supporting said closure member and movable towards and away from said door opening to present said closure member into and out of substantial sealing relationship with respect to said door opening, retainer means associated with said translatable structure for maintaining the same and its closure member in substantial sealing relationship with said door opening, and molten metal agitating means supported on and movable with said translatable member and extending through said closure member into said furnace.

KIRTLAND MARSH.

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