United States Patent

[11] 3,632,094

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[45] Patented **Jan. 4, 1972**

[54] **PROCESSING AND PREHEATING SCRAP METAL FOR FURNACE UTILIZATION**
29 Claims, 22 Drawing Figs.

[52] **U.S. Cl.** ..... **263/36,** 214/18 SC
[51] **Int. Cl.** **F27b 1/02**
[50] **Field of Search** ..... 263/36, 39, 40, 43; 214/185 C

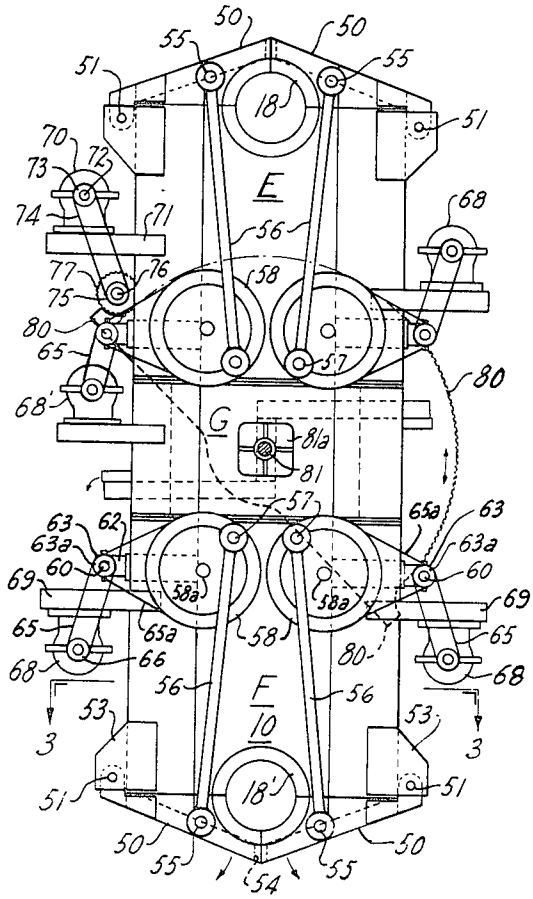
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Primary Examiner—John J. Camby
Attorney—Green, McCallister & Miller

ABSTRACT: Procedure and apparatus are utilized for charging scrap metal in accordance with its density to cushion the impact involved in loading it into a vessel such as a preheating silo, and for enabling an accurate control of the quantity of preheated scrap charged based on weighing it before it has been preheated. A preheating silo having upper and lower compartments and a separating partition therebetween utilizes a flow of hot furnace gases into a lower compartment, upwardly through the partition, and into and out of an upper compartment to preheat the scrap from the standpoint of providing a higher temperature portion in the lower compartment that may be directly charged into the furnace and a lower temperature portion in the upper compartment that is to be subjected to further treatment to bring it up to a furnace charging temperature. The compartments of the preheating silo are utilized interchangeably as cold scrap receiving and as hot scrap delivering chambers.



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SHEET 1 OF 6

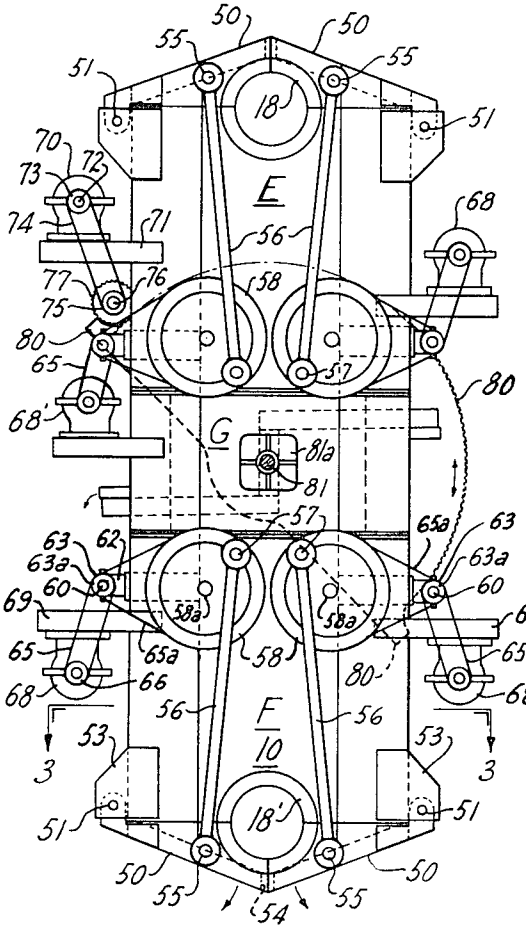


Fig. 1

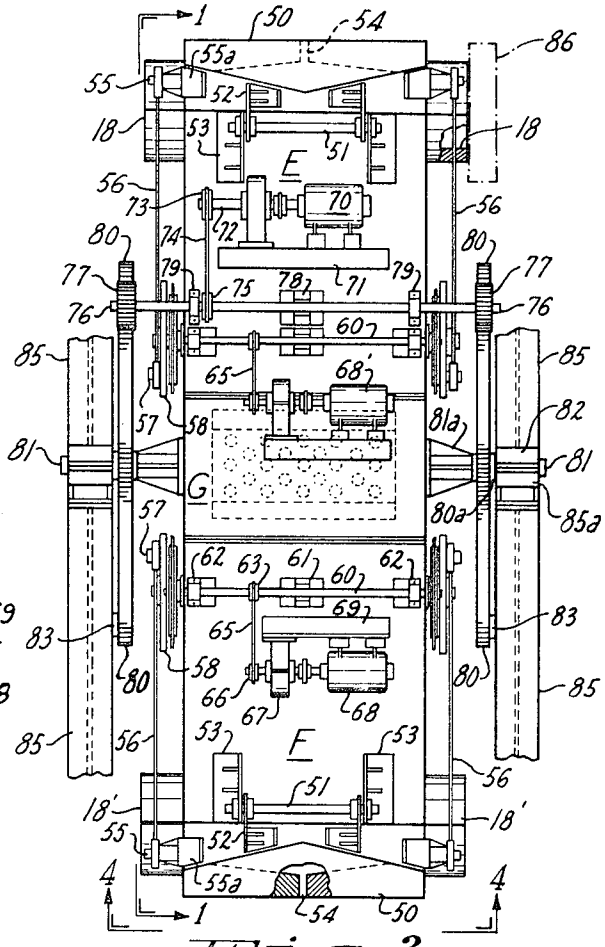


Fig. 2

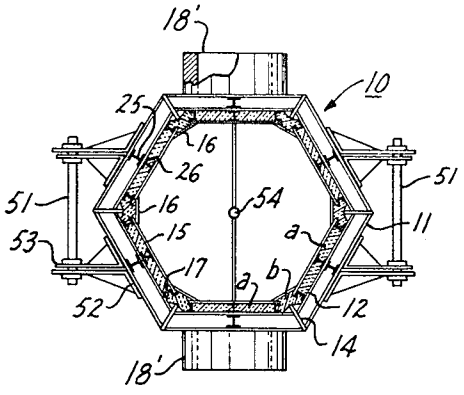


Fig. 3

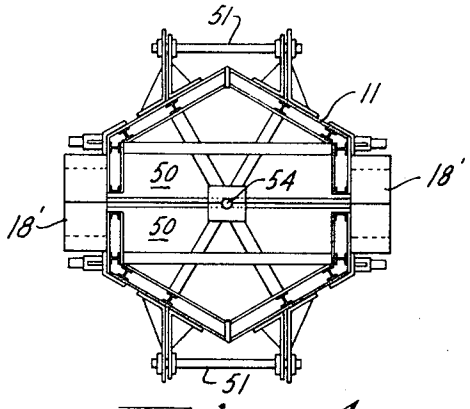


Fig. 4

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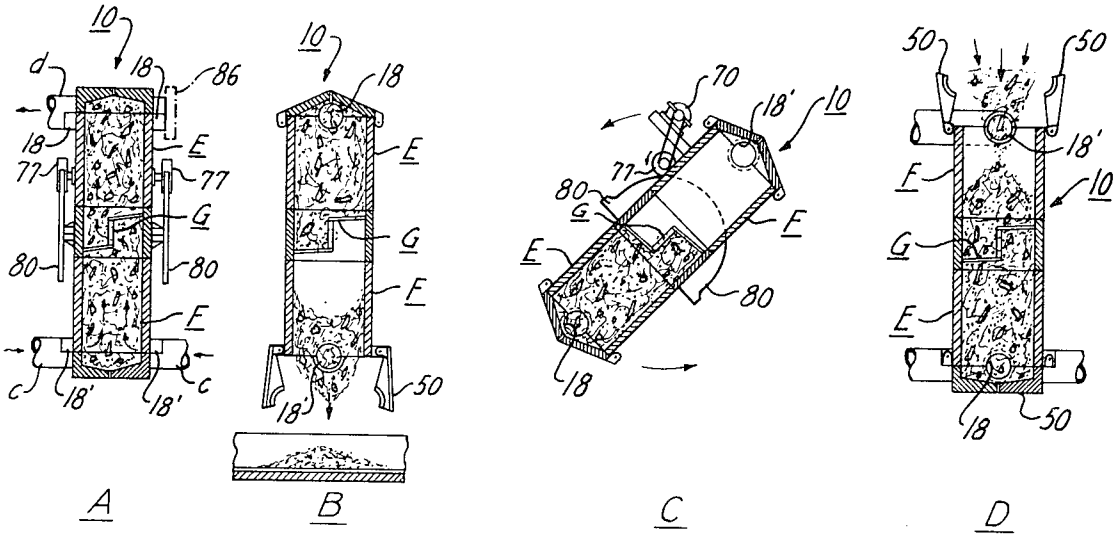


Fig. 8

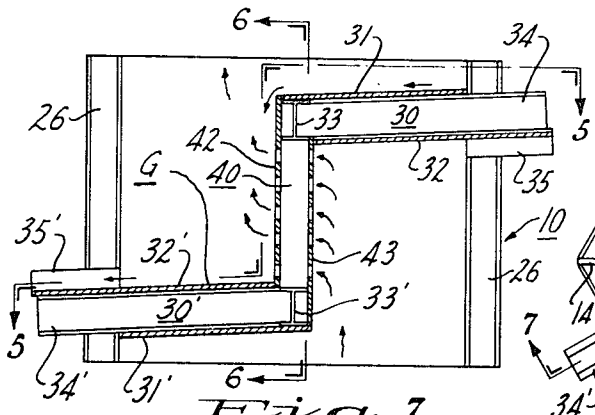


Fig. 7

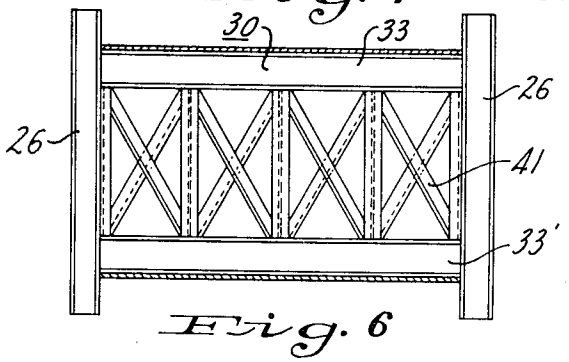


Fig. 6

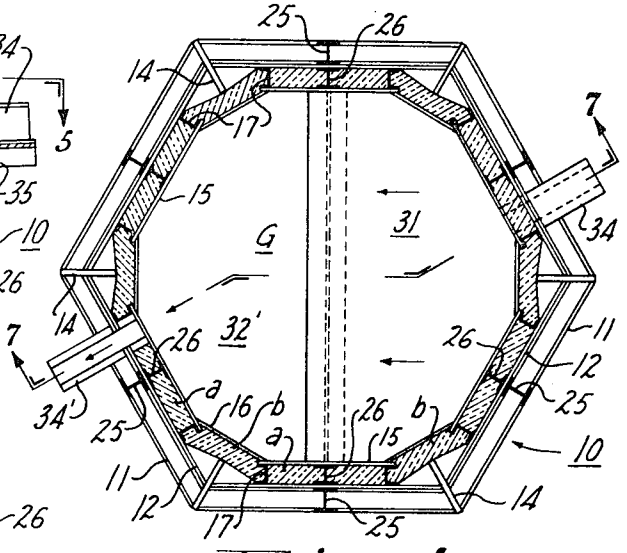


Fig. 5

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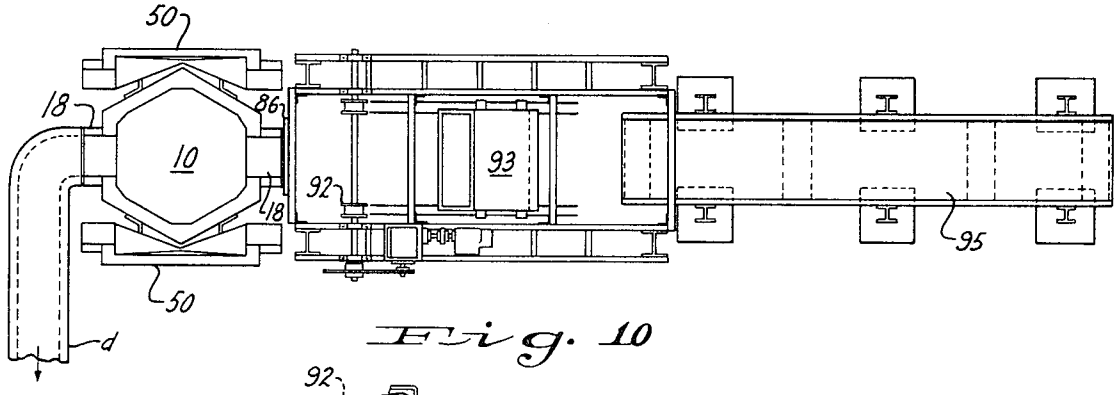


Fig. 10

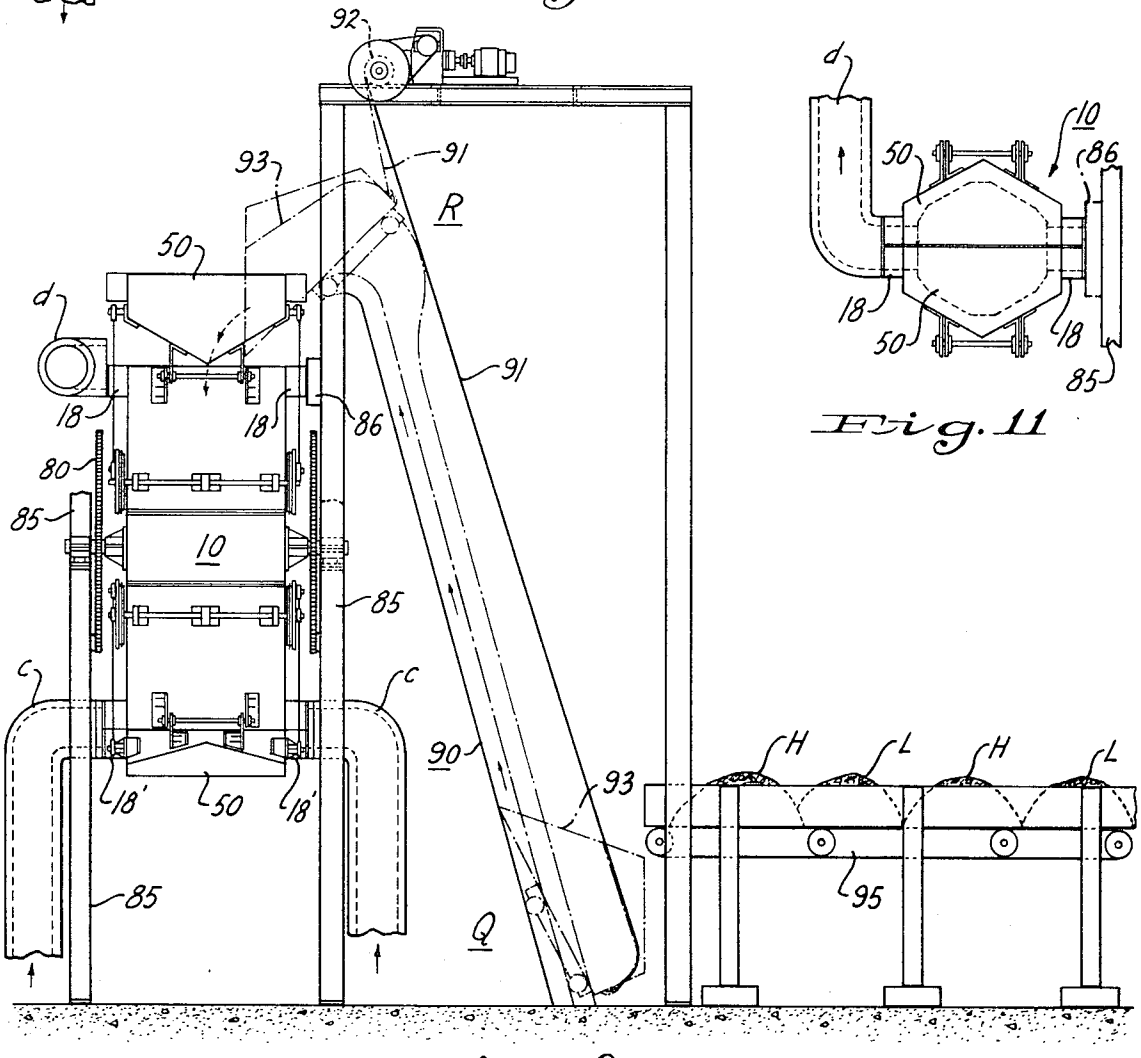


Fig. 9

Fig. 11

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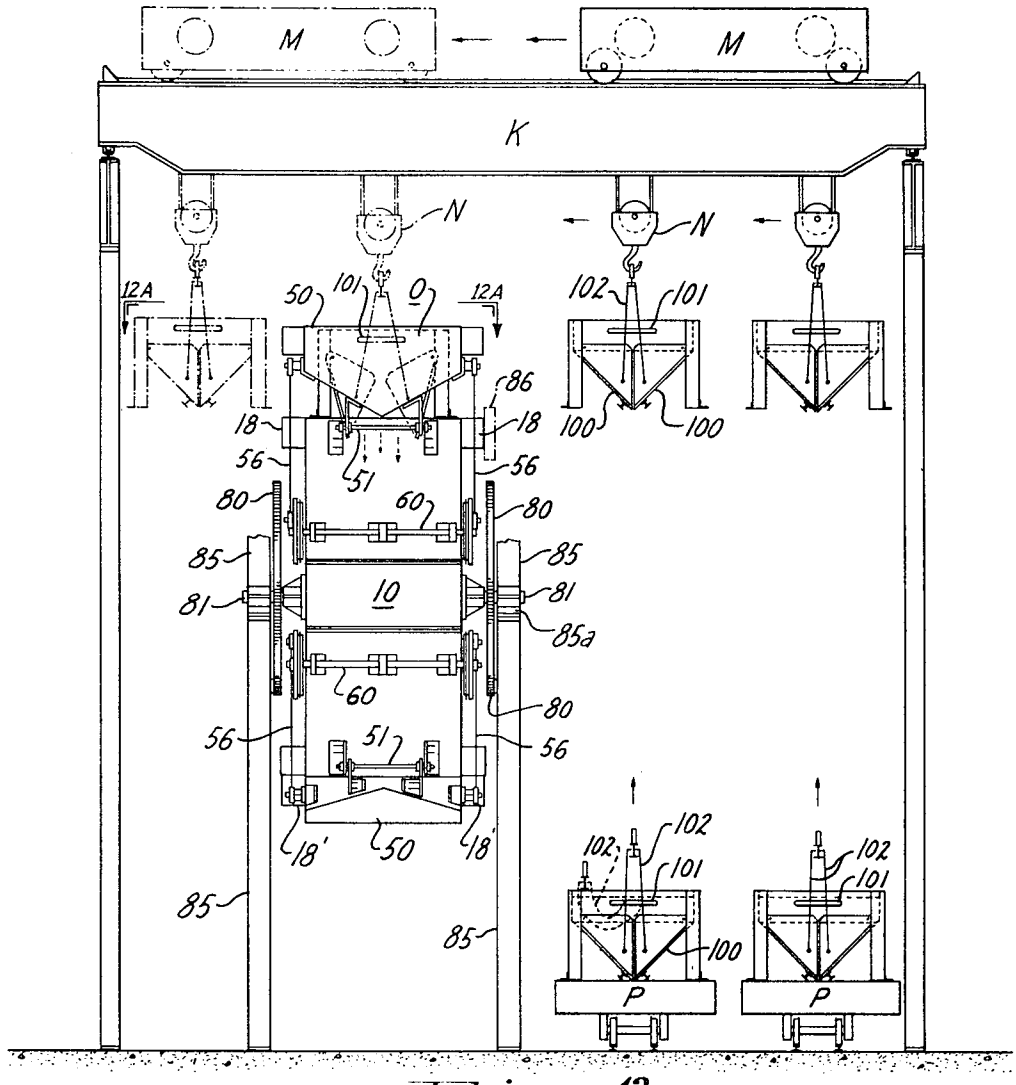


Fig. 12

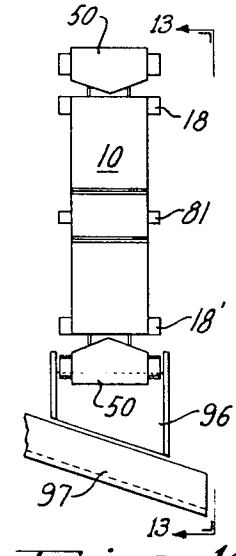


Fig. 14

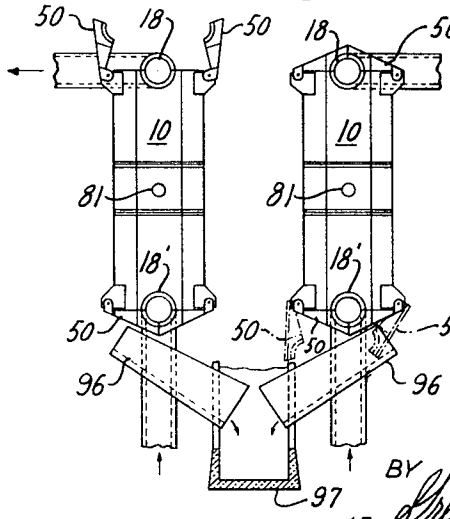


Fig. 13

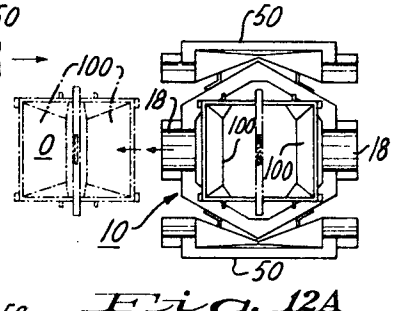


Fig. 12A

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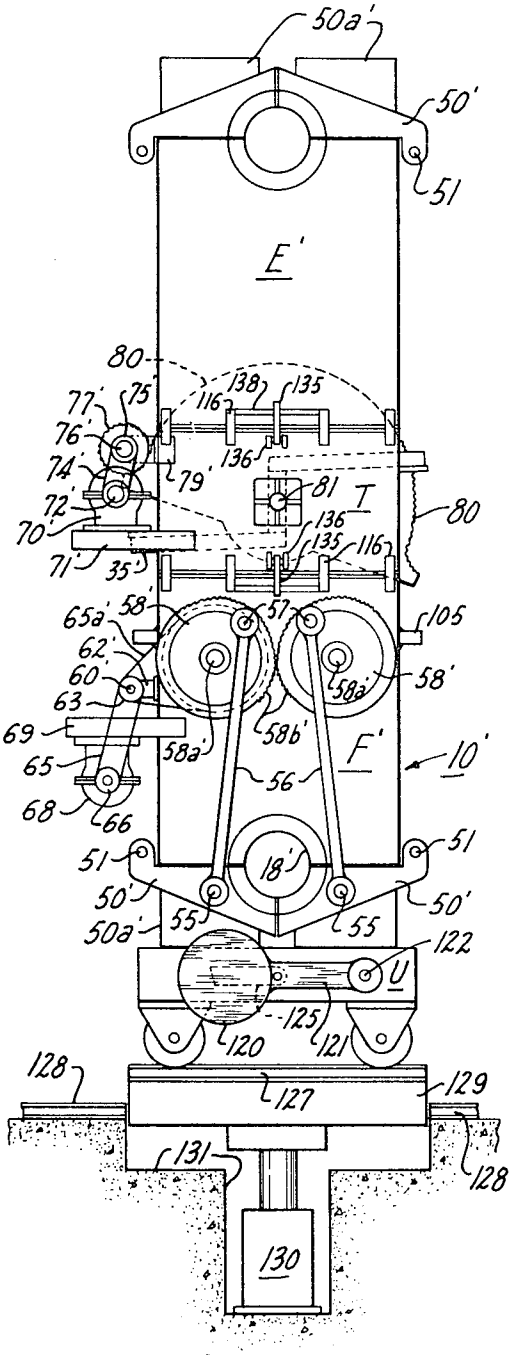


Fig. 15

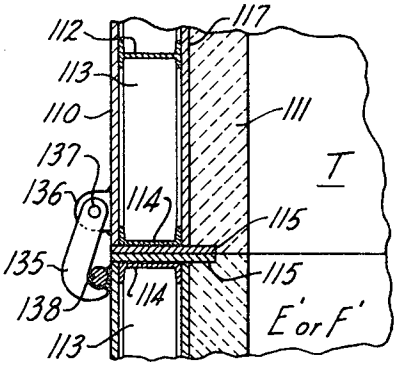


Fig. 21

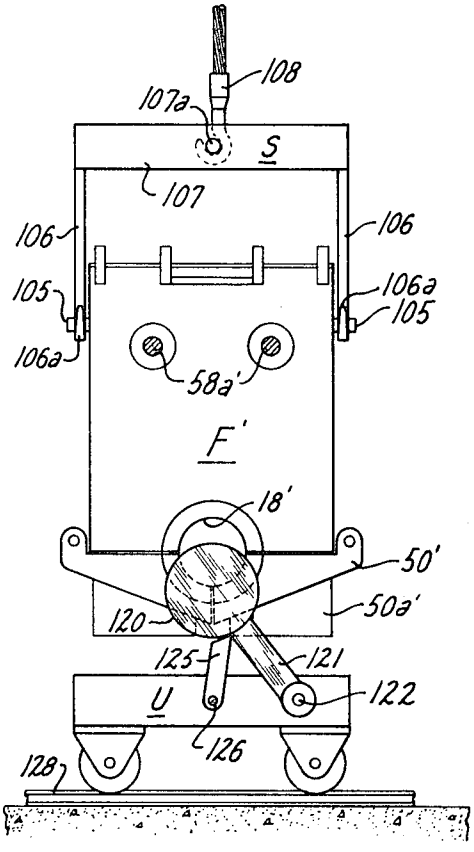


Fig. 16

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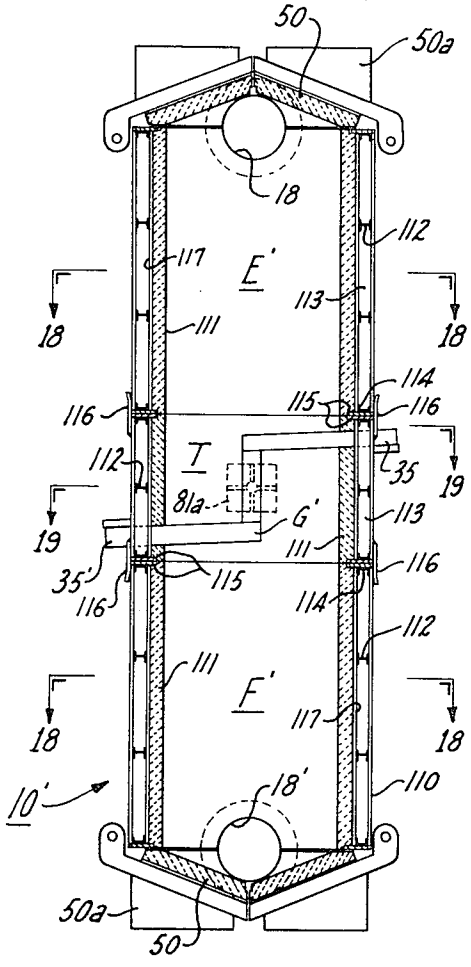


Fig. 17

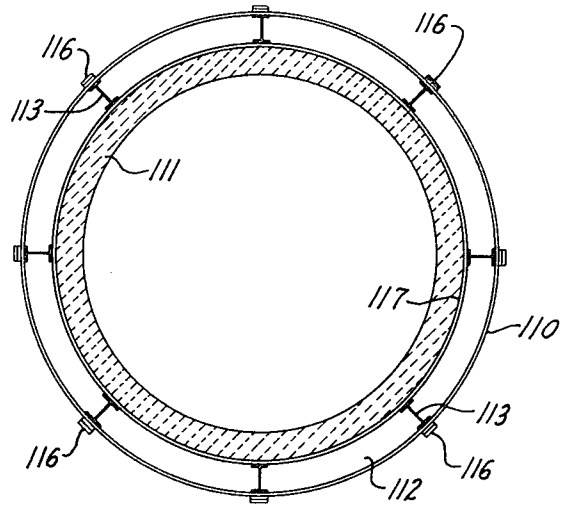


Fig. 18

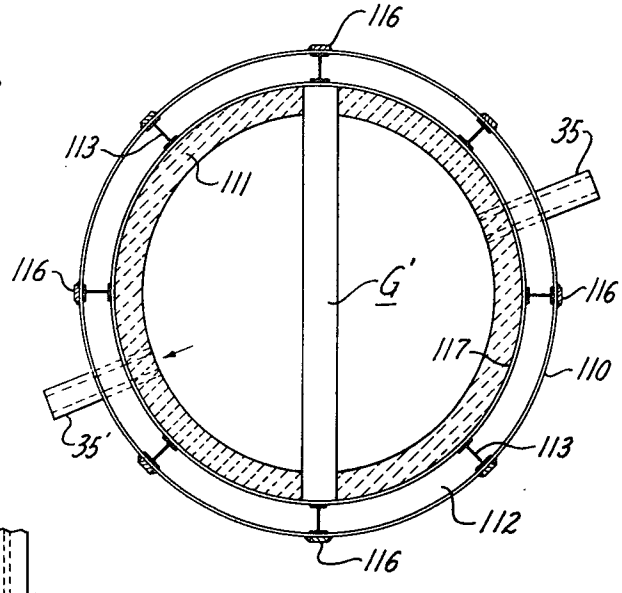


Fig. 19

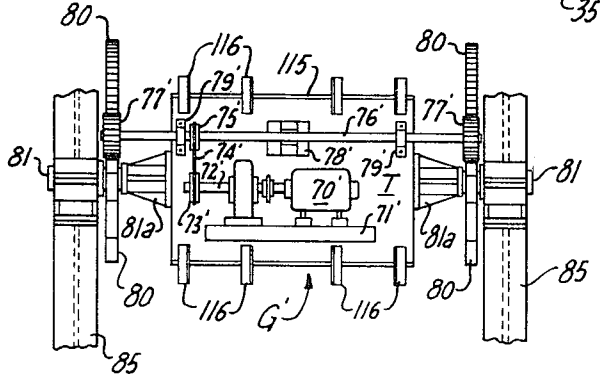


Fig. 20

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PROCESSING AND PREHEATING SCRAP METAL FOR FURNACE UTILIZATION

This invention deals with an improved approach to the utilization, conditioning and handling of charging material such as scrap metal or steel scrap in connection with refining and processing of molten metal. A phase of the invention deals with an improved preheating silo and its utilization.

It will be apparent that the invention may be employed in a variety of systems and for various metals. However, it is particularly applicable to ferrous metal or steel refining processes employing a conventional electric or converter type of vessel. It enable an increase in efficiency or quantity of utilization of scrap charging material such as so-called steel scrap.

It has thus been an object of the invention to devise improved procedure and apparatus for facilitating the utilization of scrap charges and particularly, in the melting and refining of ferrous metals and alloys.

Another object of the invention has been to more economically and efficiently utilize scrap materials for furnace charging.

Another object of the invention has been to progressively utilize hot furnace gases in preheating charge materials such as scrap metal, in such a manner that the scrap metal will be preheated in two stages within segregated zones or chambers.

A further object of the invention has been to devise procedure for preheating scrap material which involves the utilization of opposite end portions of a preheating vessel or silo alternately as charge-receiving and charge-delivering portions.

A further object of the invention has been to simultaneously preheat segregated portions of charge material by the application of a continuous flow of hot furnace gases therethrough and in such a manner as to bring a preheated portion of the charge up to a furnace charging heat and to preliminary heat a relatively cold portion thereof.

A still further object of the invention has been to layer scrap material of different weights or densities for charging it into a treating vessel.

These and other objects of the invention will appear to those skilled in the art from the illustrated embodiments and the description which follows.

In the drawings,

FIG. 1 is a side view in elevation taken along the line 1—1 of FIG. 2 illustrating a preheating container, vessel or silo for furnace charging material in the nature of metal scrap.

FIG. 2 is a side view in elevation on the scale of FIG. 1, taken at right angles with respect thereto and showing the left side of the apparatus.

FIG. 3 is a horizontal section on the scale of and taken along the line 3—3 of FIG. 1.

FIG. 4 is a horizontal bottom end view on the scale of and taken along the line 4—4 of FIG. 2.

FIG. 5 is an enlarged horizontal section of the silo of FIGS. 1 to 4, inclusive, on the scale of and taken along the line 5—5 of FIG. 7 to particularly illustrate partition means between upper and lower chambers, zones or compartments of the silo apparatus or vessel.

FIG. 6 is a vertical sectional view in elevation showing details of steel framing on the scale of and taken along the line 6—6 of FIG. 7.

FIG. 7 is also a vertical section showing details of the partition construction on the scale of and taken along the line 7—7 of FIG. 5.

FIG. 8 is a somewhat diagrammatic side view in elevation illustrating typical steps in the utilization of the preheating silo.

FIG. 9 is a somewhat schematic reduced side view in elevation illustrating means for charging the silo apparatus illustrated in FIGS. 1 to 4, inclusive.

FIG. 10 is a fragmental top plan view on the scale of and of the apparatus illustrated in FIG. 9.

FIG. 11 is a fragmental top view on the scale of FIGS. 9 and 10 and particularly illustrating the silo of such figures with its upper doors in a closed relation and as connected at its upper end to exhaust duct means.

FIG. 12 is a somewhat schematic side view on the scale of FIG. 9, illustrating representative modified means for charging the preheating vessel or silo.

FIG. 12A is a top plan view of a portion of the apparatus of FIG. 12 on the same scale of such figure and taken along the line 12A—12A thereof; this view shows an extreme left-hand positioned scrap box in dot and dash lines with its bottom swing doors in a completely closed position and a second (right-hand positioned) scrap box in full lines positioned within the upper portion of a preheating silo having its upper doors swung to an open position, and with the doors of the thus positioned scrap box also being in the open, charge-delivering position illustrated in FIG. 12.

FIG. 13 is a greatly reduced view in elevation taken along the line 13—13 of FIG. 14, illustrating how preheated scrap may be alternatively discharged from a bottom compartment, zone or chamber portion of a pair of containers or silos into a conveyor such as a continuous conveyor for thereafter being transported to a furnace or to a scrap charging bucket; in this figure, the left-hand silo is shown having its bottom doors in a closed position and its upper doors in an open position for receiving a charge of cold metal material into its upper compartment; the right-hand silo is shown in full lines with its upper and lower pairs of doors in a closed position such as is normal when hot combustion gas is being circulated therethrough to preheat the charge material therein; the dot and dash lines of the right-hand silo, however, show the open position of the lower pair of doors for discharging a fully preheated charge from the lower compartment or zone into a conveyor chute.

FIG. 14 is a side view in elevation on the scale of and taken at right angles with respect to FIG. 13.

FIG. 15 is a side view in elevation on the scale of and similar to FIG. 1 but showing a modified form of preheating container vessel or silo for furnace charging material.

FIG. 16 is a partial side view in elevation of a lower compartment part or unit of the apparatus of FIG. 15 showing it removed from an intermediate or central partition part; it is being raised from a transfer car for charging into a furnace.

FIG. 17 is a sectional view in side elevation on the scale of and taken in the same direction as FIG. 15.

FIGS. 18 and 19 are enlarged horizontal sections taken respectively along the lines 18—18 and 19—19 of FIG. 17.

FIG. 20 is a fragmental side view in elevation on the scale of and taken at right angles to FIG. 15, particularly illustrating driving mechanism for rotating a central, base, primary or baffle compartment part or unit of the silo construction to which removable upper and lower parts or units are connected in a vertically aligned relation during a scrap preheating operation.

And FIG. 21 is a greatly enlarged fragmental vertical section showing details of means for removably securing or latching top and bottom compartment parts or units with respect to a central or intermediate part or unit.

With particular reference to FIG. 8 of the drawings, a preheating silo, vessel or container apparatus 10 is provided with two segregated or physically separated chambers E and F which, during a preheating cycle illustrated by step A of this figure, may be termed upper and lower chamber portions, zones or compartments. Hot combustion gas as supplied from a melting and refining furnace, is tempered or further preheated as may be found to be desirable. An auxiliary furnace and gas mixing system is illustrated in FIG. 1 of the drawings of my U.S. Pat. No. 3,479,438. The hot gas is introduced through a pair of bottom input ducts *c* into the silo apparatus 10 and passed, as indicated by the arrows of step A, upwardly along the bottom chamber F (or E) and through the preliminarily preheated scrap material therein to finally preheat it, through passageways in a centrally located partition G (see FIG. 7), into the upper chamber E (or F) and upwardly therealong and through the cold scrap material therein to preliminarily preheat it.

The separation between chambers E and F as accomplished by the use of a somewhat dual-angle shape or offset type of partition G has been found to provide an effective flow of hot

gases and, at the same time, to enable an improved type of operation. In the earlier procedure of U.S. Pat. No. 3,479,438, a full length or uninterrupted, single preheating silo chamber was utilized. After a preheating operation has been accomplished using apparatus of the patent, the silo is tilted substantially horizontally to enable a taking-off of a hotter preheated bottom portion of the scrap column as a furnace charge and the introduction of cold scrap at the other end to supplement or take the place of the hot scrap that has been removed. This operation requires the weighing of the hot scrap after its preheating, and care has to be taken to avoid removing all or part of the upper portion of the scrap column which is too cold for furnace charging and which, in effect, has only received a preliminary preheat.

In accordance with the present invention, the loss of heat by after-weighing the scrap material is eliminated, and the amount or weight of scrap supplied at each silo utilization is fully and inherently accurate. That is, the weighing of the scrap may be effected while it is cold and before it is charged into the silo **10**, since preliminary preheated scrap that is to be further heated to a final charging temperature has its own compartment within which the cold scrap is introduced and is given a so-called preliminary preheat. Utilizing the present method and apparatus it is not necessary to move the scrap from one end of the silo **10** towards another end which is also advantageous in minimizing wear and tear on the container.

In the present operation, as particularly illustrated by steps B, C, and D of FIG. **8**, the lower end or chamber portion of the silo **10** during the application of hot furnace gas thereto always constitutes the final preheating chamber or zone, and the upper or chamber portion thereof always constitutes the preheating zone or chamber for recently introduced cold charge or scrap material. However, the chamber portions E and F of the silo apparatus **10** are alternately employed as final and as preliminary preheating chambers. For example, after the lower chamber portion F shown in step B has discharged its hot scrap charge to a conveyor, then the silo **10** is rotated a full 180°, as illustrated by step C, whereby the now empty lower chamber portion F now becomes the upper chamber portion and the former upper chamber portion E containing the preliminarily preheated scrap now becomes the lower chamber portion. At this time, a new charge of cold scrap may be introduced into the empty upper chamber portion F of the silo, as illustrated by step D. Upper swing doors **50** may be then closed and the silo **10** is now ready for a second scrap charge heating operation, but with its chambers E and F in a reversed relationship.

It will be apparent from the operations illustrated in FIG. **8** that the silo apparatus **10** is in a vertically elongated position, both when finally preheated hot scrap is being discharged and when a cold or new scrap charge is being introduced. The partition G particularly illustrated in FIGS. **5**, **6**, and **7**, not only enables the above described type of operation, but also as will be hereinafter pointed out, enables an early separating-out or removal of lower melting point metals, such as lead and tin, and a later separating-out of intermediate melting point metals, such as aluminum and copper, any of which would normally be considered as contaminates in a steel mill melt.

Referring to FIGS. **1** to **4**, inclusive, of the drawings preheating vessel, container or silo **10** is shown having a longitudinal axis that normally, during its preheating utilization and during the charging and the discharging of the material being processed, lies on a vertical axis or plane. The silo **10** is illustrated as having a hexagonal section, see particularly FIGS. **3**, **4**, and **5**. The main sidewalls of the silo **10** are made up of outer planar wall plate or panel members **12**, reinforcing I-beam members **11** that extend horizontally about the outer panel members **12** between corner pieces **14**, vertical or longitudinally extending reinforcing I-beam members **25**, and corner or end connector pieces, strips or plates **14**, all of which may be welded together to form a strong unitary structure. The beams **11** may have any suitable spaced relation to provide a properly reinforced structure and to facilitate the mounting of motors, etc., on the container or silo **10**. To protect wall plate or panel members **12** against heat and wear and tear from the standpoint of the charges that are introduced and removed from the inside of the silo or container **10**, insulating primary or main and secondary or corner pad assemblies *a* and *b* are positioned along the inside area. Each pad is retained in position by a metal facing, cover or lining plate member **15** or **16** and by cooperating end channels **17** which are welded to associated facing plates **15** of assemblies *a* and form end enclosures therefor.

Main pad assemblies *a* cooperate with the corner pad assemblies *b* to define a complete lining about the inside area of the silo **10**. It will be noted that the corner assemblies *b* do not have end channels but have end groove portions with which the channels **17** of adjacent main pads *a* interlock. The corner pad assemblies *b* centrally rest upon the corner strips or plates **14** that provide central back supports therefor. The main assemblies *a* are shown positioned centrally of each planar panel **12** of the wall of the silo **10**.

Transversely spaced-apart and vertically extending I-beams **25** are secured to extend vertically upwardly along the outer plate or panel members **12** of the main wall of the vessel **10** (see FIG. **5**). Each beam **25** cooperates with an aligned inner I-beam member **26** to define a pair. Each member **26** extends along the width of a central portion of an associated pad *a*. It will be noted, as shown in FIGS. **3** and **5**, that adjacent flanges of each group of I-beam members **25** and **26** are welded respectively to inner and outer sides of an associated outer plate wall member **12**. Also, the outer I-beam members **25** of each group may be welded or secured to the horizontal members **11**, and the inner flange of the I-beam **26** of each group is welded or secured to the inner side of an associated face plate member **15** of an associated main pad assembly *a*.

Referring particularly to FIGS **5**, **6**, and **7**, partition G of dual angle, Z or zigzag shape has an inclined floor half or part **30** provided with a dual-layer, solid, top or flow plate member assembly **31** (when the container **10** is in the position of step A of FIG. **8**) that extends for about one-half the transverse extent or dimension of the silo apparatus **10** within its hollow longitudinal area. At its outer edges, the top plate assembly **31** may be weld-secured to the liner plate members **15** and **16** and at its innermost edge to rest upon a cross-extending I-beam **33**. A solid, underspaced metal plate member assembly or means **32** is, at its inner edge, shown secured to an outer edge of the lower flange of the beam **33** and along its outer edges to the lining plate members **15** and **16** in the same manner as the upper solid plate member assembly **31**. The spacing between the assemblies **31** and **32** is vented to the ambient atmosphere through a short length pipe **34**. A short length pipe **35** is aligned with the surface of the plate assembly **32** to serve as an outflow port or vent for molten material collected on the assembly **32** of lower melting point materials, such as lead and tin (when the container is in the position of step D of FIG. **8**). The port or vent **35** is used when the assembly **30** is moved to the lower position shown for the assembly **30'** in FIG. **7**.

A second, inclined floor half or part **30'** extends across the other half of the silo compartment area and is of the same general construction as the fully described half **30**. Thus, the parts of the second half **30'** have been given the same reference numerals with prime affixes. A vertical partition part **40** spaces the two floor halves or parts **30** and **30'** and rigidly connects them together at their inner ends. The part **40** has a central reinforcing frame **41** (see FIG. **6**) and a pair of spaced-apart wall plates **42** and **43** (see FIG. **7**) that are secured to the frame **41** and have open portions, holes or perforations therethrough to define through-flow passages for the upper flow of hot gas from the lower chamber portion of the silo **10**. The normal flow is from the lower or final preheating chamber into the upper or preliminary preheating chamber, see also step A of FIG. **8**.

With reference to FIG. **7** and to FIG. **8**, when the container or silo **10** is in the position represented by A, the exit pipe **35'** serves to remove molten metal that flows inwardly along and

downwardly from the then upper floor assembly or half **30** upon and outwardly along the then lower floor assembly or half **30'**. It will be noted that the assemblies or halves **30** and **30'** slope to one side of the silo **10** and this is true irrespective of whether the silo **10** is in the position represented by A of FIG. **8** or in the reverse position represented by D. However, assuming that the silo **10** is in the position represented by A of FIG. **8** and thus, that softer or lower melting point materials are being removed through the outlet pipe **35'**, then when the position of the silo **10** is reversed to the position of D, the outlet pipe **35** serves as the outflow means. There will be little if any tendency for the molten metal or other low melting point material to flow from the chamber or zone which happens to be the upper one into the chamber or zone which happens to be the lower one within the silo **10** during its operative utilization.

With particular reference to FIGS. **1** to **4**, inclusive, the chambers E and F of the silo **10** are of identical construction and are provided with identical types of ports and door constructions. Also, each door construction is operated in the same manner. Thus, the description applies equally to the chambers E and F of FIG. **1**. The silo **10** has open ends, each of which is closed by a pair of cooperating swinging doors **50**. Each door **50** at its inner end is secured on a cross-extending pivot mounting shaft **51** by a pair of mounting wings **52** (see FIG. **2**). Each shaft **51** is rotatably journaled or mounted at its opposite ends within a pair of stands or mounting brackets **53** that are secured to the outer wall **12** of the silo. As shown particularly in FIGS. **1** and **2**, the inner portion of each door **50** of the cooperating end pairs is inclined towards the center of the silo **10** which, of course, is a downward, central inclination from the standpoint of the particular chamber, such as F which, at the time, is the bottom chamber.

A small central drain opening, vent or port **54** extends through the pair of doors **50** at the lowest point of convergence to serve as an outflow port for intermediate melting point metals such, for example, as aluminum and possible some copper. Since lead has a melting point of about 622° F. and tin a melting point of about 450° F., these two metals may be normally removed from one of the upper vents **35** or **35'**. On the other hand, such slightly higher melting point metals as aluminum, about 1,220° F., and copper, about 1,980° F., may be removed through the bottom one of the ports **54**. During normal operation where steel scrap is being processed, the gas entry temperature at a pair of then bottom inlet ports **18'** (or **18**) of the silo **10** will be about 2,300° F., the temperature at the vents or passageways of the partition G will be about 1,300° F., and the temperature of the cooled gases leaving the then top exhaust ports **18** (or **18'**) will be about 300° F. It is preferred, as previously intimated, to provide an auxiliary combustion chamber to establish and hold an entry hot combustion gas temperature of about 2,300° F.

Again referring to FIGS. **1** to **4**, inclusive, each door **50** of the upper and lower end pairs of the silo **10** is opened and closed by means of an opposite, side-positioned pair of connecting rods or arms **56**. Each arm **56**, as shown particularly in FIGS. **1** and **2**, is pivotally connected at one end on a stud pin **55** of a fixed mounting bracket **55***a* that is secured to project from an adjacent side of the associated door **50**. At its other end, each rod or operating arm **55** is pivotally connected by a pin **57** to an associated crank wheel **58**. A pair of crank wheels **58** is shown on each side of the silo **10** with one wheel of the pair being connected to operate one of the doors **50** and the other wheel being connected to operate the other cooperating door **50** of the particular side involved. Each crank wheel **58** is rotatably mounted on an associated stud shaft **58***a* that projects from the side of the silo **10** and has a chain sprocket portion that is driven by a chain **65***a* (see FIG. **1**) and a sprocket **63***a* that is secured on an adjacent end of a cross-entending motor-driven drive shaft **60**. Each side-positioned shaft **60** is rotatably journaled within an intermediate bearing stand **61** and a pair of end-positioned stands **62** on the outside wall of the silo **10** and is driven through the agency of a centrally positioned chain sprocket **63** (see also FIG. **2**), a chain **65** and a sprocket **66** that is mounted on the shaft of a speed reduction unit **67**. A reversing electric motor **68** that is mounted on a platform **69** secured to the silo **10** drives speed reduction unit **67** that is also mounted on the platform **69**. It will thus be apparent that in this embodiment, each door **50** is operated by the same motor **68** and a pair of arm members **56** that extend along opposite sides of the silo **10**. Each door **50** of each door pair thus is actuated by its own individual motor **68** or **68'**.

The construction and mounting of the motors **68** and the drive of each of the doors **50** is the same, except that one door is driven by a motor **68'**, see FIG. **1**, that has a vertically offset relation with respect to the opposite motor **68**, in order to provide operating clearance for a motor drive **70**, etc., used for rotating the silo **10**.

A heavy duty reversible electric motor **70** is mounted on a shelf **71** that is secured on the wall **12** of the silo **10** for driving the silo in its rotative movement, illustrated by step C of FIG. **8**. As illustrated particularly in FIGS. **1** and **2**, the motor **70** has a drive shaft **72** whose chain sprocket **73** drives a chain **74** and through a second sprocket **75** mounted on a cross-extending shaft **76**. As shown in FIG. **2**, the shaft **76** is journaled on a central stand **78** and a pair of end stands **79** that are mounted on the outer wall **11** of the silo. A pair of pinions **77** are secured on the shaft **76** adjacent its opposite ends to engage or mesh with an associated radial rack member or arm **80**. A pair of oppositely positioned rack members **80** are provided and each rack rotatively receives a pin or stud shaft **81** within its hub portion **80***a*. Each pin shaft **81** is carried by a mounting bracket **81***a* that is secured to a central portion of the silo **10** to project radially outwardly therefrom. Each rack **80** is rigidly and nonrotatably secured to one upright member of stationary frame structure **85** by a lock spacer and pin **83**. The frame **85** may be securedly floor-mounted to serve as a mount for the silo **10**. It is thus apparent that when the motor **70** is actuated, the silo **10** will rotate or turn on the central axis defined by the pin shafts **81**, as effected by actuation of the pair of pinions **77** about and in an intermeshing relation with the associated pair of fixed-positioned racks **80**.

In FIGS. **9** and **10**, means is shown for loading cold scrap material into an upper end of a preheating container or silo apparatus **10**. This means includes a skip hoist **90** that is operated by a cable **91** and a motor-driven drum or sheave **92** for, at its lower end, receiving scrap material and, at its upper end, delivering the material into the silo **10** when the upper pair of doors **50** are in an open position. Hoist bucket **93** is adapted to first receive a heavier weight portion H of scrap material and then a lighter weight portion L when it is in its lower, scrap receiving position Q. It thus when in its upper position R delivers the scrap material into the upper chamber portion of the silo **10** in the reverse order of first the lighter weight material L and then the heavier weight material H. The portions H and L are preferably weighed before being introduced into the upper portion of the silo **10**, since they are delivered as finally preheated material from the same chamber portion fully therefrom to thus assure an accurate desired amount of furnace charging material.

The skip hoist **90** may be fed with a charge of scrap material through the agency of a loading belt **95** on which alternate piles H and L of scrap material are deposited by scrap buckets or other suitable means. In this connection, one pile of heavier or more dense scrap material H and an adjacent and following pile of lighter or less dense scrap material L may represent about 25 tons or a sufficient amount for charging one-half of the silo **10**, assuming that it has a 50 ton capacity. The second set of piles H and L may be retained for feeding to another silo or if the silo in position has a 100 ton capacity it may also be fed into its upper chamber as cold material for preliminary preheating therein. The lower or first charged lighter scrap portion or layer L rests on the partition G and serves as a cushion for the subsequent introduction of the heavier scrap material H. This layering also facilitates the upward movement and heating action of the hot gas within the silo **10**.

In FIGS. 9 and 10, the pair of upper doors 50 are in an open position for receiving scrap material, as indicated by the arrows of FIG. 9. FIG. 11 is illustrative of the outflow of cooled gas into exhaust or stack duct *d* from the left-hand upper port 18 (or 18') when, for example, the upper doors 50 are closed and hot combustion gases are being passed into, through and out of the silo 10, see step A of FIG. 8. The right-hand port 18 (or 18') is closed or sealed off by a closure plate 86 that is secured to and extends from one leg of the stationary supporting frame structure 85.

Referring to FIGS. 12, 12A, 13 and 14, a system employing a traveling overhead crane K provided with hoist cars M and hoists N is shown. Individual hoists N are adapted to lift filled scrap buckets O from wheeled trucks or cars P at a lower floor level upwardly, and then to move them to an overhead-aligned position with respect to a silo 10. Each scrap bucket O has a pair of double-tiered, swingably mounted drop doors 100 that are held closed when the buckets are positioned on an associated car or truck P (see FIG. 12) by engagement of the lower edges or lips of the doors with the truck floor, and upon being lifted by a hoist N, by the upward pull exerted by a pair of cables 102. One end of each cable 102 is shown attached to an associated door 100. A tie ring 101 through which the cables 102 extend keeps them from tangling when an overhead pull of the hoist N is released. However, when a bucket O is positioned to rest, for example, on sides of a container or silo 10 and the lifting force of its hoist N is released, then as indicated by the arrows within the mouth of the silo 10 of FIG. 12, the doors 100 fall or pivot downwardly to an open scrap delivering position.

FIG. 12A shows a box O with its bottom drop doors 100 in an open position by full lines and in a closed position by dot and dash lines. FIGS. 13 and 14 illustrate the operative cooperation that may be accomplished with respect to a pair of silos 10 where one (right-hand) silo, as shown by the dot and dash lines, has its bottom doors 50 open to deliver a premeasured weight of fully preheated or conditioned hot scrap material to a downwardly inclined chute 96 and then upon a continuous conveyor 97 for movement directly into or to an adjacent relation with respect to the mouth of a furnace that is to be charged. At this time, the upper pair of doors 50 may be closed to retain heat within the container or silo 10 during the described discharging of the hot scrap material from its lowermost chamber. As illustrated in FIG. 13, where a pair of silos 10 are used, one (left-hand) silo may be loaded from its top end with cold weighed scrap, while the other (right-hand) silo 10 is being employed to preheat scrap material with its top and bottom doors 50 in a closed position, as represented by the full lines. The open dotted line position of the lower doors 50 of the right-hand silo 10 of FIG. 13 shows fully preheated scrap being discharged from a lower compartment upon the inclined chute 96 for discharging on the conveyor 97. It is ideal when operating silos 10 in pairs to unload and load one while the other is being employed to preheat metal scrap. A pair or a group of silos 10 may thus be utilized to provide a continuous supply of hot or preheated charging scrap material for a line of furnaces.

FIGS. 15 to 20, inclusive, illustrate that principles of the invention may be applied to a silo that has its metal shell wall 114 protected on its inner side by a lining of refractory furnace brick or tile 111. This is particularly advantageous when higher temperatures are involved in the preheating operation. To facilitate use of such a refractory lining, as particularly illustrated in FIGS. 18 and 19, a silo or container unit 10' is shown of cylindrical shape or circular section. Aside from the circular shape and the specific construction of the wall members, the silo 10' may otherwise be of the same in construction and utilization as the silo 10 that has been previously described. That is, it will have a central or intermediate supporting base part or unit T and a pair of upper and lower, aligned, compartment-defining scrap preheating compartment parts or units E' and F'. Central, intermediate or supporting compartment part T has a partition G' and attendant molten metal drains 35 and 35' of the same general construction as the partition G and the attendant drains 35 and 35' shown in FIG. 6 of the earlier described embodiment.

Again referring to FIGS. 18 and 19, as well as to FIG. 17, compartment or chamber defining parts or units E', F' and T all have a similar wall construction. In this connection, outer banding steel 110 provides a shell wall that is mounted or secured, as by weld metal, on a skeleton framework made up of horizontally positioned, circumferentially extending, vertically spaced-apart, annular I-beam members 112 and of vertically extending, circumferentially spaced-apart I-beam members 113. An inner steel platelike shell wall 117 is supported by and secured to the structural members 112 and 113 in an inwardly spaced relation with respect to the outer shell wall 110. Conventional furnace brick or tile members may then, as shown, be formed and mounted in any conventional manner as a lining 111 along the inner reaches of the shell wall 117.

The refractory lining construction 111 may be used in a single container unit construction, such as illustrated in the embodiment of FIGS. 1 and 2 or, as illustrated in the embodiment of FIGS. 15 to 21, may be used in a three or separable part construction. The units E', F' are separable with respect to central, intermediate, primary, base or supporting part or unit T which serves as a partitioning unit to carry partition G'. Referring particularly to FIGS. 17 and 21, the ends of the compartment parts or units E', F' and T are shown provided with planar sealing or seating plate members 115 of annular shape. Each member 115 is carried in a secured relation on an associated, horizontally peripherally extending channel member 114 that provides an end closure for an associated structural assembly 112, 113. The central unit T is shown provided with annular, upright, steel aligning, guide tabs or members 116; each guide member 116 has one end portion secured, as by weld metal, to outer sidewall 110 thereof. The other end portion of each guide member 116 is adapted to slidably abut against adjacent portions of outer sidewall 110 of an upper or lower part E' or F' to align the parts E' and F' with respect to the central part T and hold them in a vertically supported, endwise-sealed and mounted relation with respect to the unit T when the assembly 10' is being used for a preheating operation.

The units E' and F' are identical in their construction and removable mounting and are detachably held in an aligned, connected and sealed cooperating relation by circumferentially spaced-apart clamps or clamping fingers 135 (see FIGS. 15 and 21). An annular rod 138 that is weld-secured to the shell wall 110 of each part E' and F' (or to the frame structure 112, 113 if no outer shell wall is used) serves as a catch or latch for the clamps 135. Each clamp 135 is shown pivotally mounted by means of a pivot pin 137 on a post or bracket 136 that is secured on the shell wall 110 of the central part T. A suitable number of the clamps 135 are mounted in a circumferentially spaced relation about the silo 10' and are employed for removably securing upper compartment part E' as well as lower part F' in position with respect to the central part T.

Since in the construction of FIGS. 15 and 17, the silo 10' is constructed in the form of three parts that are removable with respect to each other, it is necessary to mount drive motor 70' on the part T for rotating the silo assembly 10' about the pair of vertical support columns 85, see FIG. 20. The overall construction of the drive mechanism for rotating the silo 10' on columns 85 is generally the same as that shown and described in the earlier embodiment and similar parts have thus been given prime affixes. In a similar manner to the previously described embodiment, reversible electric motor 70' is adapted to actuate a gear reduction unit and its shaft 72'. A sprocket 73' on the shaft 72' cooperates with a chain 74' to actuate a sprocket 75' on a cross-extending drive shaft 76' that is journaled in bearing stands 78' and 79' and that carries a drive pinion 77' on each of its extending end portions. Each pinion 77' meshes with an associated rack member 80 that has a rigid, stationary-mounted relation with the supporting frame structure 85.

The operation of the construction shown in FIGS. 15 and 17 may be the same as previously described in connection with the embodiment of FIGS. 1 and 2, but it enables a better utilization of end compartment units or parts E' and F', since they may be removed from the base or central part T. The doors 50' of the units or parts E' and F' are provided with boxlike extension portions 50a' that enable the units to evenly rest on the flat bed of a transfer car U. Lower part F' may, after its group or set of clamps 135 is released, be lowered out of position with respect to the central unit T on transfer car U that, at this time, is positioned on an auxiliary track 127 and is carried on a platform 129 for movement from upper vertical position of FIG. 15 to a lowered position. In the lower position, the transfer car U is in alignment with an may be moved from the track 127 along a plant trackway 128 (see FIG. 16.) The platform 129 is shown carried by a reciprocating hydraulic lift motor 130 for vertical movement into and out of a floor pit 131.

Fully preheated scrap contained in the bottom unit F' (or E') may be moved on the car U along the plant floor to a position adjacent a furnace that is to be charged and then lifted by means of a bail 107 (see FIG. 16) to an overhead position with respect to the furnace at which its doors 50' may be opened for charging scrap into the furnace. Thereafter, the part or unit F' may be returned to its car U and moved to a scrapyard for recharging it through its then open upper end. Finally, the part F' may be returned to a vertically aligned position with respect to the base part T and raised by the table 129 into a cooperating endwise-aligned, connected relation with the lower end of the part or unit T. It may again be securely clamped and sealed in its connected relation by its group of clamps 135. At this time, the silo unit 10' with the upper part E' still in position, may be rotated by motor 70' so as to bring the unit F' and its cold scrap to the top position of FIG. 15 and the unit E' and its partially preheated scrap to a lower position at which the partially preheated scrap will be fully preheated upon a subsequent application of hot furnace gases.

FIGS. 15 and 16 show the transfer car U provided with means for closing-off the gas inlet ports 18' of an associated lower unit or compartment, such as F'. That is, immediately after the flow of hot furnace gases has been discontinued as to its application to the inlet ports 18', a closing off of the ports 18' may be effected by means of a pair of wiping, swing closure gates or discs 120, each of which is carried on a swing arm 121 that is pivotally connected to a side of the cart at 122. Each arm 121 and its associated closure disc 120 may be retained in a closed relation by a swinging dog 125 that is also pivoted on a side of the car at 126. Raising and lowering movement of the platform 129 and the car U carried thereby as shown in FIG. 15 is, as previously indicated, accomplished by means of fluid motor 130.

The construction of FIGS. 15 and 16 has been further simplified by utilizing a single reversible drive motor 68 instead of two for each pair of doors 50' of the silo 10 ' to operate both pairs of doors 50' at the outer ends of the parts E' and F'. Since the drive is the same for both parts E' and F', details are illustrated from the standpoint of the part F'. The single motor drive is accomplished by moving the crank wheels 58' of the adjacent side-positioned pairs for each part E' and F' into a closer relation with each other and providing them with meshing gear teeth 58b'. The right hand crank wheel 58' of FIG. 15 no longer needs a chain sprocket. Thus, an actuation of cross-extending drive shaft 60' (left side of FIG. 15) and the chain 65a' which actuates the crank wheel 58' on its stub shaft 58a', will be the same time, through the intermeshing relationship of the teeth 58b', actuate the other crank wheel 58' (right hand) on its stub shaft 58a'.

As shown in FIGS. 15 and 16, each compartment part E' and F' may be provided with a pair of trunnions 105 that may removably carry bail provided with a cross connecting member 107 and a pair of legs 106 having hook ends 106a. The cross member 107 has a pin 107a for receiving the hook of an overhead hoist 108 that may be conventionally carried by a plant crane (not shown). If desired, the motor-operated opening and closing means for the doors 50 or 50' of the compartment parts may be eliminated and the doors opened and closed by any conventional type of means or operation and, in this connection, may be manually unlatched by a side-positioned release or may be unlatched by an overhead hoist and closed and latched by the hoist.

Although it is preferable to provide the inner shell wall of the container or silo 10 (or 10') with a protective refractory lining along its full extent where higher temperatures are to be encountered, it is not essential to so protect the intermediate area or part of the container 10 (or 10'). That is, the temperature of the hot gas will be substantially reduced after passing through the bottom compartment or part and on reaching the intermediate or partition carrying area or part. Since the upper and lower parts are used in sequence as bottom parts, both should be capable of withstanding the higher temperatures.

I claim:

1. In a scrap metal preheater, a longitudinally extending container having an elongated chamber therethrough open at opposite end portions thereof, said container being adapted to be positioned in a vertically extending relation during its operation, a support structure rotatably positioning said container for movement between one operating vertical position and a second operating vertical position of 180° with respect to the first position, swinging door means operatively positioned at opposite ends of said container for closing and opening the open end portions thereof, port means at opposite ends of said container for introducing hot gases to the lower end portion thereof and for exhausting cooled gases from the upper end portion thereof, a cross-extending partition dividing the chamber of said container into two parts, said container being adapted to preliminarily and then finally preheat scrap metal in one part while finally and then preliminarily preheating scrap metal in the other part, the upper chamber part for each preheating operation constituting a scrap receiving preliminarily preheating chamber and the lower chamber part constituting a final preheating chamber for the scrap, said partition having means for segregating the two chamber parts and maintaining scrap in each part in a separated relation with respect to scrap in the other part, and said partition having flow passageways therethrough for bypassing hot gases moving upwardly through scrap in the lower chamber part into the upper chamber part and through scrap material therein.

2. In a scrap preheater as defined in claim 1, said port means at opposite ends of said container being defined between an adjacent end portion of said container and said swinging door means that is operatively positioned thereat, whereby a side of said port means will be opened when said door means is swung to an open position with respect to the adjacent open end portion of said container.

3. In a scrap metal preheater as defined in claim 1, a lower hot gas delivery duct means and an upper cooled gas receiving exhaust duct means, each said port means being adapted to be moved into sliding aligned engagement with an associated duct means when said container is rotated between its defined vertical operating positions, whereby the upper port means will have a connected relation with said upper exhaust duct means and the lower said port means will have a connected relation with said lower hot gas delivery duct means.

4. In a scrap metal preheater as defined in claim 3, each of said port means being provided half by an associated end portion of said container and half by said door means when said door means is in a closed relation, and each said door means having a pair of complementary portions which when in a closed relation with respect to each other define the door half of the associated port means.

5. In a scrap metal preheater as defined in claim 1, said partition having means for collecting material melted in the upper chamber part and directing it outwardly through a side of said container.

6. In a scrap metal preheater as defined in claim 1, said door means having means for collecting material melted in the lower chamber part and venting it from said container.

7. In a scrap metal preheater as defined in claim 6, said partition being constructed to collect material melted within the upper chamber part and vent it from said container.

8. In a scrap preheater as defined in claim 1, said partition having an upper inclined partially cross-extending plate portion and a lower inclined partially cross-extending plate portion which together substantially define a transverse closure between said chamber parts, and a vertical wall connecting inner portions of said pair of inclined plate portions together and having passageways therein for bypassing hot gases from the lower chamber part upwardly into the upper chamber part.

9. In a scrap metal preheater as defined in claim 8, said lower plate member inclining downwardly from a substantially intermediate positioning within the elongated chamber towards an outer sidewall of said container, and an outlet pipe open to said plate member for receiving and venting molten material collected thereon, said upper plate member inclining inwardly downwardly within the elongated chamber of said container, and an outlet flow pipe open to an under side of said upper plate member for serving as a vent for molten material when said container is tilted 180° to its second vertical operating position.

10. In a scrap metal preheater as defined in claim 1, said door means at each end of said container having a pair of complementary doors pivotally mounted for central outward swinging movement with respect to said container, motor and arm means operatively positioned on said container and connected to each said pair for moving said doors simultaneously into a complementary inward closing position and into an outwardly diverging open position.

11. In a scrap metal preheater as defined in claim 1, each said door means declining from opposite sides of said container towards a central apex with respect thereto, and a port through said central apex for venting molten material from said lower chamber part outwardly therefrom.

12. In a scrap metal preheater as defined in claim 1, each said door means comprising a pair of doors pivotally mounted at their outer ends on said container for swinging movement between an outwardly diverging open position and an inwardly converging and complementary closing position, a pair of oppositely connected operating means for each of said doors, and motor means for actuating said operating means to swing each said door into and out of a closed position with respect to the other door of the same pair; said port means comprising a pair of oppositely extending ports at each end of said container, each said port means being half defined by an adjacent end portion of said container and half defined by the pair of swinging doors at such end portion, whereby said each port means will be sidewise-opened when an associated pair of doors is swung to an open position with respect to said container.

13. In a scrap metal preheater as defined in claim 1, said partition being of substantially Z shape as defined by a pair of solid metal plate members representing legs of the Z and a vertical portion representing a central connecting portion of the Z, and said vertical portion having open portions therethrough for passing hot gas from the lower chamber part into the upper chamber part.

14. In a preheater as defined in claim 1, said container having a metal shell wall and a protective refractory tile lining along an inner face of said metal shell wall.

15. In a preheater as defined in claim 1, said support structure being an upright frame structure on which said container is pivotally mounted, gear rack means carried by said frame structure adjacent said container, drive motor and gear means mounted on said container and having pinion means meshing with said rack means for actuating said container to rotate it with respect to and within said frame structure and with respect to said rack means.

16. In a metal scrap preheater as defined in claim 1, said support structure having an upright pair of spaced-apart frame members for said container, a pair of pivot shafts projecting centrally from said container and rotatably mounting it between said frame members, a pair of gear racks rotatably carried on said pivot pins and secured to said frame members, and actuating means mounted on said container and having pinions meshing with said gear racks for actuating said container to rotate it about said pair of pivot shafts.

17. In a metal scrap preheater as defined in claim 1, said container having an intermediate part within which said partition is positioned and which is provided with open end portions, said two parts having opposed open end portions adapted to be endwise-aligned with the open end portions of said intermediate part, and means for detachably securing each of said two parts in an endwise-aligned and sealed-off relation with respect to said intermediate part.

18. In a metal scrap preheater as defined in claim 16, at least each of said two parts having a metal shell wall provided with an inner refractory lining therealong.

19. In a scrap metal preheater as defined in claim 17, means for lowering said lower chamber part when detached from said intermediate part and then for moving said lower part into and out of furnace charging and scrap receiving positions.

20. In a scrap metal preheater as defined in claim 17, a wheeled car for receiving said lower chamber part, said swinging door means being at the lower end portion of said lower chamber part and having means for positioning said lower part on said car, and means for raising and lowering said car to effect a corresponding raising and lowering movement of said lower chamber part when detached from said intermediate part.

21. In a method of preheating metal scrap, providing a preheating container having upper and lower chambers connected by a separating partition, introducing cold scrap material into the upper chamber through its upper end to rest upon the partition, providing preliminarily preheated metal scrap in the lower chamber, passing hot furnace glass upwardly through the container and the scrap in the lower chamber through the partition and upwardly through the scrap in the lower chamber through the partition and upwardly through the scrap in the upper chamber, and preliminarily preheating the scrap in the upper chamber while finally preheating the scrap in the lower chamber, discharging the finally preheated scrap in the lower chamber through the bottom end of the container while retaining the preliminarily preheated scrap in the upper chamber, and rotating the container about 180° to position the former upper chamber at its preheated scrap content in a lower position and the former lower chamber in an upper position.

22. In a method as defined in claim 21, introducing cold scrap into the now upper chamber, and then passing hot gases up through the preliminarily heated scrap in the now lower chamber through the partition upwardly through the cold scrap in the now upper chamber.

23. In a method as defined in claim 21, introducing cold scrap into the lower chamber before rotating the container, and after the rotation has been accomplished, then passing hot gases upwardly through the container.

24. In a method as defined in claim 21, providing an accurate amount of fully preheated scrap by first weighing the cold scrap material before introducing it into the upper chamber, and always removing the full scrap material content of the fully preheated scrap from the lower chamber.

25. In a method as defined in claim 21, collecting lower melting point material at the bottom of the upper chamber and flowing it outwardly from a side of the container.

26. In a method as defined in claim 21, collecting higher melting point metal at the bottom end of the lower chamber and flowing it outwardly from a bottom end of the container.

27. In a method as defined in claim 26, collecting lower melting point material at the bottom end of the upper chamber and flowing it outwardly from the container.

28. In a method of preheating metal scrap material, providing a preheating container having a vertically elongated preheating chamber therein, introducing a first portion of scrap material of relatively lightweight into the chamber and then introducing a second portion of relatively heavier weight scrap material into the chamber and upon the first introduced portion, the second portion being cushioned by the first portion within the chamber, and then preheating the scrap material within the chamber by moving hot gases progressively upwardly through the heavier weight portion and then through the lightweight portion.

29. In a method as defined in claim 2 wherein the container has a cross-extending partition dividing it into upper and lower chamber portions, providing cold scrap material in the upper chamber portion to rest on the partition, providing preliminarily preheated scrap in the lower chamber portion below the partition; and moving the hot gas upwardly through the preliminarily preheated scrap in the lower chamber portion to finally preheat it, through the partition and then upwardly through the cold scrap in the upper chamber portion to preliminarily preheat it.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,632,094 Dated January 4, 1972

Inventor(s) Levi S. Longenecker

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 13, change "enable" to --enables--; line 35, change "preliminary" to --preliminarily--.

Column 3, line 20, change "preliminary" to --preliminarily--.

Column 5, line 38, change "possible" to --possibly--.

Column 9, line 14, change "an" to --and--; line 67, change "be" to --at--.

Column 10, line 39 (claim 1), change "preliminarily" to --preliminary--.

Column 12, line 39 (claim 21), change "glass" to --gases--; lines 42 and 43, omit the phrase "lower chamber through the partition and upwardly through the scrap in the".

Column 14, line 1 (claim 29), change the reference to claim "2" to --28--.

Signed and sealed this 23rd day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents