United States Patent

Kemmetmueller

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[45] **June 13, 1972**

[54] APPARATUS FOR PREHEATING SCRAP

[72] Inventor: **Roland Kemmetmueller**, Pittsburgh, Pa.

[73] Assignee: **American Waagner-Biro Company, Inc.**, Pittsburgh, Pa.

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[21] Appl. No.: **28,456**

[52] **U.S. Cl.** ..... **266/13**, 266/33 S, 266/39, 214/18 SC

[51] **Int. Cl.** **C21c 5/00**

[58] **Field of Search** ..... 13/33; 75/43; 214/18 SC; 266/13, 1 R, 33 S, 33 R, 39

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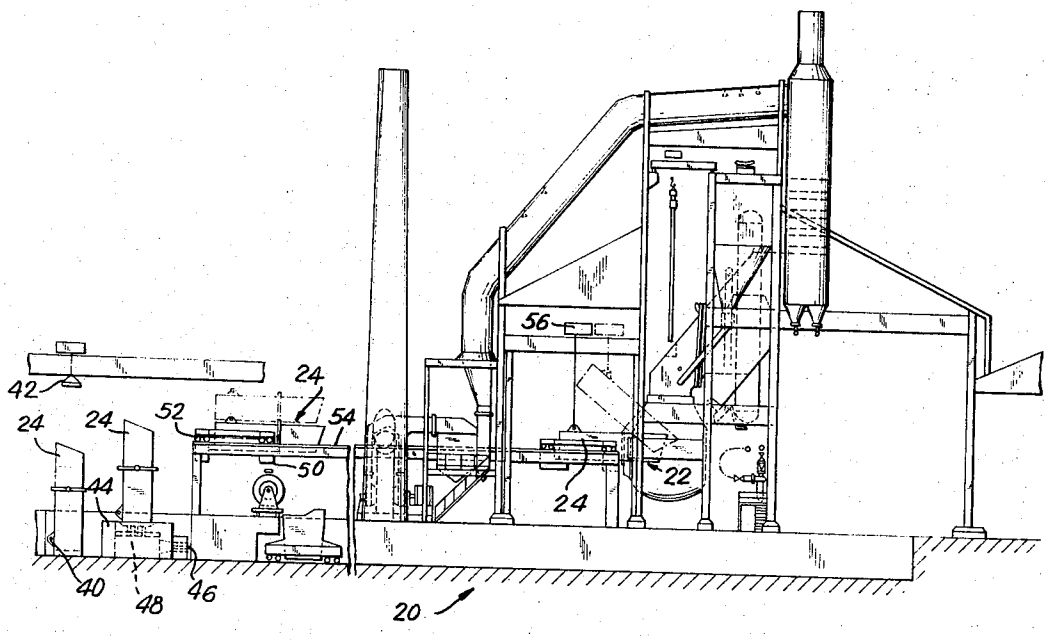
Primary Examiner—Gerald A. Dost
Attorney—Steinberg & Blake

[57] **ABSTRACT**

An apparatus for operating furnaces in metal-treating plants. The furnaces require a charge made up at least in part of scrap metal. The scrap metal is preheated prior to reaching the furnace, either by making use of special burners or by utilizing waste heat which is available in the plant. The scrap in a suitable container is preheated and then delivered in this condition to the furnace so that the extent to which heat must be supplied in the furnace itself is reduced.

9 Claims, 16 Drawing Figures



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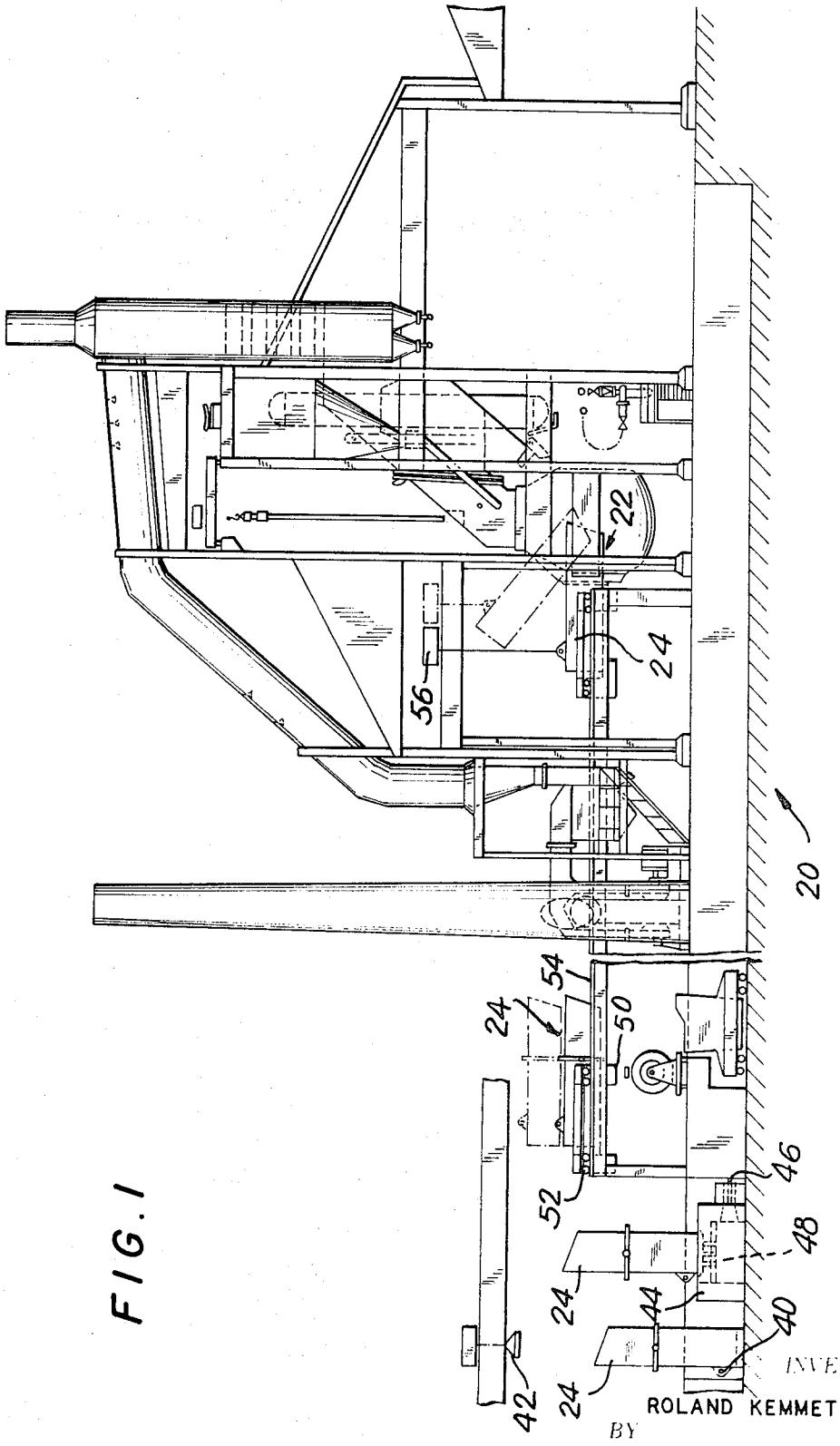

FIG. 1

INVENTOR.
ROLAND KEMMETMUELLER
BY
Steinberg and Blake
ATTORNEYS

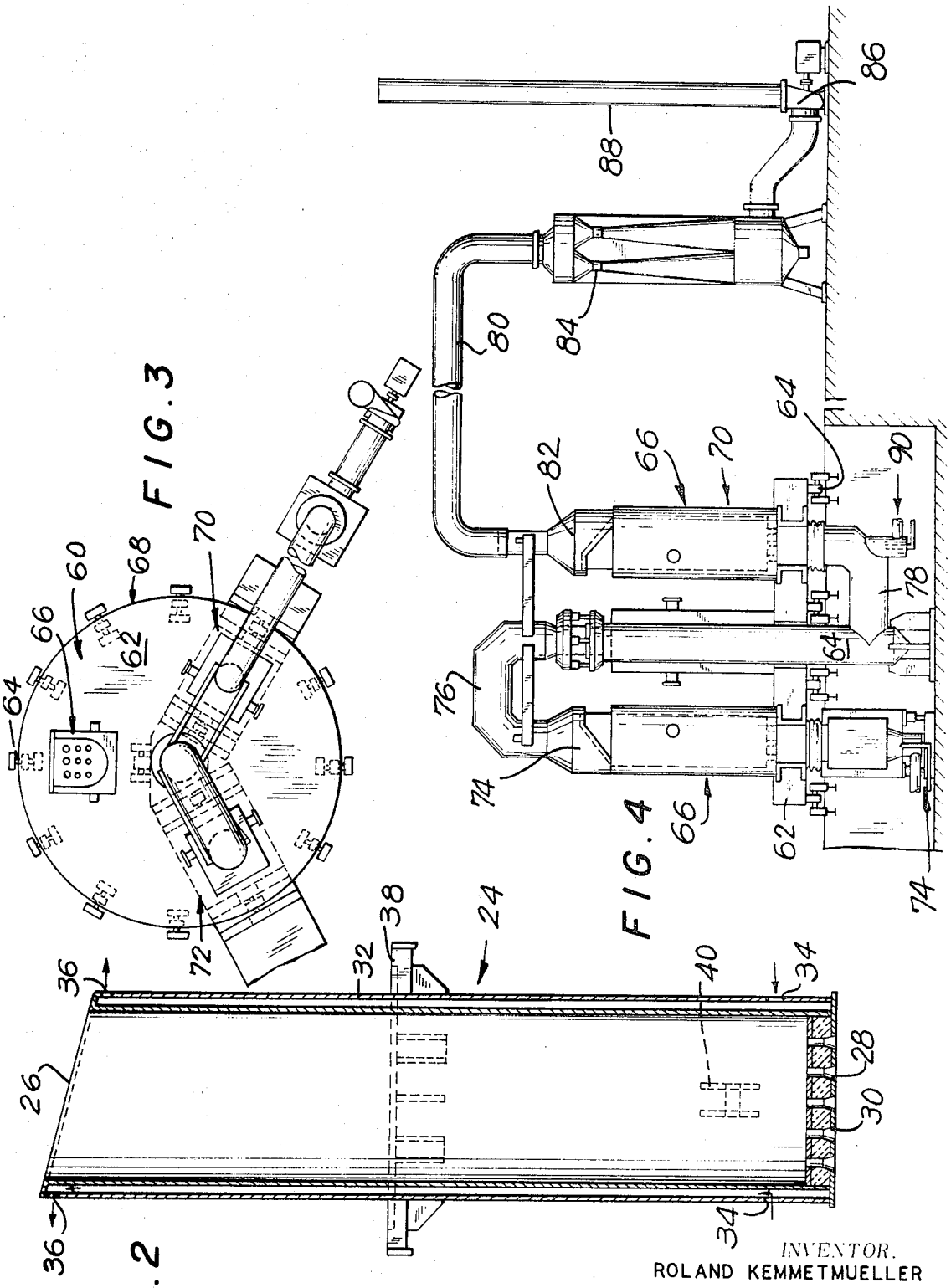

FIG. 3

FIG. 4

FIG. 2

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ROLAND KEMMETMUELLER

BY

Steinberg and Blake
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FIG. 5

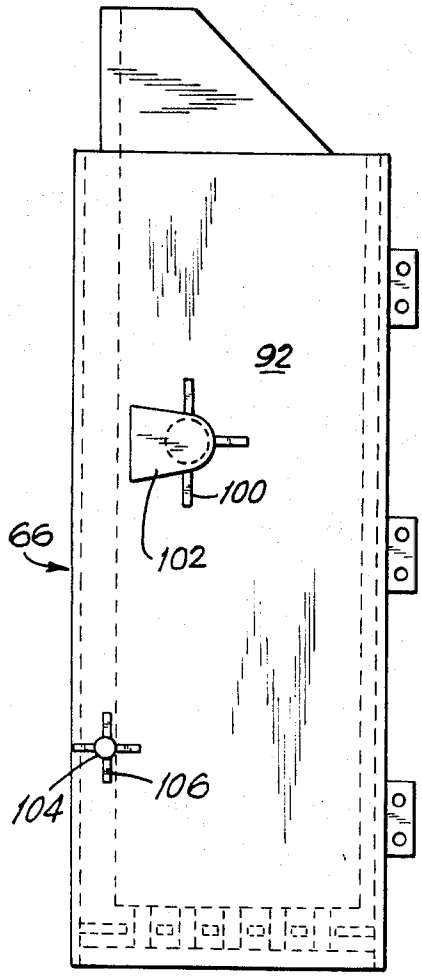


FIG. 7

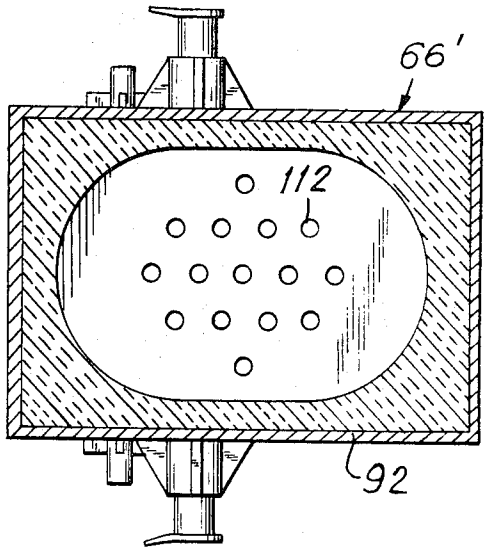


FIG. 6

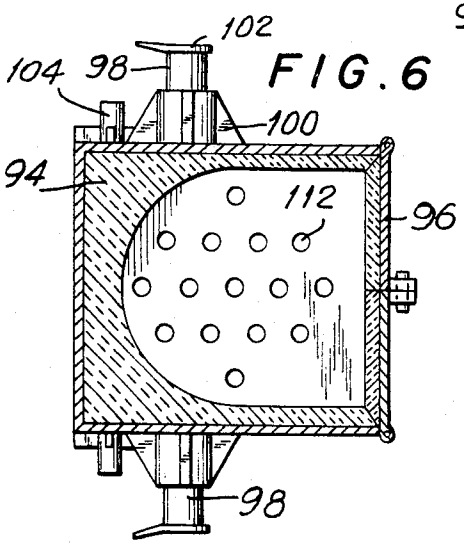
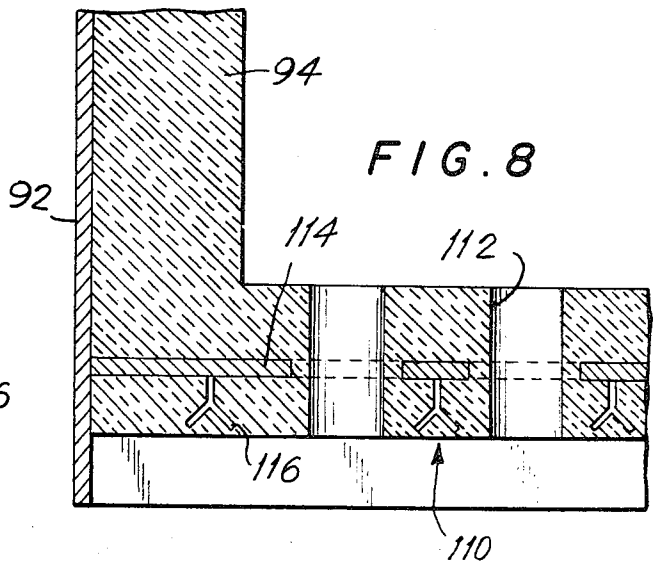


FIG. 8



INVENTOR.
ROLAND KEMMETMUELLER

BY

Steinberg and Blake
ATTORNEYS

FIG. 10

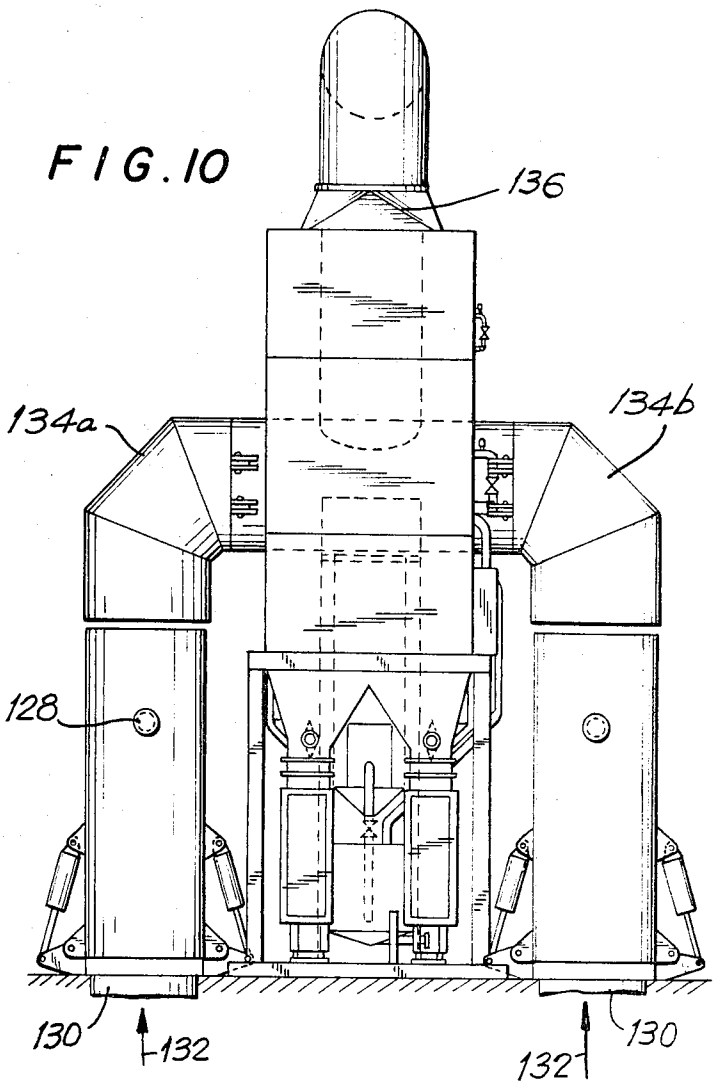
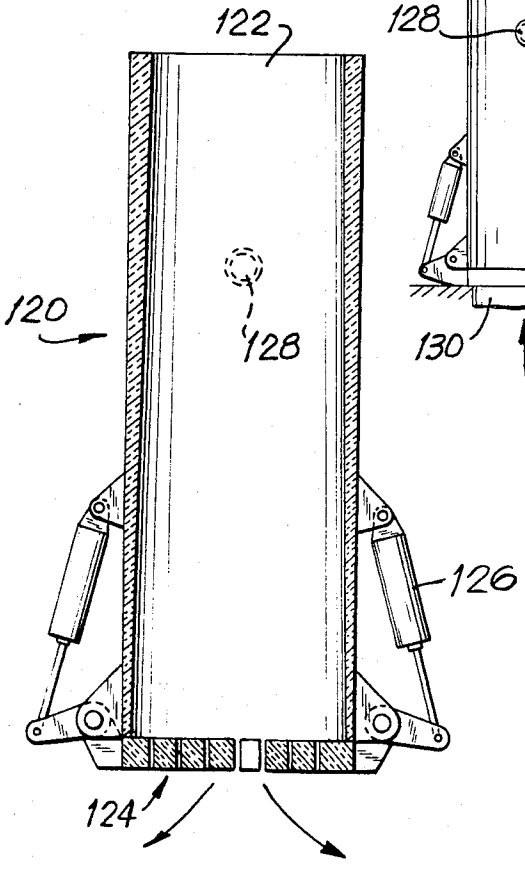


FIG. 9



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ROLAND KEMMETMUELLER

BY

Steinberg and Blake
ATTORNEYS

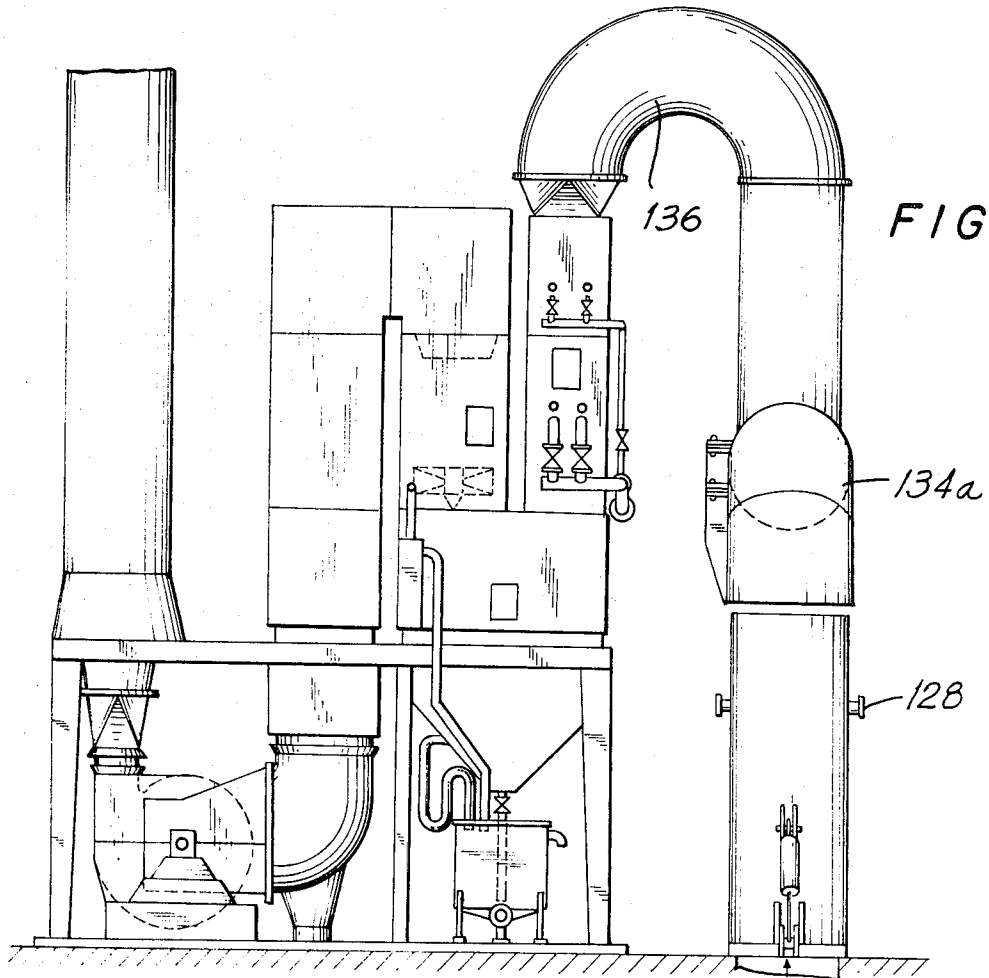

FIG. 11

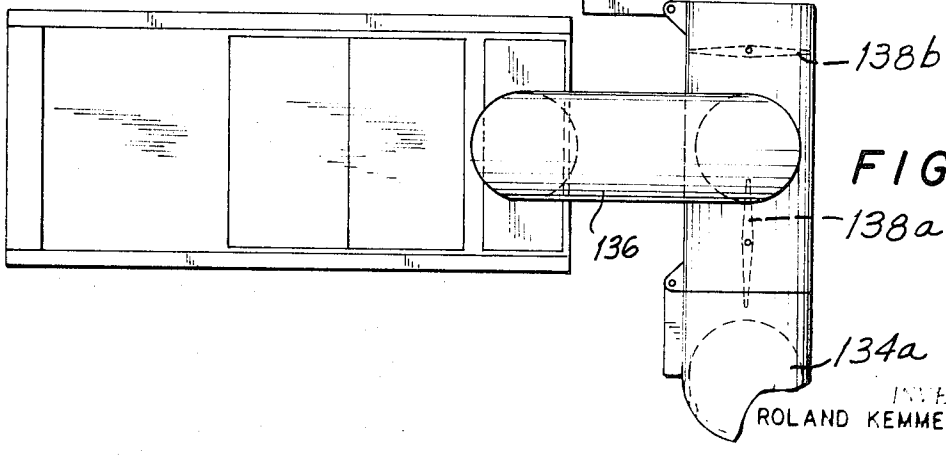

FIG. 12

INVENTOR.
ROLAND KEMMETMUELLER

BY
Steinberg and Blake
ATTORNEYS

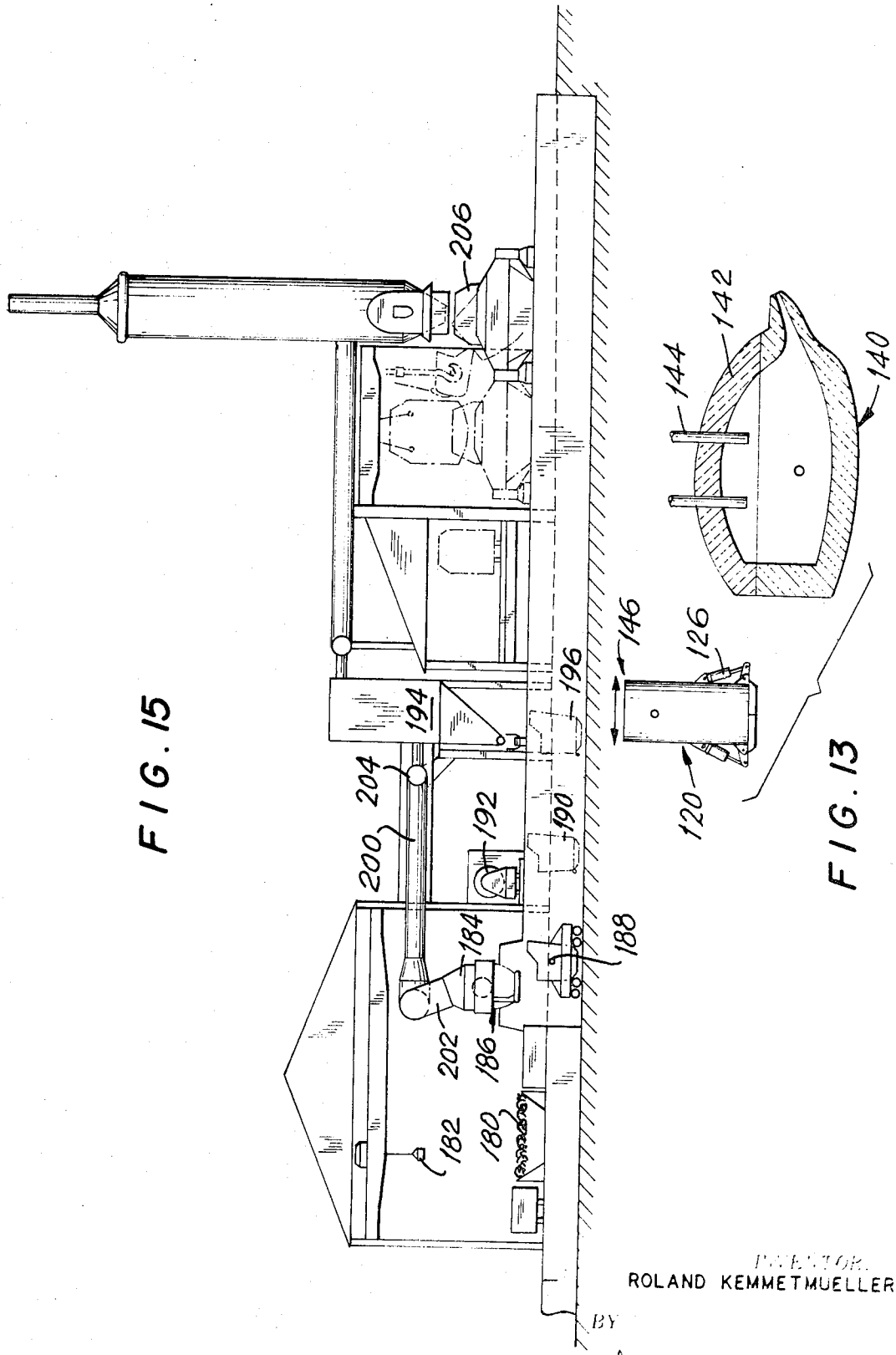

FIG. 15

FIG. 13

INVENTOR.
ROLAND KEMMETMUELLER

BY

Steinberg and Blake
ATTORNEYS

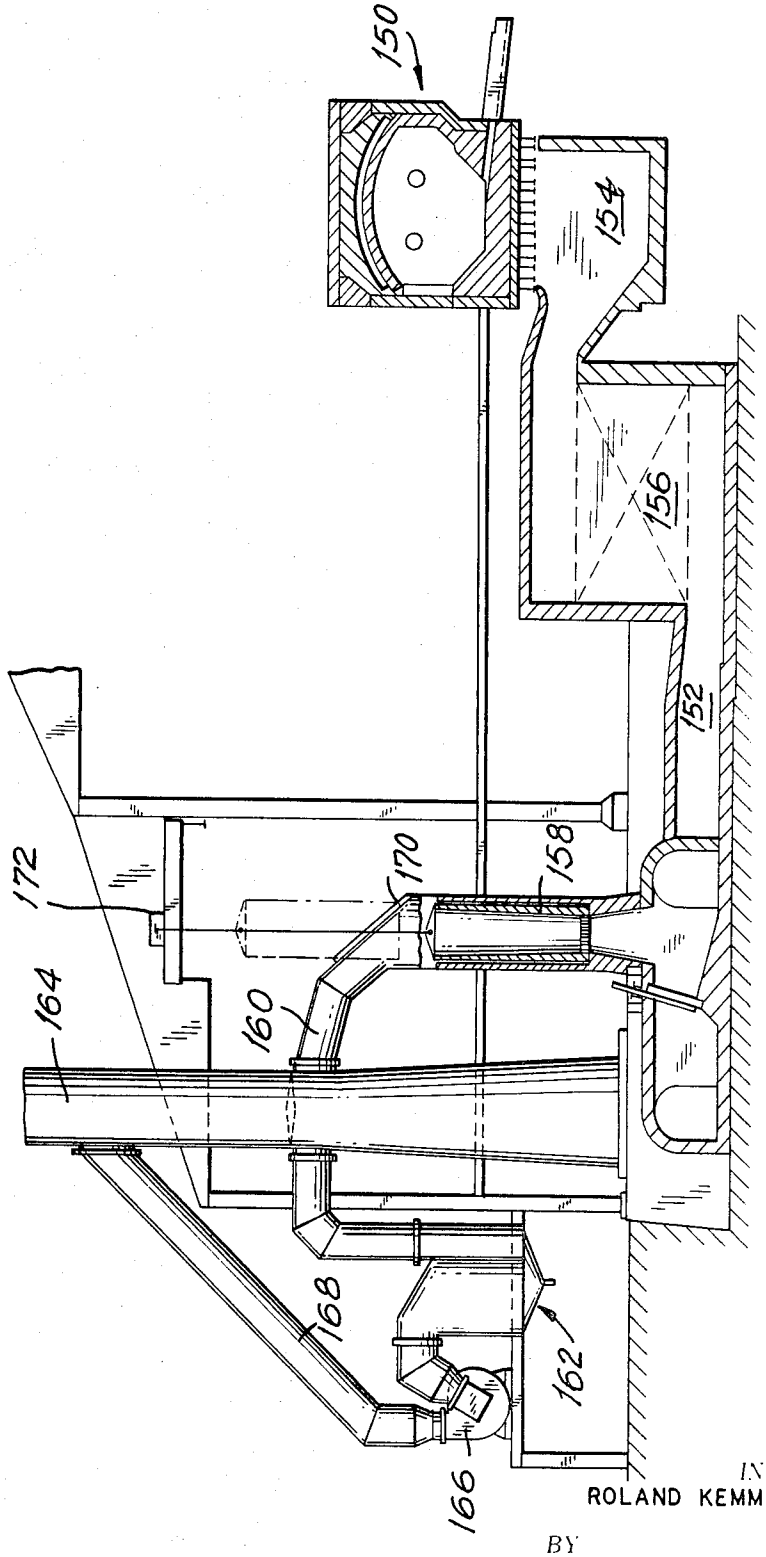

FIG. 14

INVENTOR.
ROLAND KEMMETMUELLER

BY

Steinberg and Blake
ATTORNEYS

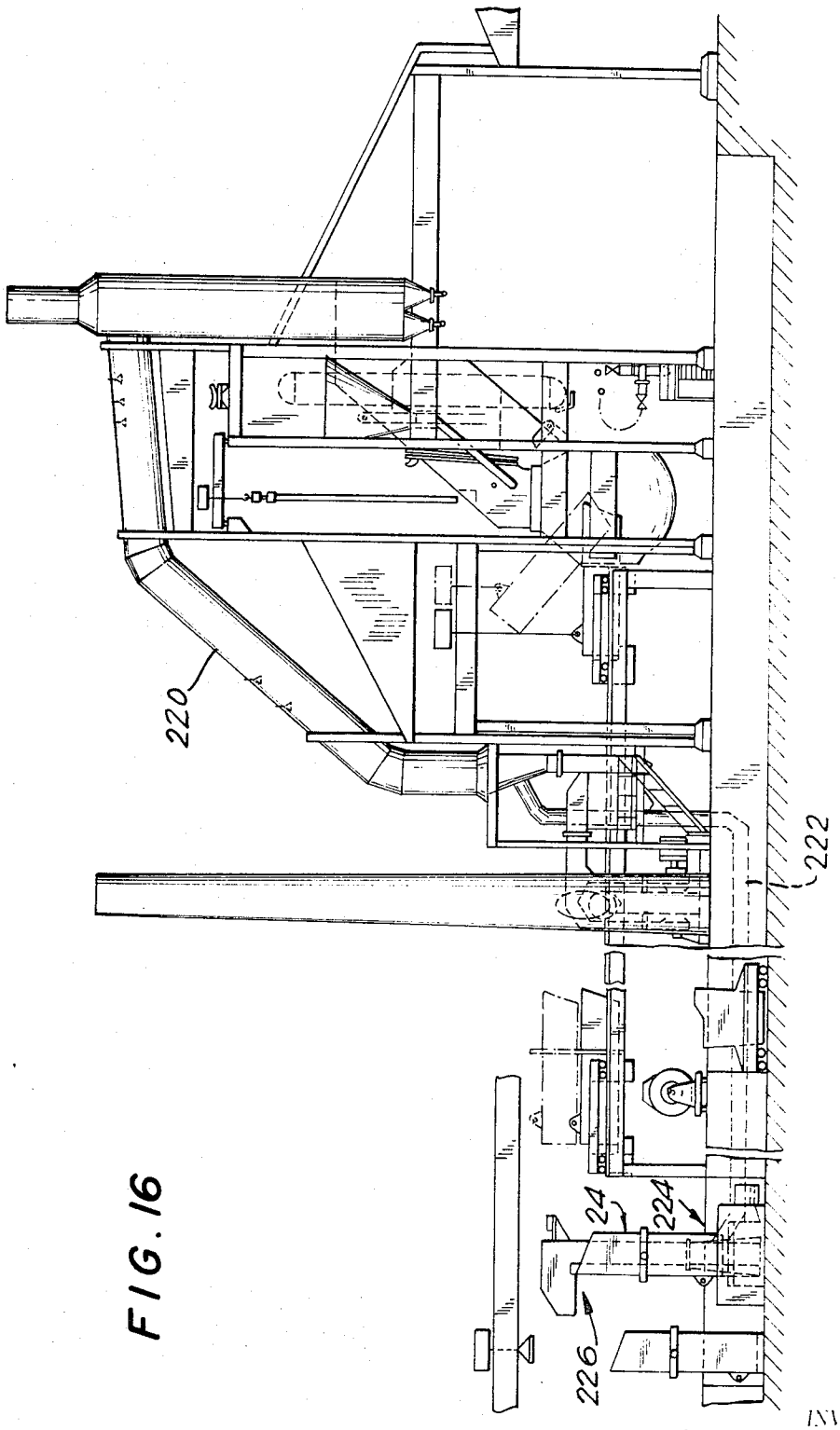

FIG. 16

INVENTOR.
ROLAND KEMMETMUELLER

BY
Steinberg and Blake
ATTORNEYS

APPARATUS FOR PREHEATING SCRAP

BACKGROUND OF THE INVENTION

The present invention relates to metal-treating.

In particular, the present invention relates to metal treating which involves the manufacture of steel, for example, from charges which are delivered to a furnace to be refined therein.

As is well-known, among the several available processes for refining metal, such as BOF furnaces, open-hearth furnaces, electric arc furnaces, and the like, it is essential to supply to the furnace a charge which will become molten therein to be treated so as to achieve a metal of desired properties. Part of the charge delivered to such furnaces conventionally includes scrap metal. Such scrap is conventionally taken from a scrap yard where the scrap is stored, and, with suitable scrap-charging apparatus, the scrap is conventionally delivered directly into the furnace to be treated therein with the remainder of the charge.

With this conventional procedure, the scrap, of course, is delivered cold to the furnace, so that a considerable amount of heat is used in converting the scrap itself into a molten condition. In the operation of a BOF furnace, for example, there are blow periods which alternate with off-blow periods, and the duration required for the blow periods is undesirably increased by the necessity of providing for the scrap the temperature which will place it in the required condition. Corresponding disadvantages are encountered in all other types of metal-treating plants and processes where a charge which includes scrap is delivered into a furnace to be treated therein. In all cases, irrespective of whether the treatment takes place in an open-hearth furnace, an electric arc furnace, or the like, there is a drawback in that an undesirably large amount of time and heat are used simply in placing the scrap in a proper molten condition.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the invention to provide an apparatus which will avoid these drawbacks.

In particular, it is an object of the present invention to provide an apparatus which make it possible to supply the scrap in a preheated condition to the furnace.

A further object of the present invention is to provide an apparatus according to which there will be on hand the required supply of preheated scrap in the amount and at the frequency required for proper furnace operation.

Also, it is an object of the invention to provide for this apparatus a scrap container which lends itself to the efficient preheating of the scrap as well as to the receiving of scrap and the discharging thereof in preheated condition.

Furthermore, it is an object of the invention to provide an apparatus which make it possible to use for the preheating of the scrap, sources of heat which are readily available and which might otherwise be used less efficiently.

Furthermore, it is an object of the invention to provide an apparatus according to which additional components of the charge, such as lime, are preheated prior to delivery to the furnace.

According to the invention, a container means is provided for containing scrap metal and for admitting heat thereto. At a preheating station a support means supports the container means, and a heating means at the preheating station supplies heat to the container means to be received by the scrap therein. A transporting means coacts with the container means for delivering the scrap in preheated condition to a furnace in which the metal is treated. Thus, according to the method of the invention, a charge which includes scrap is delivered to a furnace, and this scrap of the charge is preheated prior to delivery to the furnace.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic representation of the method and apparatus of the invention as used in a BOF plant;

FIG. 2 is a schematic section elevation of a container means used in the method and apparatus of FIG. 1;

FIG. 3 is a schematic top plan view of a scrap preheating station;

FIG. 4 is an elevation of the arrangement shown in FIG. 3;

FIG. 5 is an elevation of a scrap container means of the invention;

FIG. 6 is a transverse sectional plan view of the structure of FIG. 5;

FIG. 7 is a sectional plan view of another embodiment of a container means;

FIG. 8 is a fragmentary view on an enlarged scale showing in a sectional elevation further details of a scrap container at the region of the bottom wall thereof;

FIG. 9 is a schematic sectional elevation of another embodiment of a container means of the invention;

FIG. 10 illustrates the manner in which a pair of the container means of FIG. 9 can be used with a source of waste heat;

FIG. 11 is an end view of the arrangement of FIG. 10 as seen from the left of FIG. 10;

FIG. 12 is a top plan view of the arrangement of FIG. 11;

FIG. 13 schematically illustrates the manner in which the invention is used in connection with an electric arc furnace;

FIG. 14 schematically illustrates the manner in which the invention is used with an open-hearth furnace;

FIG. 15 is a schematic representation of another embodiment of the method and apparatus of the invention according to which lime as well as scrap are preheated; and

FIG. 16 shows an arrangement similar to FIG. 1 but using waste heat to preheat the scrap.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1; the plant 20 which is schematically illustrated therein is a BOF plant having the usual converters 22 which receive the charge. Part of this charge is, of course, scrap metal. In accordance with the invention, in order to deliver this charge to a converter 22, a suitable container means 24 is located at the scrap-charging station shown at the left part of FIG. 4. This container means has a top open end and a bottom wall formed with openings passing therethrough. Thus, referring to FIG. 2, it will be seen that the container means 24 has the top open end 26 and a bottom wall 28 formed with the openings 30 through which heat can have access to the contents within the container means 24 so as to flow upwardly through the latter to heat the scrap therein. The walls 32 of the container means are of double-walled construction in that they include inner and outer walls defining between themselves a space for air which enters through suitable openings. Thus, when the container means is at a preheating station as described below, through openings 34 air enters into the lower portion of the container means in the space between the inner and outer walls thereof to flow upwardly through the inner space of the double-walled structure and to discharge at the upper openings 36.

The container means 24 has fixed to its exterior surface a pair of trunnions 38 to be engaged by hooks of a transporting means. Also, the container means fixedly carries at its lower region a rear auxiliary hook 40 for a purpose referred to below.

Returning now to FIG. 1, the container means 24 receives a charge which may simply be in the form of scrap delivered from the scrap yard to the top of the containing means by a magnetic crane 42 or the like which can be positioned over the container means 24 to drop scrap metal into the latter at the scrap-charging station. Of course, an entire row of such container means 24 may be located at the scrap-charging station for receiving scrap metal.

Once a container means has a suitable load of scrap metal therein, suitable cranes are provided for engaging the trun-

nions 38 with suitable hooks so as to raise the container means 24 and place it at the scrap preheating station shown in FIG. 1 just to the right of the scrap-charging station. At this scrap preheating station there is a support means 44 made of a suitable fire-resistant material and having a perforated wall on which the container means 24 rests when at the scrap preheating station. At its lower right portion the support means 44 carries a heating means in the form of a suitable gas burner 46, in the illustrated example, and the combustible gas which issues into the interior 48 of the support means 44 beneath the container means 44 is ignited to provide heat which rises up into the container means to heat the scrap therein.

In this case also it is to be noted that more than one container means 24 may be situated on the support means 44 so that various stages in the heating of scrap metal may be going on simultaneously. Thus, one container means 24 may have been on the support means 44 long enough to have its scrap metal reaching a final stage of preheating while another container means 24 may have been on the support means 44 for a shorter time with the scrap therein just rising in temperature toward the final preheating stage.

When a container means 24 has reached the final preheating stage for the metal therein, a transporting means in the form of a suitable crane engages the trunnions 38 and places the container means with the preheated metal therein on a suitable conveyor 50 such as a suitable cradle having rollers 52 which roll along rails 54. With this construction it is possible to convey the container means 24 with the heated scrap metal therein along the rail 54 simply by advancing the cradle 50 therealong with any suitable drive, and in this way the container means 24 will reach the discharge position shown in FIG. 1 adjacent to converter 22.

At this location a crane 56 engages the auxiliary hook 40 to tilt the container means 24 from the horizontal to the inclined position indicated in FIG. 1 at the converter 22, and in this inclined position the contents of the container means are discharged into the converter 22. Of course, the converter 22 has been tilted so that its mouth will be in a position to receive the charge. Then the container means is delivered through any suitable return transporting structure back to the scrap-charging station.

It is to be noted that with this apparatus the plurality of container means are situated at different locations depending upon the particular stage of the preheating of the metal therein and the charging and discharging of the scrap therefrom. Of course, there is more than one converter 22. For example, one converter is on blow while another is on offblow, and the movement of the plurality of container means 24 to and from these converters is, of course, synchronized with the operations.

With the invention, the extent of heat which must be supplied to the converter in order to place the charge therein in the proper molten condition is reduced, and also the time required for reaching this condition is reduced, because the scrap reaches the converter in a preheated condition.

Referring to FIG. 3, the support means at the preheating station may include a rotary turret 60 which is rotated by suitable angular increments about a vertical axis so as to displace a plurality of the container means of the invention through different stages of preheating of scrap therein.

The turret 60 is in the form of a rotary table 62 supported on suitable rollers 64 and rotated through predetermined angular increments through any suitable drive. The center of the table 62 is formed with a vertical opening through which a vertical duct 64 extends. A container means 66 is shown in FIG. 3 at the location where the completely preheated scrap is in the container so that the latter can be delivered to the furnace, for example, in the manner described above. This container 66 is replaced by an empty container which while turning through an angle of 120° will receive scrap at the scrap-charging location 68. The container with the scrap therein reaches the scrap preheating station 70 where the scrap is preheated so that its temperature rises through an initial stage. Then during subsequent turning of the turret means 60, the container with the scrap therein reaches the final heating stage 72, and thereafter the container with the preheated scrap reaches the station 66 to be removed and replaced by an empty container means 66. Thus, the container means 66 corresponds in all respects to the container means 24 described above. However, it will be apparent that there are a plurality of container means respectively at different stages in the preheating cycle on the rotary turret 60 which forms part of the support means at the preheating station with this embodiment.

As may be seen particularly from FIG. 4, a heating means for this embodiment includes a gas burner 74 which delivers the hottest gases for movement up through the perforated bottom wall of the container means 66. These hot gases are received in a hood 74 situated at the final heating location and the hot gases flow through a duct 76 to pass down through the duct 64 and then along the horizontal duct 78 and up through the container means 66 at the initial heating station 70. Thus, the hot gases which have already given up part of their heat to the scrap at the final heating station are again passed upwardly through the scrap at the initial heating station, and now the relatively cool gas is received in the duct 80 through the hood 82 which is over the container means at the initial heating location. This gas is delivered through a wet scrubber 84 and is acted upon by an induced draft fan 86 so as to be delivered to the discharge flue 88. Just before the gas reaches the container means 66 at the initial preheating station 70, it may be additionally heated to the desired extent by an additional burner 90 so as to give the scrap the desired temperature at the initial preheating location 70.

The details of the container means 66 are illustrated in FIGS. 5–8. This container means includes an outer metal wall 92 lined with a suitable fire-resistant material 94 which can be encased in the manner shown. These outer walls 92 are thus lined with the fire-resistant material 94 to give the interior of the container means a configuration such as that which is shown in FIG. 6 or that which is shown in FIG. 7. In the case of FIG. 6 the interior is of substantially U-shaped configuration and is closed by a pair of wall portions 96 which are bolted to each other in the manner illustrated. In the case of the container of FIG. 7, however, a substantially oval-shaped interior is given to the container means 66' which has a larger interior volume in this case. In both cases, trunnions 98 are connected to the side walls and reinforced through suitable fins 100, with outer end plates 102 being provided, so that hooks from cranes can be received on the trunnions to transport the container means in the manner described above in connection with FIG. 1. Also, adjacent the lower rear there are a pair of additional pins 104 fixed through auxiliary fins 106 to the side walls and capable of receiving hooks for tilting the container means 66 to the attitude where the heated scrap will discharge through the top opening.

As may be seen from FIG. 8, the bottom wall 110 of the container means is formed with the openings 112 which are arranged in the manner shown in FIGS. 6 and 7. This bottom wall 110 using the form of the castable firebrick material 94 which is reinforced, however, in the case of the bottom wall, by the metal plate 114 formed with the openings illustrated so that these openings 112 can pass directly through the firebrick material. In addition to the plate 114, suitable reinforcing rods 116 are embedded in the fire-resistant material 94 along the bottom wall.

Referring to FIG. 9, an additional embodiment of a container means 120 is illustrated therein. This container means also has an open top 122 through which the scrap can be delivered to the interior of the container means. However, in this case, the container means has a perforated bottom wall 124 hingedly connected in a pair of sections to opposed sides of the container means 120. The container means contains suitable pressure-fluid devices 126 in the form of jacks or the like connected to a suitable source of fluid-under-pressure and capable of being actuated to displace the bottom wall sections between the open and closed positions schematically shown in

FIG. 9. Thus, with this embodiment, the trunnions **128** at the sides of the container can be engaged by hooks of a crane so that the entire container means **120** can be transported wherever desired. However, it is never tilted. Instead, the bottom wall is simply swung by actuation of the devices **126** to an open position enabling the contents to be discharged wherever desired.

As may be seen from FIGS. **10–12**, a pair of the container means of FIG. **9** may be simultaneously situated on tubular supports **130** which are in the form of cylinders into the interior of which waste heat is supplied as indicated by the arrow **132**. This waste heat may be the excess heat resulting from the operation of an electric arc furnace or resulting from the operation of an open-hearth furnace, for example. This heat will pass up through the containers to be guided by the ducts **134***a* and **134***b* to the discharge duct assembly **136**.

As is shown most clearly in FIG. **12,70** the duct assemblies **134***a* and **134***b* are swingable between the positions indicated and in the interior of the ductwork there are a pair of swingable dampers **138***a* and **138***b*. Thus, when the damper **138***a* is in the illustrated open position, the heat will be delivered through the left container **130** of FIG. **10** and the damper **138***b* is simultaneously closed so that the heat will be delivered to the discharge duct **136**. At this time the duct assembly **134***b* is swung to the illustrated open position so that the container means **120** with the completed heated scrap therein can be removed for delivery of the scrap to the furnace. While the heating continues with one of the container means of FIG. **10**, a new container means with unheated scrap replaces the one which has been removed with fully-heated scrap. Then the duct **134***a* is swung to the open position and the duct **134***b* is swung to the closed position and the positions of the dampers **138***a* and **138***b* are reversed so that now the operations will continue with the heating of the new scrap and the removal of the fully-heated scrap. In this way, use is made of waste heat, such as excess heat from any furnace as described above, and at the same time while operations in connection with removal and replacement of scrap are going forward, heating is taking place.

As may be seen from FIG. **13**, an electric furnace **140** has, as is well-known, a top **142** provided with the electrodes **144**. The container means **120** is transported in a manner schematically indicated in FIG. **13** to and from the electric arc furnace **140**. When at the region of the electric arc furnace, when the latter is to be charged, the top **142** is removed, the container means **120** is transported by the transporting means **146** to the furnace **140** and the devices **126** are actuated to open the bottom wall thus enabling the preheated scrap to be discharged into the furnace **140**. Then the container means **120** is returned to receive a new charge and the above operations are repeated, the top **142** being replaced.

Referring now to FIG. **14**, an open-hearth furnace **150** is schematically illustrated therein. The heat from the furnace is used in a conventional way for regenerating purposes by being directed through checkerworck regenerators **156** from which hot blast air is derived for combustion purposes. However, in accordance with the invention, some of this air is directed through a duct **152**, beyond the slag pocket **154** and beyond the checkerworck installation **156** up through a container means **158** which may have the structure of any of the above-described container means. With this system, it is also possible to direct heat through scrap in one container while another container is being prepared to have heat passed therethrough. After the hot air currents pass through the container to give up heat to the scrap therein, the air is directed through ducts **160** and a scrubber **162** out through a stack **164** by the action of an induced draft fan **166** which directs the hot gases through the duct **168** to the discharge flue **164**. The duct **160** has a removable cover **170** which is removed so that a crane **172** can have access to the container means **158** with the heated scrap therein for raising this container means as indicated in the phantom lines in FIG. **14**. Then the container means is transported by the transporting means formed by the crane **172** and the guides therefor back to the open-hearth furnace **150** to enable the preheated scrap to form part of the charge for the furnace.

In the embodiment of the invention which is illustrated in FIG. **15**, scrap from the scrap yard **180** is delivered, as by an electromagnetic crane mechanism **182**, into a container means **184** having a configuration similar to a converter. It is swingable on trunnions so as to receive the scrap, and a heating means in the form of ignition burners **186** is provided for preheating the scrap. When the proper stage of preheating has been achieved, the scrap is emptied into a ladle **188** to be delivered to the furnace. Just to the right of the ladle **188** is shown a ladle **190** for receiving molten pig iron from the car **192** as is conventional.

To the right of the scrap preheating station are the lime storage means in the form of bins **194** in which lime is stored to form part of the charge, this lime being delivered to a container **196** for delivery to the furnace to form part of the charge.

In accordance with a further feature of the invention, in this embodiment, the heat derived from the heating means **186**, after passing up through the container **184** to preheat the scrap therein, is received in a duct system **200** to be delivered thereby to the lime bins **194** in order to heat the lime therein. Thus, the duct system **200** will have at its left end swingable duct components **202** for respectively communicating with the two or more containers **184** for the scrap, these containers having scrap therein at different stages of preheating. The swingable components **202** communicate with a header which communicates with the main component **200** which also communicates with a header **204** from which various branches go to the different lime bins so that the hot air will have access to the lime in the bins for preheating the lime prior to flowing thereof out through the bottom chute outlets into the containers **196**. Then the preheated lime as well as the preheated scrap are delivered together with the pig iron to the furnace **206** for providing in the latter a charge which has not only preheated scrap but also preheated lime, so that in this way it is possible to achieve advantages set forth above with respect to reduction in heat consumption and time of operation at the furnace **206** itself.

FIG. **16** shows an embodiment of the invention which is substantially similar to that of FIG. **1**. However, in this case, the flue gas duct **220** directs flue gas from the stack along a special duct **222** back to the preheating station **224** where instead of gas burners the flue gas itself is burned in order to provide the heat for the scrap within the container means **24**. Thus, oxygen may be added to the flue gas in order to render the latter combustible together with the added oxygen to provide in this way a heating means for heating the scrap within the container means **24**. A swingable flue system **226** may be used over the containers for receiving the hot gases therefrom. Thus, with this embodiment, use is made of the flue gases themselves to provide the heating means for the scrap.

It is to be noted that in all of the embodiments described above, it is of advantage to add to the scrap within the container means coke fines for combustion with the scrap within the container means. Such coke fines can be added as being metered out of any chute or the like located over the scrap containers, the coke fines being directed into the containers simultaneously with the dropping of the scrap into the containers so that in this way the coke fines are distributed through the materials in the containers in a given amount to enhance the operations.

I claim:

1. In a metal-treating plant, a furnace for receiving a charge at least part of which is scrap metal, container means for containing scrap metal and admitting heat thereto, support means for supporting said container means at a preheating station, heating means located at said station for delivering heat to scrap in the container means, and transporting means coacting with said container means for delivering scrap in preheated condition to the furnace, said container means being in an

upright position at said preheating station and in said upright position having a top open end and a bottom end formed with openings through which heat from said heating means has access to scrap in said container means, said transporting means coacting with said container means, not only for removing the latter with preheated scrap therein from said support means but also for placing said container means at an attitude where the scrap will fall out through said top open end thereof.

2. The combination of claim 1 and wherein said container means has an insulated wall means extending between said bottom end and said top end thereof.

3. The combination of claim 2 and wherein said insulated wall means includes an outer metal wall and an inner lining of fire-resistant material.

4. The combination of claim 2 and wherein said insulated wall means includes inner and outer walls defining an air space between themselves.

5. The combination of claim 4 and wherein said outer wall of said container means is formed with openings adjacent said bottom and top ends of said container means while the top end of said air space is closed so that air will flow upwardly through said air space between said inner and outer walls into said air space through said outer wall openings adjacent said bottom end of said container means and out of said air space through said outer wall openings adjacent the top end of said container means.

6. In a metal-treating plant, a furnace for receiving a charge at least part of which is scrap metal, container means for containing scrap metal and admitting heat thereto, support means for supporting said container means at a preheating station, heating means located at said station for delivering heat to scrap in the container means, and transporting means coacting with said container means for delivering scrap in preheated condition to the furnace, said support means at said preheating station including a rotary turret for simultaneously supporting a plurality of said container means which are respectively at different stages between initial and final preheating of scrap within the plurality of container means.

7. The combination of claim 6 and wherein said heating means includes a source of heat situated below that one of said plurality of container means which is at a final preheating stage for directly heating scrap in said one container means, and said heating means including duct means extending from the top of said one container means to the bottom end of another container means which has not yet reached said final preheating stage for directing to said other container means heated air which has already given up some heat to scrap in said one container means.

8. The combination of claim 7 and wherein said heating means includes an additional source of heat situated below said other container means for additionally heating scrap therein.

9. The combination of claim 7 and wherein said duct means has a vertical portion extending through a central region of said rotary turret and around which said rotary turret turns.

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