April 27, 1965 F. W. BROOKE 3,180,724

METHOD AND APPARATUS FOR PRE-CONDITIONING METAL CHARGE MATERIALS

Filed Feb. 12, 1962 5 Sheets-Sheet 1

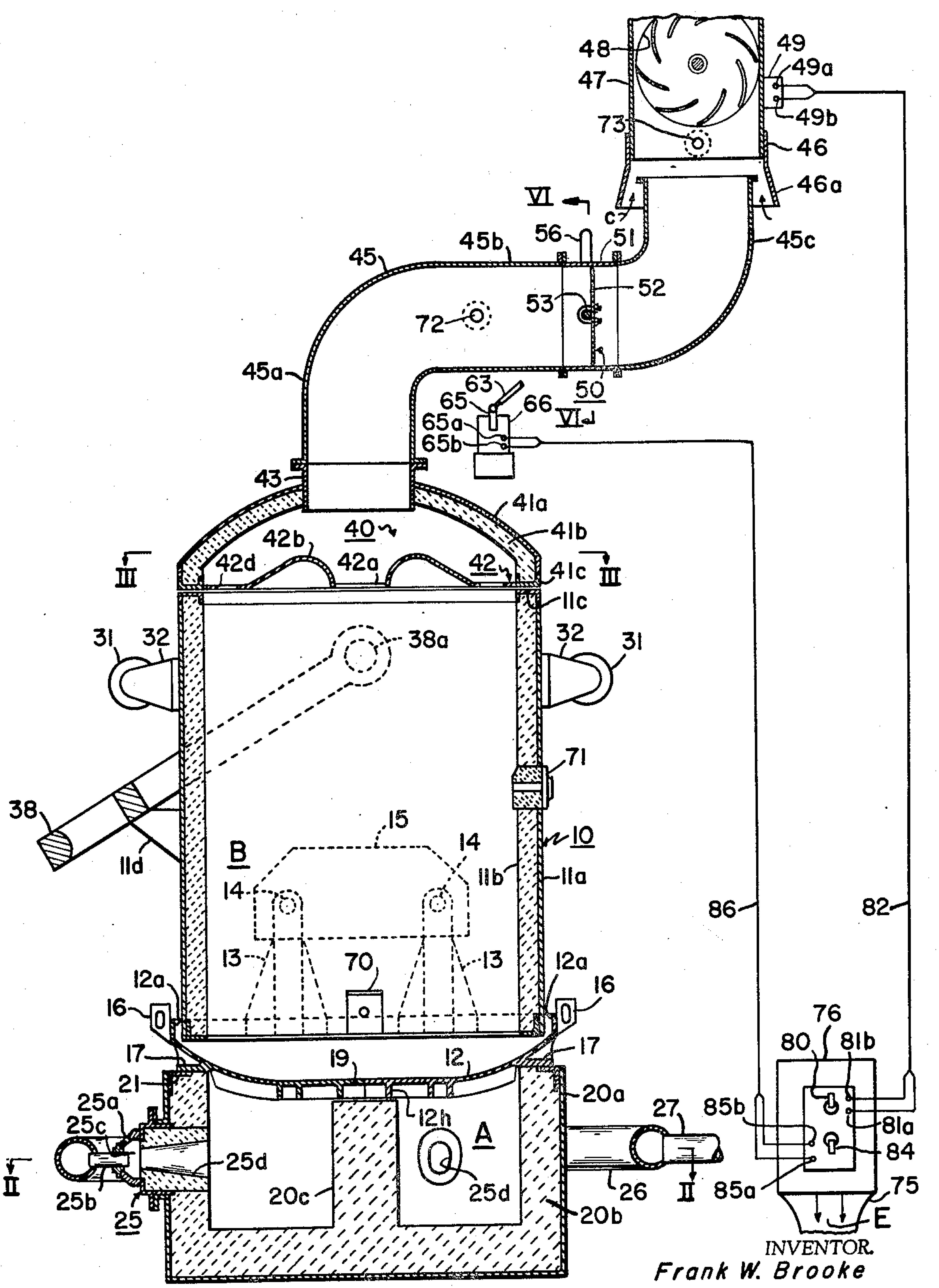

Fig. 1

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HIS ATTORNEYS

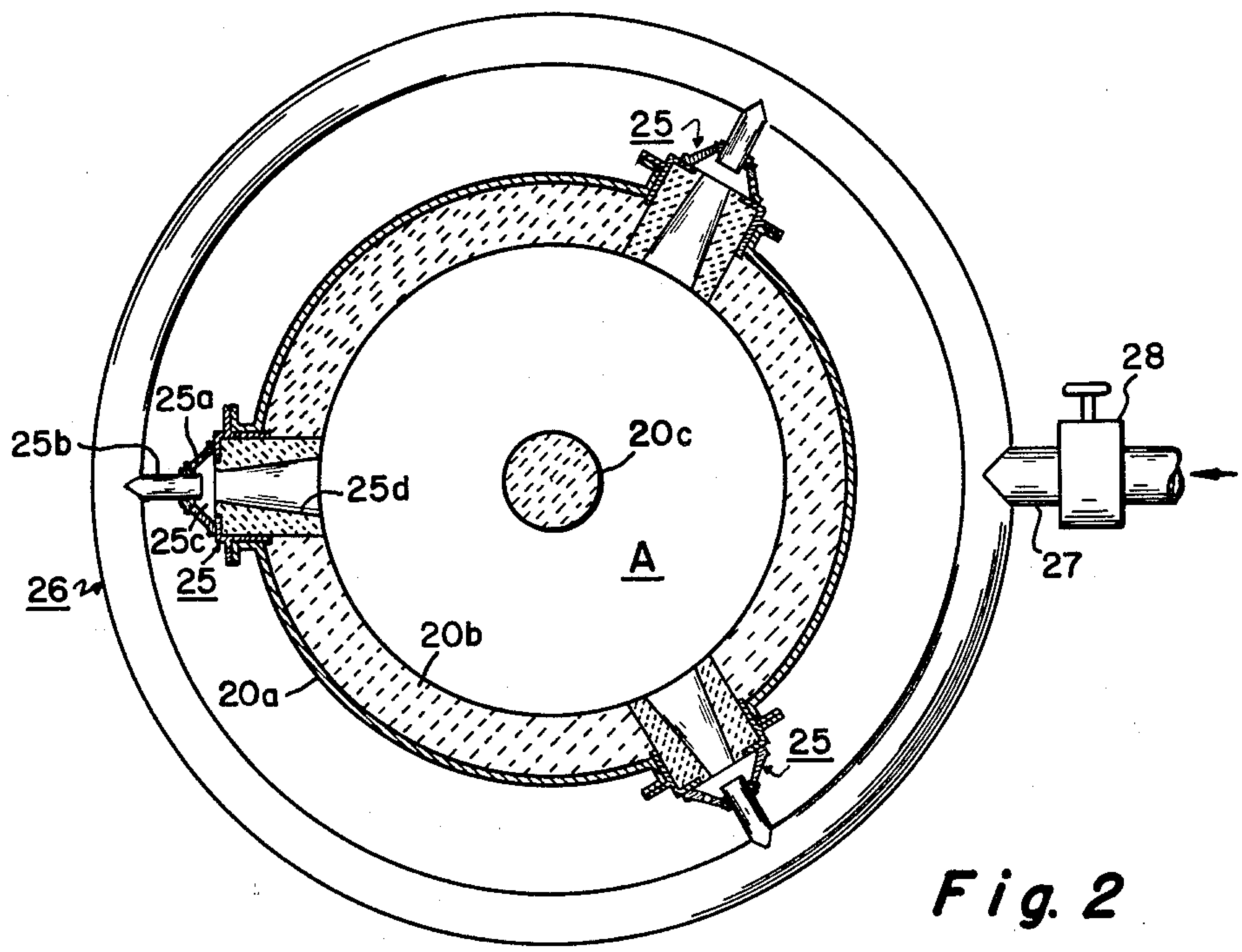

Fig. 2

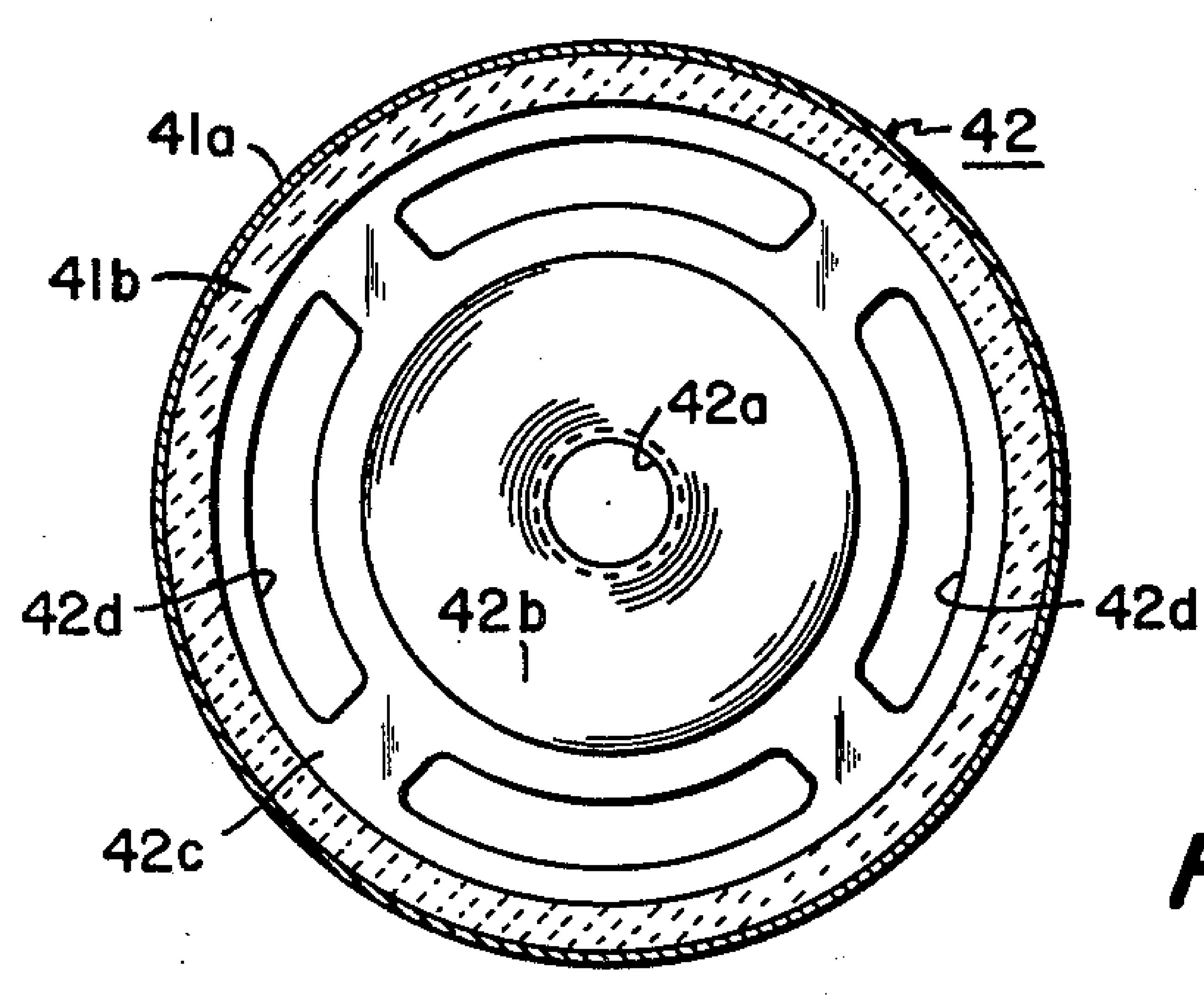

Fig. 3

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METHOD AND APPARATUS FOR PRE-CONDITIONING METAL CHARGE MATERIALS

Filed Feb. 12, 1962 5 Sheets-Sheet 3

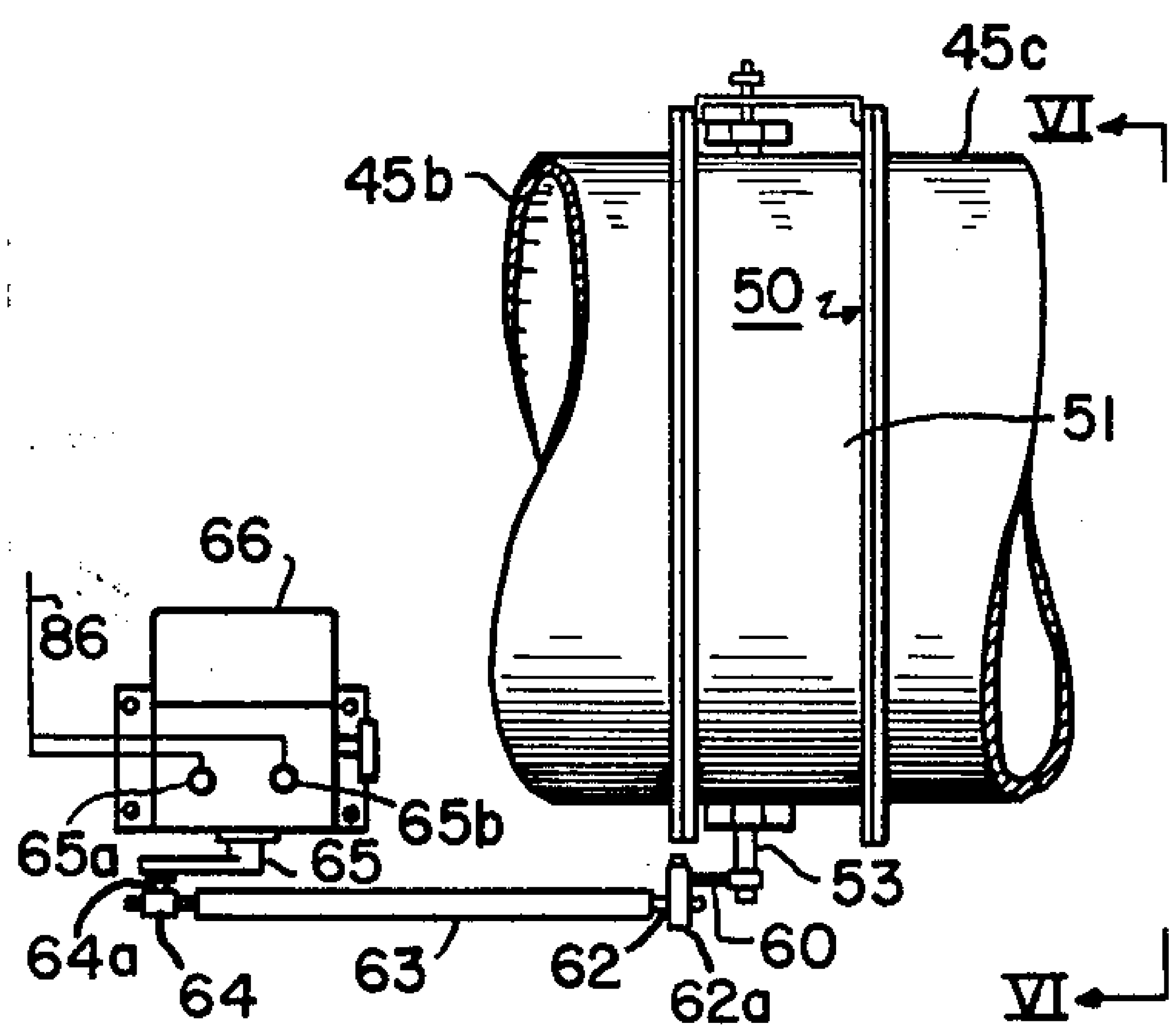

Fig. 4

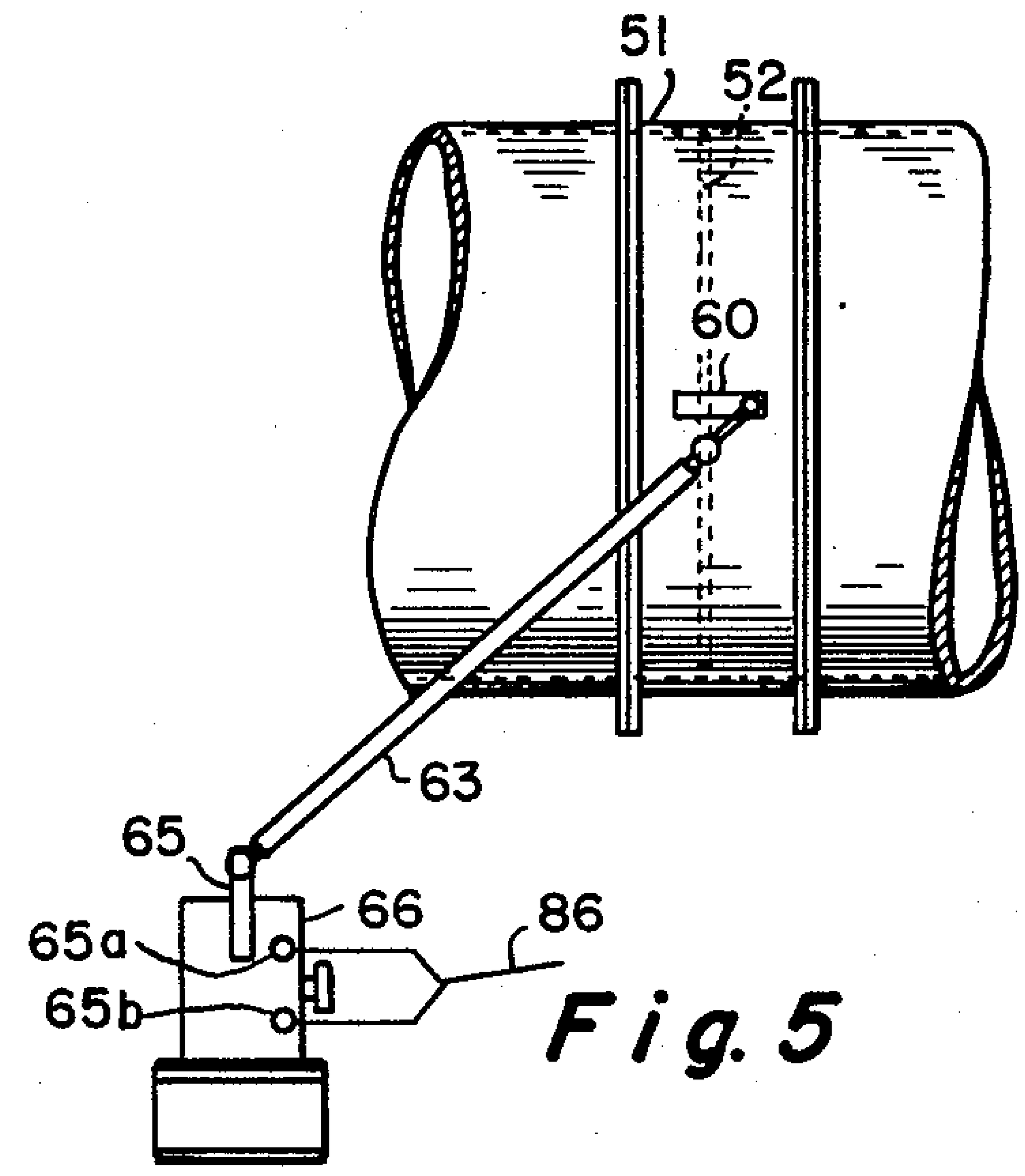

Fig. 5

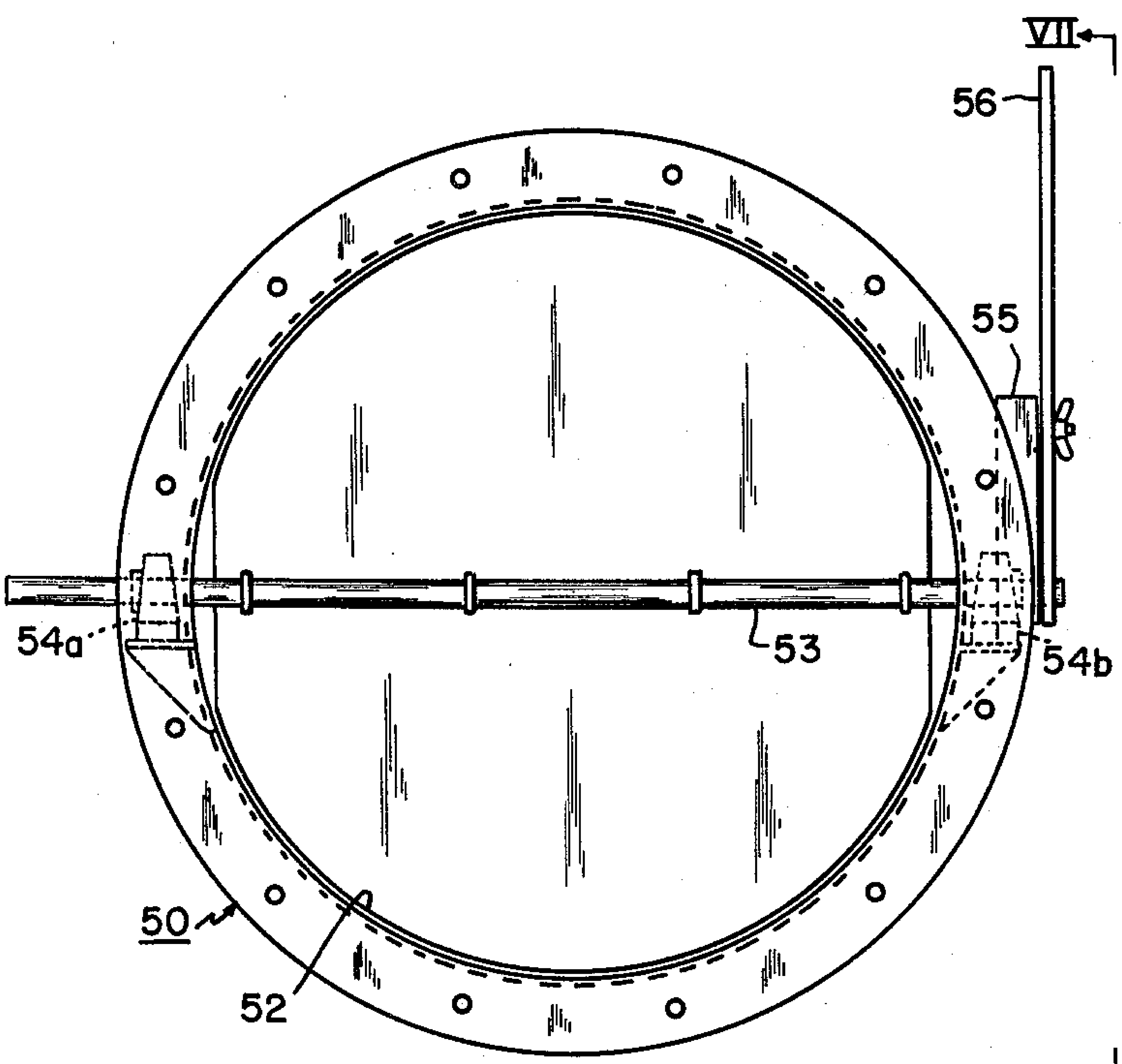

Fig. 6

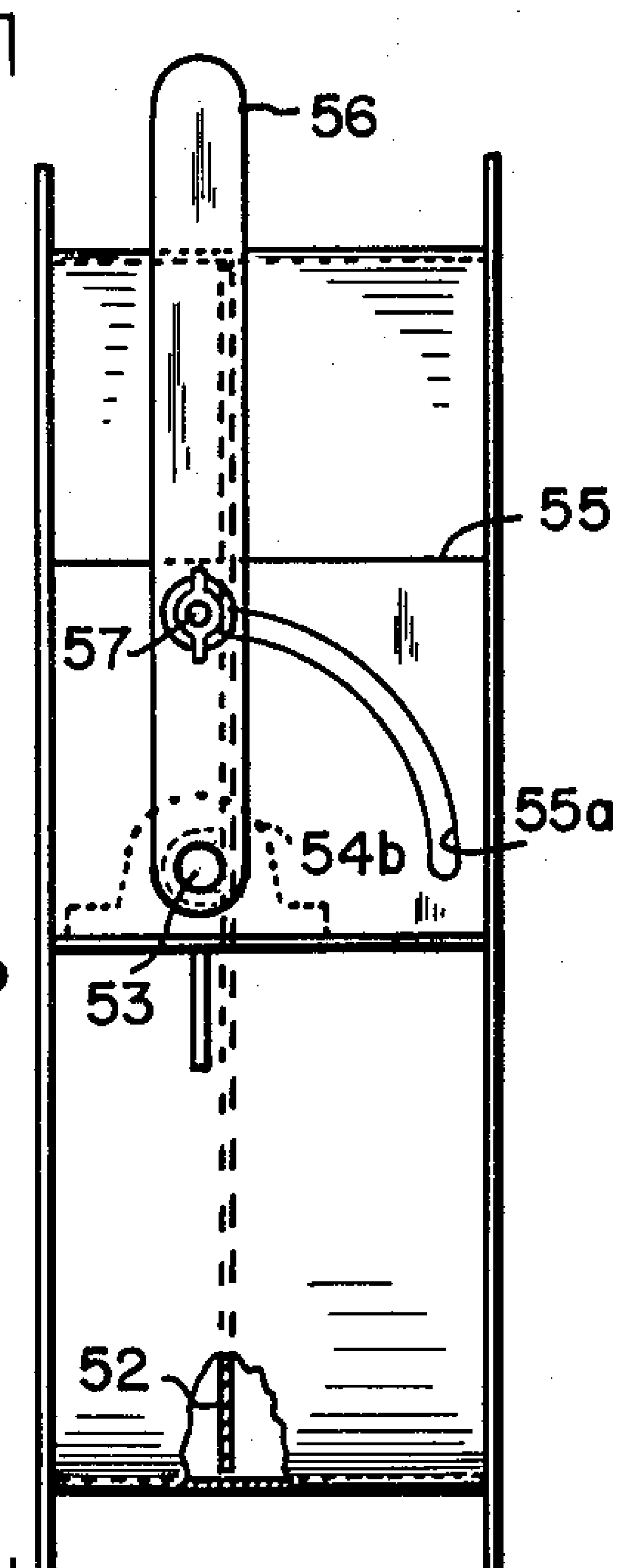

Fig. 7

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April 27, 1965 F. W. BROOKE 3,180,724

METHOD AND APPARATUS FOR PRE-CONDITIONING METAL CHARGE MATERIALS

Filed Feb. 12, 1962 5 Sheets-Sheet 4

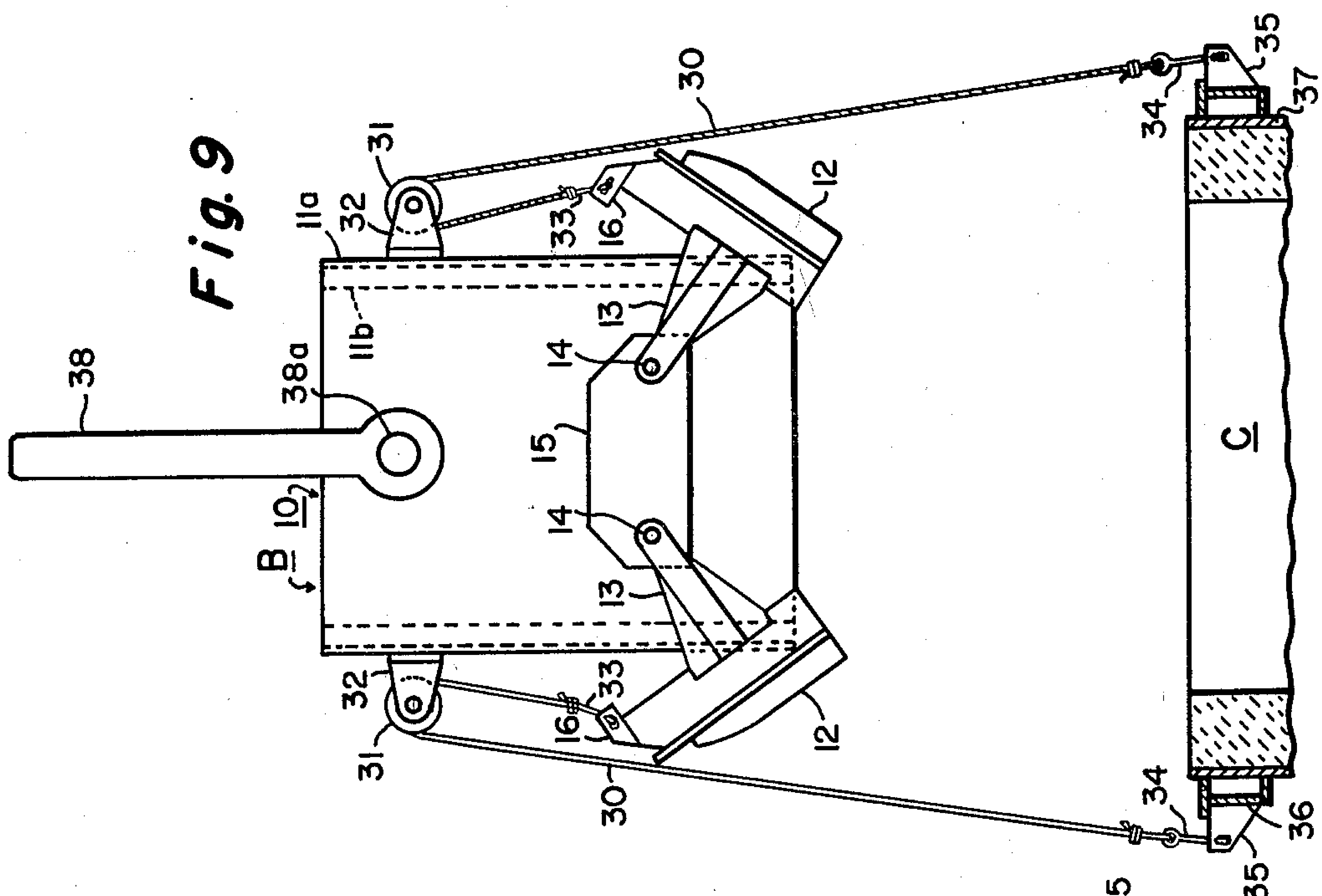

Fig. 9

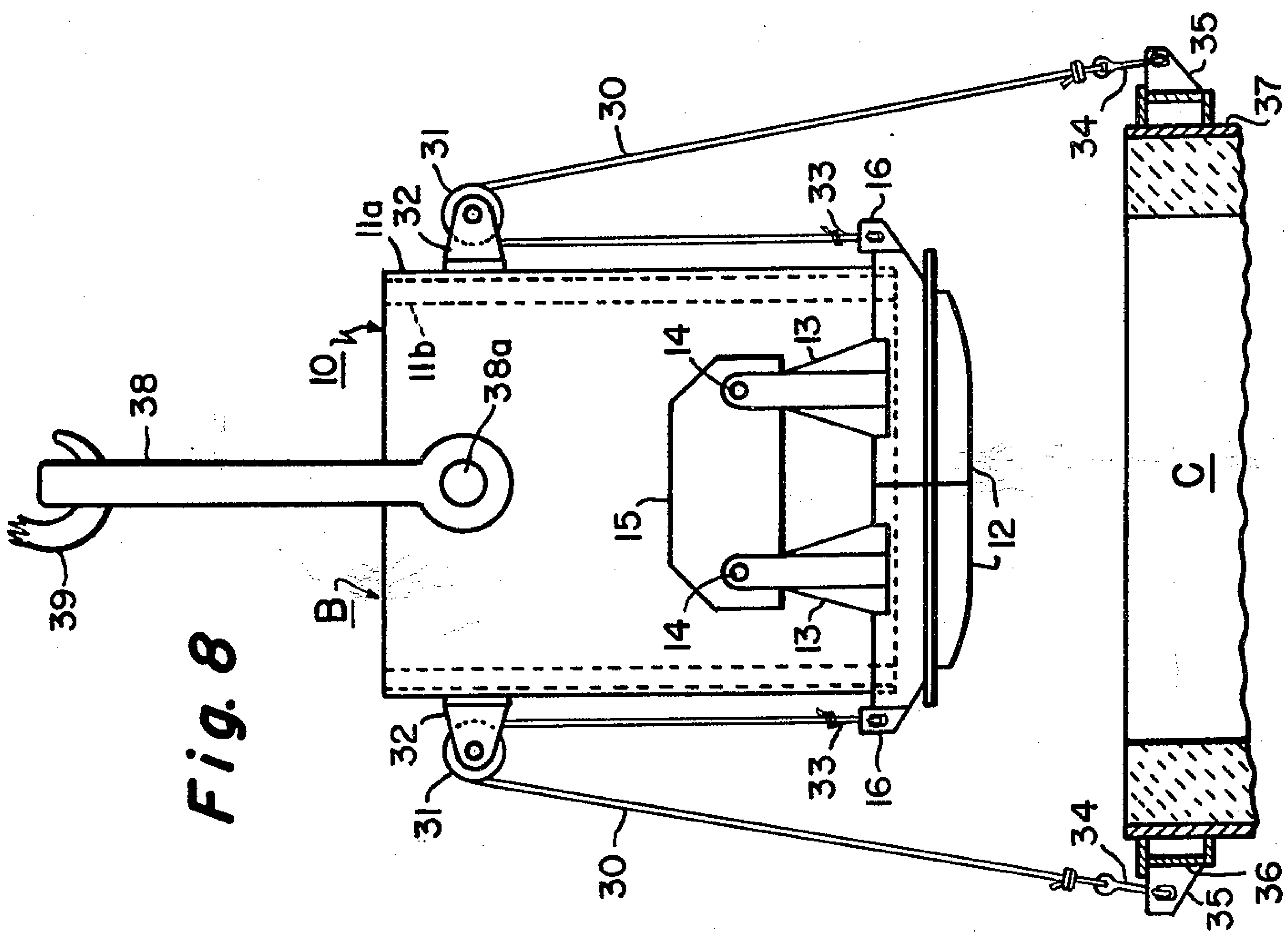

Fig. 8

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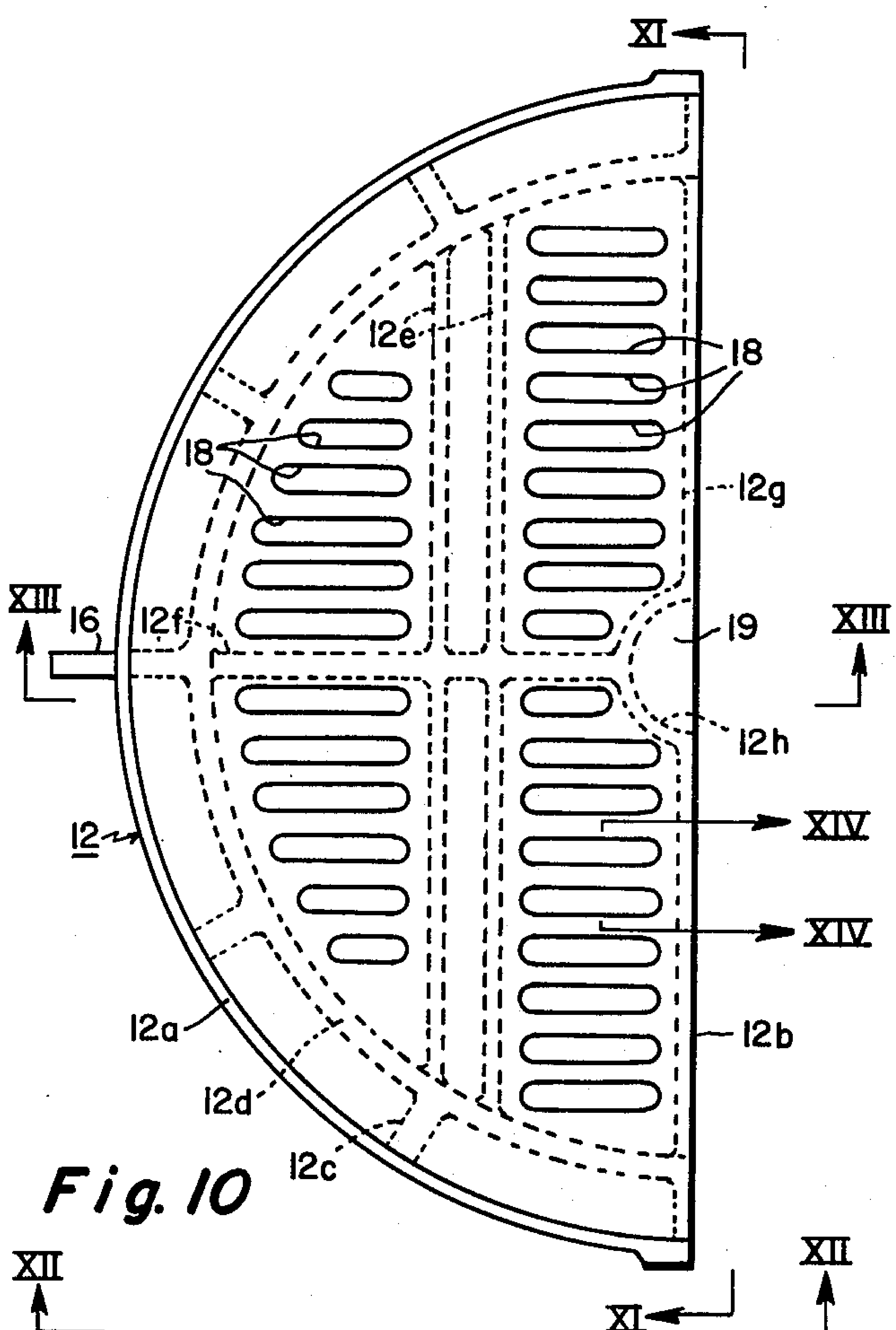

Fig. 10

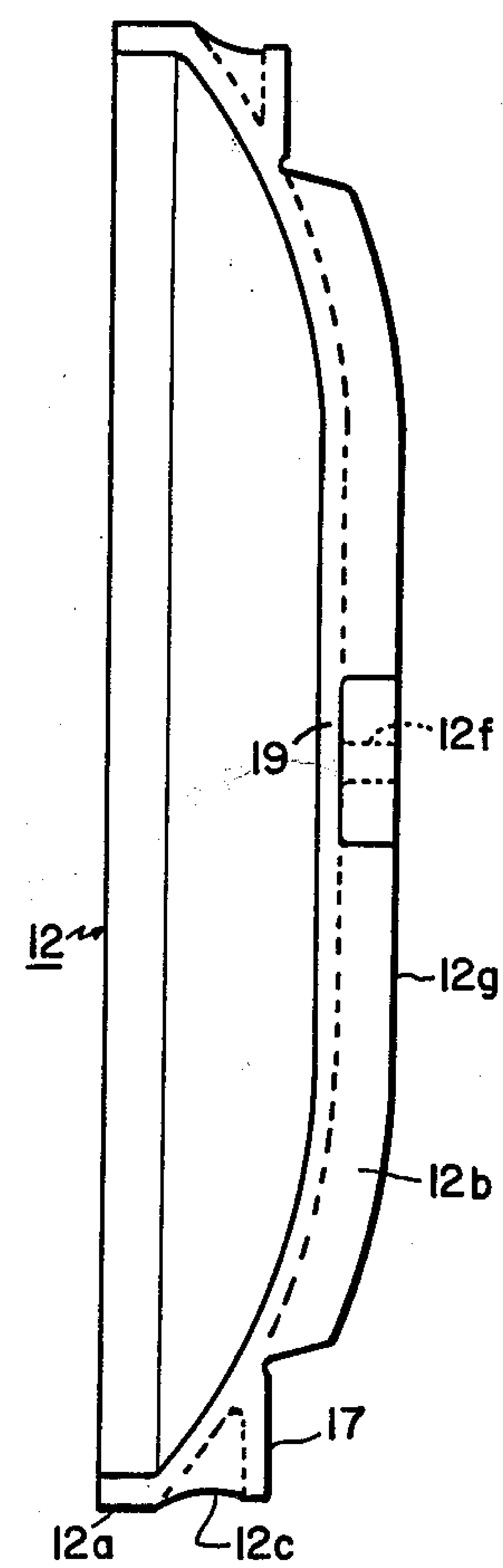

Fig. 11

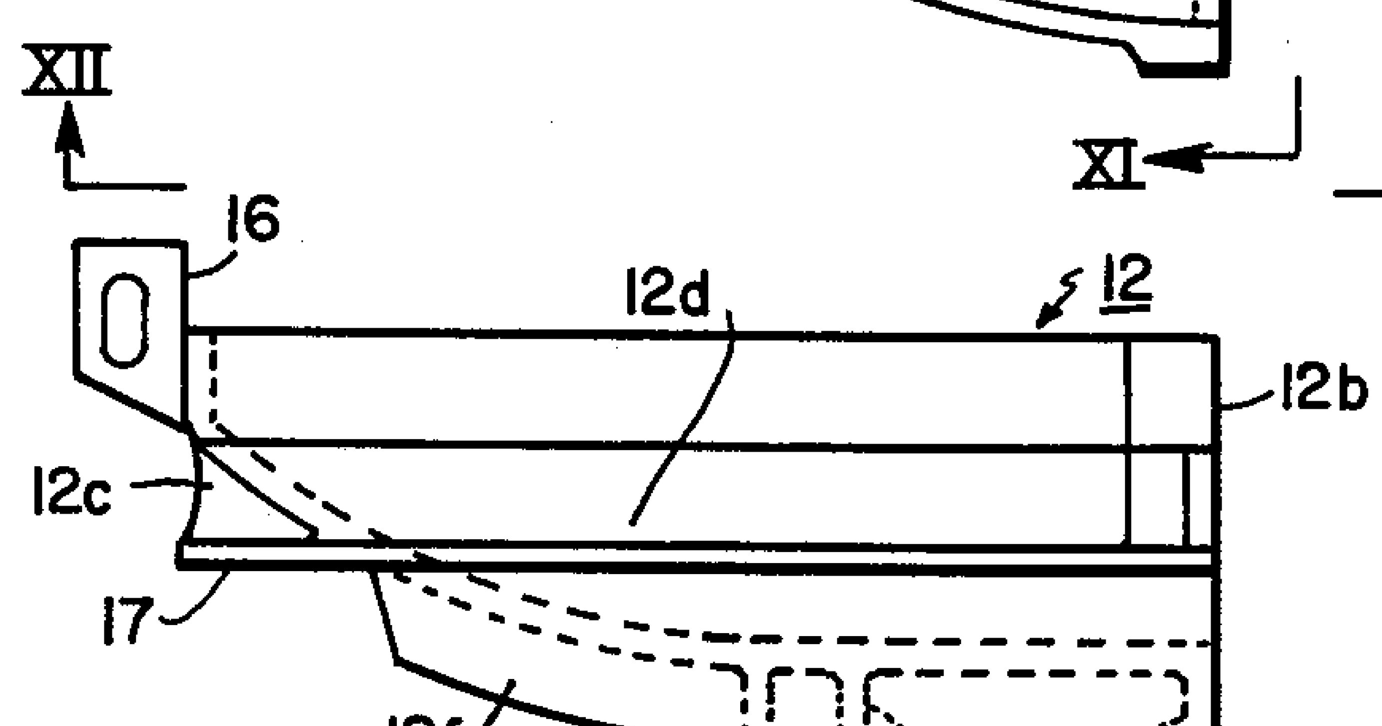

Fig. 12

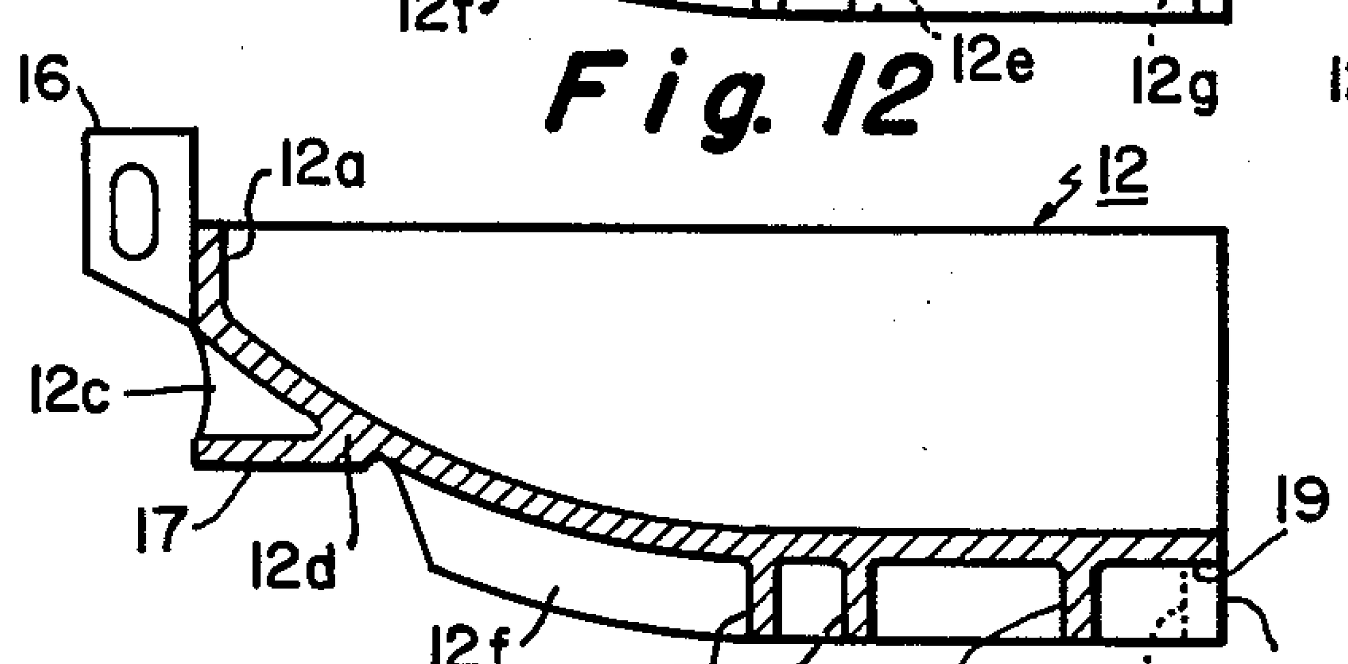

Fig. 13

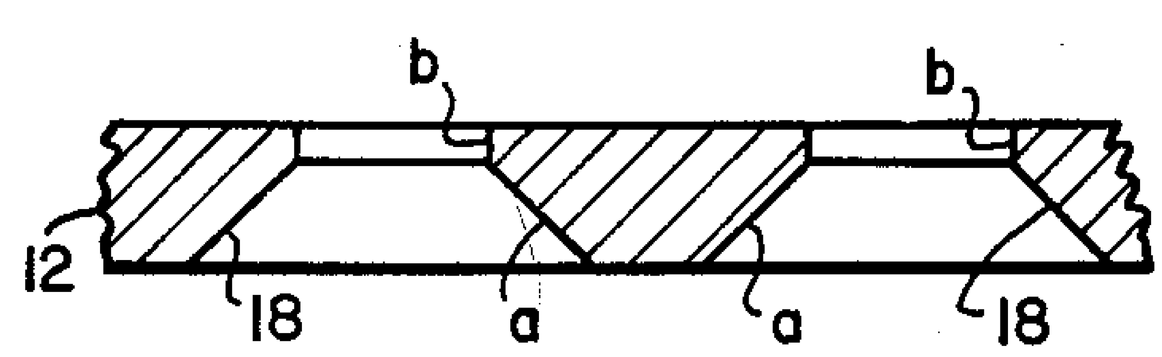

Fig. 14

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United States Patent Office

3,180,724

Patented Apr. 27, 1965

3,180,724
METHOD AND APPARATUS FOR PRE-CONDITIONING METAL CHARGE MATERIALS

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Filed Feb. 12, 1962, Ser. No. 172,493
13 Claims. (Cl. 75—13)

This invention pertains to pre-heating or pre-conditioning metal charge materials in the nature of metal scrap, or briquettes, sponge, etc. The charge materials, and particularly ordinary scrap metal, tend to form a somewhat heterogeneous mass or at least a mass that, when placed in a container, presents considerable resistance to the flow of hot gases therethrough. Ore briquettes or sponge may be provided in accordance with conventional procedures by the direct reduction of ore, such as iron ore.

An important phase of the invention deals with improved apparatus and procedure for pre-conditioning metal charges before they are introduced into a melting furnace, such as an electric arc or induction furnace.

In my Patent No. 2,804,295, I disclose apparatus which was primarily devised for pre-conditioning scrap metal and which has served a useful purpose in this connection, particularly in preparing scrap charges for electric furnace melting. However, difficulty has been encountered in producing enough hot gas flow from the combustion chamber, particularly at the start of the heating operation, in producing a desired type of gas flow, in fully and uniformly conditioning the charge, and in controlling the operation to meet atmospheric and operating conditions. My present invention has been devised to meet the need for an improved construction which will have a much longer period of operating life with minimum maintenance, which will make practical the conditioning of a wider range of metal charge materials, including ore reduction materials, which will minimize the time required for the conditioning operation and will accomplish it in a more efficient, complete and uniform manner as to the materials, which will enable a full and effective control of the conditioning operation, and which will enable the provision of charges which are pre-conditioned throughout and whose materials may be conditioned to a common status prior to charging them into or utilizing them in a melting furnace.

My present invention has been devised to meet problems heretofore encountered in the pre-conditioning of metal charges so as to place induction and electric arc melting furnace installation on a better competitive basis with other modern-day melting methods and particularly, where relatively high quality metals and alloys are needed. As pointed out in my above-mentioned patent, pre-heating of scrap metal is not only advantageous from the standpoint of eliminating lower melting point comtaminants including metals, oil, water, zinc, lead, arsenic, etc., but also from the standpoint of reducing the power and heating requirements of the melting furnace as well as reducing the melting periods.

Also, as pointed out in such patent, the pre-heating of material, such as plain carbon steel scrap, to a temperature of about 1400° F. will greatly reduce its elastic limit and tend to make it non-magnetic. It will be noted that ordinary scrap metal contains much greater quantities of carbon steel than other metals and alloys. The first feature enables the compacting of the charge prior to its introduction into the melting furnace, while the latter feature is advantageous from the standpoint of minimization of electric current used in an electric type of melting operation. The procedure developed in accordance with my present invention not only provides such advantages, but additionally makes possible the minimization of gaseous contaminants, such as hydrogen, nitrogen, and oxygen from the standpoint of the final melting.

The present invention has resulted from my work in endeavoring to meet the problems heretofore encountered in pre-heating metal charge materials. It has been devised to meet undesirable features of prior procedure in such a manner that the field of application of pre-heating may be extended to other materials than ordinary scrap metal and further, in such a manner that pre-heating or pre-conditioning will be much more practical and enjoy a wider field of utilization.

An important factor which has heretofore limited the prior utilization of a pre-heating apparatus was discovered to rest in difficulties encountered in connection with the proper support of the materials during the heating operation to effect their safe transfer in a pre-heating container after the completion of the pre-heating operation, to a charging position over the open mouth of a furnace, and their safe and accurate discharge into a melting furnace.

In my earlier construction, I employed refractory-lined bottom gates which were held closed by winding rope around their inner ends. This entailed considerable difficulty, not only from the standpoint of the initial locking of the gates and the manual operations involved, from the standpoint of retaining such gates locked under the intense heat involved without burning away the rope, but also from the standpoint of cutting away the rope and discharging pre-heated material without danger to the workmen and plant equipment, at the proper moment, into the melting furnace. Further, difficulty was encountered in connection with the necessity for frequently replacing such gates, not only due to damage from the charge and compacting of heterogeneous scrap materials within the pre-heating container, but also from the standpoint, as I have now discovered, that heat supplied at the gates tends to concentrate in the area of such gates and to non-positively flow through larger passageways or interstices of the mass and along the outer periphery of the mass during the pre-heating operation, rather than to substantially uniformly move through the mass and out to a stack through a top discharge opening of the container. Further, in this connection, the smaller the individual portions of the mass or the more compact the mass is during the heating operation, the greater is this difficulty.

I have also discovered when metal charge materials are being pre-conditioned, that heretofore there have been so-called dead or cold areas produced, due to the lack of proper, uniform, and fully effective circulation of hot heating and conditioning gases through the mass. In this connection, I found that the manner of supplying the hot gases to the pre-heating container, the temperature adjacent the gates which serve as bottom supports for the material in the conditioning container, the mean temperature of the mass within the container, the temperature of the hot gases leaving the container, and positive flow inducing means are important in accomplishing a control and heating of the mass, such that uniformity of its conditioning is effected, minimization of wear and tear on the pre-heating apparatus is accomplished, and highly improved results are attained, all in accordance with my procedure.

It has thus been an object of my present invention to solve problems heretofore encountered in connection with the pre-heating of charging materials and to broaden the practicability and scope of utilization of a pre-heating or pre-conditioning operation for metal charges that are to be introduced into a melting furnace;

Another object of my invention has been to devise new and improved procedure for pre-conditioning metal charge materials and new and improved apparatus for carrying out the procedure and meeting the problems involved;

A further object of my invention has been to devise procedure and apparatus for meeting the heretofore disadvantageous and limiting features of prior pre-heating apparatus and procedure and to accomplish pre-conditioning in an improved highly efficient and effective manner;

A further object of my invention has been to devise pre-heating apparatus in which a metal grate construction of improved gas flow construction will serve as a partible gate that will be foolproof and positive in its action, and that can be safely and easily operated to eliminate difficulties and dangers heretofore encountered in connection with gates used in prior apparatus;

A further object of my invention has been to devise an improved heating and heat transfer means that will make possible a positive, maximized, more effective, and substantially uniform upward flow of heating or conditioning gases into a conditioning chamber and through the material masses therein contained, and all in such a manner as to minimize wear and tear on the grate construction in its utilization and to enable an improved conditioning of the material mass or charge;

A still further object of my invention has been to devise a method of operation and of controlling the flow of heating gases through a mass of charge materials so as to effect a substantially uniform conditioning of such material in a minimized time period, and in such a manner as to assure a better and more improved pre-conditioned product for furnace charging;

These and other objects of my invention will appear to those skilled in the art from the illustrated embodiment, the description, and the claims.

In the drawings, FIGURE 1 is a side view in elevation and partial section illustrating apparatus for carrying out my invention;

FIGURE 2 is a horizontal section on the scale of and taken along the line II—II of FIGURE 1; this section is taken through a hot gas generating combustion chamber of the construction;

FIGURE 3 is a horizontal section on the scale of and taken along the line III—III of FIGURE 1; particularly illustrating details of the construction of a top enclosing hood or cover for the conditioning container of my construction;

FIGURE 4 is a fragmental plan view showing details of damper or gas outflow control means utilized in the apparatus of FIGURE 1 and of a reversible motor drive means for adjusting or controlling its operation or opening and closing action;

FIGURE 5 is a side elevation on the scale of FIGURE 4 showing the apparatus of such figure;

FIGURE 6 is an enlarged end or transverse section in elevation, taken along the line VI—VI of FIGURES 1 and 4, showing details of the construction and mounting of a butterfly damper valve whose operating mechanism is shown in FIGURES 4 and 5;

FIGURE 7 is a side section in elevation on the scale of and taken in the direction of the line VII—VII of FIGURE 6;

FIGURE 8 is a reduced somewhat diagrammatic view in elevation illustrating means for and the operation of moving the portable container of FIGURE 1 to an upper aligned position with the open mouth portion of a melting furnace in preparation for charging pre-conditioned materials therein; in this figure, pull cable means for opening the grate has been attached to the melting furnace;

FIGURE 9 is a view similar to and on the scale of FIGURE 8 illustrating means for and the operation of swingably opening the grate of the container and charging the pre-conditioned materials into the melting furnace; in this figure, the container has been moved or raised upwardly in alignment with the open mouth of the furnace from the position of FIGURE 8 to swing the grate to an open position and charge pre-conditioned metal materials into the furnace;

FIGURE 10 is a top plan view on an enlarged scale with respect to and illustrating details of the construction of the grate shown in FIGURE 1; in this figure only one complementary half part of the grate is shown, as the other part is of the same construction;

FIGURE 11 is an inside view in elevation on the scale of and taken along the line XI—XI of FIGURE 10;

FIGURE 12 is a transverse end view in elevation taken at right angles to FIGURE 11 and along the line XII—XII of FIGURE 10;

FIGURE 13 is a transverse section in elevation on the scale of and taken along the line XIII—XIII of FIGURE 10;

And, FIGURE 14 is a greatly enlarged fragmental section taken along the line XIV—XIV of FIGURE 10 and illustrating the flow opening or orifice construction of the grate.

In carrying out my invention, I provide a base or heater unit A that may have a stationary or fixed position in the plant and that has a heat-resistant (refractory-lined) wall defining an under-positioned combustion or hot gas generating chamber of circular or annular shape. A group of burners 25 (see FIGURE 2) are radially-positioned about the outer periphery of the unit A in a peripherally or circumferentially spaced-apart relationship with each other, and their flames are adapted to impinge within the chamber. In this connection, any suitable combustion gas mixture of air or oxygen with a combustible gas including oil vapor, natural gas, etc. may be used for generating hot gases of requisite temperature for preconditioning the metal charge materials. The combustion chamber construction enables the hot gases, as generated, to move about the chamber and thoroughly mix to attain a substantially uniform temperature.

A portable conditioning or container unit B has open top (outflow) and bottom (inflow) portions and a heat-resistant (refractory-lined) container or enclosing wall 10 that is employed for receiving the metal charge materials and pre-conditioning them therein. A cover, hood or lid 40 is employed to close off the upper open end portion of the container, and conduit or duct means leads therefrom or is connected to a stack or discharge point for cooled exhaust gases.

A partible grate 12 is swingably mounted on the container 10 at the bottom open end portion thereof for positioning over the combustion chamber of the base unit A, in a substantially aligned position with respect thereto, to receive the hot gases therefrom through orifices or flow openings therein that extend substantially over the full surface area thereof. The grate is of metal construction and is normally maintained in a closed position with respect to the bottom of the container during the charging of the material thereto, during the conditioning of the material therein, and during the transfer of the container to a vertically-aligned position with an open mouth of a melting furnace C.

When the container unit B has been moved, as by a conventional overhead traveling hoist-crane, to a cooperating position with the open mouth portion of the melting furnace C and is properly aligned by grate operating means with the open mouth portion, then the grate 12 is parted or opened by an upward pulling or lifting force exerted on the container (see FIGURES 8 and 9) and its gate halves are swung upwardly and outwardly by externally-positioned means to discharge the pre-conditioned material into the furnace C.

The grate 12 not only serves as a gate to close-off the bottom of the container unit B during the conditioning of the charge materials and to thus hold them in position within the enclosed chamber therein defined, but also serves as a grate or hot gas flow directing means to provide a substantially uniform and highly effective flow of hot gases from the combustion chamber into the container, and through the charge materials therein.

The combustion chamber of the base or heater unit A is provided with a central post (see FIGURES 1 and 2) to give additional support for the grate during the conditioning of the charge when the grate is in its closed position, and without interfering with the substantially uniform flow of hot gases through the grate, upwardly through the charge materials in the enclosing container 10. The cover, hood or lid 40 is chambered (see FIGURES 1 and 3) for receiving, discharging and effectively utilizing the gases, such that they give up a maximum amount of their heat to the charging materials within the container before they are exhausted or discharged from the container. The gases, as thus lowered in temperature, issue or exhaust substantially centrally from the hood, pass along ducting and flow to a suitable stack or other discharge agency or point.

During the operation of the apparatus, a constant, positive, upward-drawing force is applied to the hot gases to assure their continuous movement upwardly through the grate, through the charge materials of the container, and out to the exhaust duct or discharge point. In the duct or conduit connections between the hood and exhaust duct 47, I have provided a sliding sleeve fitting for permitting a tempering of the hot gases before they reach an exhaust fan 48.

Temperature indicating or control means, such as thermocouples, are employed at strategic points. Control 70 is an alarm type pyrometer that may be set at about 1550° F. to provide a reasonably high temperature and pressure without causing damage to the grates and equipment. I have found that a grate 12 of the construction shown (of high tensile steel alloy) will carry about 5600 pounds per square inch at about 1600° F. with a creep of 1% per 10,000 hours at such a maximum temperature. The means 70 is positioned adjacent the bottom of the container and the upper side of the grate, so that the supply of fuel to the burners may be adjusted to control the generated heat for maintaining it below a maximum temperature which would damage the grate and above a minimum temperature for maximum efficiency in conditioning the charge materials.

A second indicating control means 71 is a dial type pyrometer to indicate average temperature of the load. It projects into the container wall somewhat midway along its vertical extent to measure the mean temperature therein and thus, the average temperature of the load materials or of the conditioning operation during the conditioning period. It also indicates the temperature of the container during the idling period. Indicating control means 72 is a dial type pyrometer to enable the operator to properly set a butterfly valve or damper control 50 to provide a proper back pressure and prevent a constant speed fan 48 from pulling the heating gases through the load too rapidly and thus, lose the full advantage of the counter-flow economy.

When the reading of the control means 71 is too high, too much heat is passing through the flow opening at the top of the container; the butterfly damper 50 should then be moved to more of a closing relation to set up a back pressure on the constant speed fan 48.

The means 72 is located in the outlet duct work beyond the outflow passage from the hood 40 of the container to indicate the temperature of the gases leaving the container, so that the operator may control the outflow of gases from the hood by the damper control 50 in the exhaust duct work or connections to make maximum use of retained heat of the gases before they are discharged. At the beginning of the heating operation, the means 72 will read room temperature and, as it rises, the operator will close the angle of the butterfly damper 50, thereby regulating the rate of heating and limiting the escape of heat past the fan 48.

The temperature indicated by the third means 72 is employed by the operator to control the opening and closing of the damper valve 50, so as to open the damper when the operation is started and to gradually close it as the operation is continued, to assure a full, efficient and quick conditioning of the charge materials within the container B and with a minimum loss of retained heat from the gases entering the stack. For example, when the temperature of the gases for conditioning the charge are to be maintained at about 1400° to 1450° F., as a mean within the conditioning chamber of the container, then the damper may be adjusted to provide for discharge of gases at a temperature of about 800° to 900° F.

A fourth pyrometer 73 may be a removable hand or dial type for positioning in the duct work ahead of the fan 48, so that tempering of the exhaust gases with atmospheric air may be properly proportioned to lower the gases to a safe discharge temperature to the fan. It indicates how adjustable sleeve or collar 46 should be set. The tempering of the exhaust gases by mixing with atmospheric air is governed by the reading of the fourth indicator 73 to, for example, provide them with a temperature of not greater than about 725° F. at the point where they pass through the exhaust fan 48 that is used for positively drawing the hot gasses through the conditioning unit B.

By using a contant high speed exhaust fan 48 with backwardly curved blades in the exhaust portion of the apparatus, I assure a constant, positive drawing through of the hot gases and, in combination with a substantially full flow supply area of the grate and other features of my invention, enable and provide a substantially uniform movement of the hot gases through the charge materials. In this manner, the hot gases displace and sweep out insulating air or stagnant air pockets about portion of the charge materials, remove moisture and other contaminants, and heat all the materials up to the desired conditioning temperature.

Further, in accordance with my invention, and as particularly illustrated in FIGURES 8 and 9, I provide a partible grate 12 for normally closing-off the open bottom end portion of the conditioning container 10 that is swingably mounted and balanced thereon in such a manner as to normally urge the grate towards and maintain it in a closed position to retain the metal charge materials within the container. The construction is such that the closing-off action or force is increased with the weight or mass of the metal charge materials.

The partible grate 12 is of reinforced construction and has projecting lifting lug portions 16 which cooperate with lifting means, such as metal cables (chains) 30 that are removably latched or connected with the furnace C to accurately align the container unit B in a charging position with respect thereto (see FIGURE 8). The grate 12 is actuated by raising the container unit B relative to the open mouth of the furnace C (see FIGURE 9), so as to accomplish a discharging operation in a positive manner by cooperation between the melting furnace and the container. It is thus apparent that the opening of the partible grate 12 cannot be accidentally effected, must be positively effected, and can only be so effected when the portable conditioning unit or container B is in a full charging position with respect to the furnace. This provides a highly safe arrangement which can be accomplished remotely without any danger to the operating personnel of the plant.

With particular reference to the drawings, I have illustrated the conditioning or container unit B as having an elongated or vertically-extending container 10 of cylindrical shape. The container 10, as shown particularly in FIGURES 1 and 2, has an outer metal shell wall 11*a* and a heat-resistant refractory inner wall 11*b* that define a conditioning chamber for the metal charge materials (load) introduced therein through its open top end portion.

The partible grate 12 is illustrated as having two opposed and complemenetary partible halves or portions of identical construction, see particularly FIGURES 1 and 10. When the grate 12 is in its closed position of FIGURE 1, it curves centrally-downwardly-inwardly to form a dished or cup-like shape for supporting the metal charge materials within the container 10.

The orifices in the swinging gate construction of my invention are highly important or critical in attaining the improved results. The width distribution and total area of the orifices control the rate of heating and the overall efficiency. Care should be taken in loading the lower layers of a charge, as small pieces of scrap can become jammed in the orifices in such a way that they may stand up above the clearance and prevent proper opening of the gate halves. It will be recognized that metal scrap is the most heterogeneous item that the electric melting field has to handle. Such a hazard can be easily dealt with by setting aside about 20% to 30% of the scrap that does not contain turnings, wire clippings, small plate clippings, and the like, and charging such scrap first as a lower layer. Then, practically any type of scrap may be added, avoiding exceptionally bad shapes that will hang and cause voids. At the beginning of each day, the gate, when relatively cool, may be examined to assure that the orifices are clear. In this country there is always a small percentage of scrap which should be hand-charged at the end of any charging period.

Another important feature of the construction of the gate is that each part swings on its own independent pivot or swing axis and, in such a manner, that if one should become stuck the other one will emtpy the preheating container.

As shown particularly in FIGURES 1, 8, and 9, each part of the grate 12 has a pair of upwardly-projecting and transversely-opposed swing arms 13 which are secured by suitable means, such as weld metal, to an upper cylindrical or annular flange portion 12*a* thereof. As shown, the swing arms 13 on each side of the unit B are of reinforced construction and, at their upper ends, are pivotally or swingably mounted by pins 14 on a reinforcing mounting plate 15. There are a pair of mounting plates 15 on opposite sides of the metal plate wall 11*a* of the container 10 that are suitably secured thereto, as by weld metal. It will be noted that each plate member 15 supports a side pair of swing arms 13 which constitute swing arms for one side of the partible portions or halves of the grate 12. Each gate half swings on its own independent pivot, so that if one becomes stuck, the other may be used to empty the container 10.

As shown particularly in FIGURE 10, the two halves of the partible grate 12 are of somewhat cupped or semi-circular section and have complementary inner planar edges 12*b* which are adapted to cooperate with each other to, when they are in a closed position, define a structure that is of substantially cupped, dished or concave shape upwardly thereof. As shown particularly in FIGURE 1, the top flange portion 12*a* extends upwardly in a spaced relation with the lower perimeter or boundary of the container 10 and about the metal shell 11*a*, to provide an edge seal therewith. The outwardly-projecting lift lugs 16 have eyelets to receive hooks 33 of the metal cable (or chain) 30 and are secured or mounted on each half of the grate 12 for utilization, as shown particularly in FIGURES 8 and 9.

As shown particularly in FIGURES 10 to 13, each half of the grate 12 is provided with short, outer, radially-inwardly-extending and peripherally-spaced-apart, reinforcing ribs 12*c*, that extend from the flange 12*a* and are connected to a radially-inwardly-spaced, curved, semi-circular reinforcing rib 12*d*. A pair of transversely spaced-apart, longitudinally-extending reinforcing ribs 12*e* are connected at their outer ends to the curved rib 12*d* and centrally, to a centrally-disposed, radial or cross-extending transverse rib 12*f*. The inner planar edge 12*b* of each grate half has a reinforcing rib 12*g* that is connected to the opposite ends of the curved rib 12*d*. A centrally-disposed, semi-circular rib 12*h* is connected at its ends to inner ends of the planar rib 12*g*.

A semi-annular or circular, substantially horizontal, planar bottom flange 17, about the outer periphery of the grate halves, provides an annular positioning flange for the grate when the unit B is positioned or resting on the base unit A. In the spacing between the reinforcing ribs, I have provided flow orifices or elongated grate open portions 18 for flowing or by-passing hot gases upwardly therethrough. The open portions 18, as shown particularly in FIGURE 10 and the cross sectional detail of FIGURE 14, have a cross-section of upwardly-converging frusto-conical shape or bore *a* from the bottom face of the grate 12 and, adjacent the upper face thereof, of circular or uniform shape or bore *b*. This provides flow orifices in which the hot gases flowing upwardly through the grate 12 are first restricted to provide velocity streams by the shape or bore *a* and are then flowed, without further restriction, and in a uniform path along the wall shape or bore *b* into the bottom of the container 10.

It will be also noted that the orifice or flow passageway portions 18 are distributed substantially uniformly throughout the transverse and longitudinal area of the grate 12 to provide an overall or a substantially uniform supply and flow of the gases upwardly therethrough. As distinguished from a peripherally-segregated area of flow, this is highly advantageous in my construction from the standpoint of providing a full flow area beneath the metal charge materials and away from the peripheral or outer limits thereof, within the enclosing chamber defined by the container 10. This construction, in combination with the utilization of means for providing a positive flow of the hot gases, provides a substantially uniform type of conditioning action upwardly through the full extent of the mass of the materials within the container 10 and prevents leaving of cold and unconditioned spots and areas, particularly in the central portion of the mass. It further assures a maximum efficiency and effectiveness of conditioning and heating the materials between their interstices and such that heat of the gases is quickly transferred thereto, and such that the gases exhausted from the hood of the container 10 are of a relatively low temperature. The maximum effectiveness of use of the heat of the gases is further assured by the construction of the hood (see FIGURES 1 and 3) and by controlling or proportioning the throat through which the outflow of the exhaust gases is effected from the hood 40 of the container unit B into the duct work.

The base unit or heater A has an outer metal shell wall 20*a* and an inner refractory or heat-resistant wall 20*b* and is adapted to removably receive and position the unit B during the period of pre-conditioning the metal charge materials therein, and to provide for raising and lowering the unit B into and out of a cooperating hot-gas-receiving position with respect thereto. As shown particularly in FIGURES 1 and 2, the combustion or base unit A has an inner combustion chamber defined and enclosed by the walls 20*a* and 20*b*. The upper portion of the metal shell wall 20*a* is provided with an angle piece 21 whose upper flange defines a sealing and supporting flange to cooperate with and abuttingly receive the horizontal flange 17 of the partible grate 12.

It will be further noted that the refractory wall 20*b* has a central post 20*c* that projects upwardly in alignment with a closed, central, circular, support and distribution portion 19 for the ribs of planar top surface, as defined by the flanges 12*h* of the grate 12, to thus provide a safety support for the grate. However, it will be noted that ordinarily, as shown in FIGURE 1, there is a slight clearance spacing between the central post portion

20c and the flanges 12h so as to permit expansion and contraction of the grate within prescribed limits.

As illustrated in FIGURES 1 and 2, the unit A is shown provided with a group of burner units 25 at peripherally spaced locations thereabout to supply hot combustion gases to its chamber. The arrangement is such that the gases reach a substantially uniform temperature in the circular or annular chamber and become thoroughly mixed before being drawn or raised up through the grate 12. Each burner unit 25 has an air supply opening 25a and a fuel supply pipe 25b. In this connection, a suitable fuel, such as natural gas, may be supplied to the pipes 25b of the units 25 by a common header 26 and a main supply pipe or source 27, as controlled by a shut-off and flow control valve 28. A suitable combustion gas mixture is provided in mixing chamber 25c for the flame which issues from an inwardly-diverging open-end bore 25d.

In accordance with my invention, as previously indicated, the swingable mounting of the parts of the grate 12 on the container 10 is such that such parts are normally urged to the closed position of FIGURE 1, and that the weight or mass of the materials being conditioned will contribute to or enhance such closing action. The halves of the grate 12 can only be moved or swung to their radial-outward and upward open positions by positive pulling force action, as effected in the manner shown in FIGURES 8 and 9. In this connection, as illustrated, the pair of side cables 30 are interleaved over a pair of side pulleys 31. Each pulley 31 is rotatably carried on an outwardly-projecting mount 32 secured on the metal wall 11a, adjacent the upper end of the container 10. The hook 33 on the inner end of each cable 30 is adapted to latch within one lug 16 of the gate 12; a hook 34 at its opposite end is adapted to engage within one lug 35 that is mounted on the melting furnace C. It will be noted that the pair of lugs 35 as well as the pair of lugs 16 have a diametrically-opposed relationship. A metal banding rim structure 36 is shown secured about the open delivery end portion and on a metal shell wall 37 of the furnace C. This rim structure 36 carries the lugs 35.

The container 10 of the unit B is shown provided with a U-shaped lifting handle or bracket 38 which, at its lower ends, is pivotally mounted at 38a for swingable positioning on the metal wall 11a. As shown in FIGURE 1, a stop 11d positions the handle 38 in a downwardly-declining position when not in use to facilitate its engagement by a hoist or crane hook 39 (see FIGURE 8). Thus, the hook 39 of a conventional overhead traveling crane hoist may be employed to lift the complete unit B from the combustion unit, heater or base A to a position in alignment with the melting furnace C and, at which time, the hooks 34 are engaged with the lugs 35 to not only align the container unit 10 with the furnace C, but also to enable the opening of the grate 12 by then relatively raising the unit 10 with respect to the furnace C, as shown particularly in FIGURE 9. In this manner, the pre-conditioned charge is then directly fed or charged into the melting furnace C. After such charging, the hooks 34 are then disconnected so that the parts of the grate 12 return to their normal closed positions.

With particular reference to FIGURES 1 and 3, the shell wall 11a of the container B is provided with an annular, planar, top seating flange 11c which is adapted to define a slide-fit, sealing edge and support for an opposed, annular, sealing flange 41c of the cover, hood or lid 40. The hood 40 has an outer metal shell wall 41a and an inner heat-resistant or refractory wall 41b that defines an upper, gas-receiving chamber above the conditioning unit B, when the hood and the unit are in a cooperating aligned position, such as shown in FIGURE 1, and during the conditioning of metal charge materials within the container 10.

The hood or lid 40 has a metal bottom plate part or baffle member 42 (see also FIGURE 3) which is provided with a central gas-bypass open or port portion 42a therethrough, a surrounding central annular or cylindrical sector portion 42b that serves as a central baffling and that is of upwardly-concave shape, and an outer horizontal or planar plate portion 42c connected to the portion 42b and to the seating flange 41c. A series of elongated and peripherally-spaced passageway or open portions 42d are provided in the outer plate portion 42c for bypassing gases upwardly into the chamber of the hood 40, in combination with the central open portion 42a. The metal bottom plate structure baffle member 42 is of integral construction and is secured at its outer peripheral edges, as by weld metal, to the seating flange 41c. The baffling thus provided assures a maximum utilization of the hot combustion gases within the conditioning chamber of the container 10 before they enter the chamber of the hood 40.

The upper end of the hood 40 is provided with an exhaust collar or outlet pipe 43 (see FIGURE 1) which has a top flange defining a slidable-sealing fit with a bottom flange of a primary exhaust duct or conduit 45. The duct 45 has a vertical downstream portion 45a, an intermediate, horizontal, outwardly-projecting portion 45b within which the indicator means 72 and the damper 50 are operatively positioned, and has a vertical upstream or upper end portion 45c that projects at its upper end in a spaced relation within the downwardly-diverging or flared, annular inlet flange or skirt portion 46a of adjustable collar or sleeve 46 that is slidably-adjustably mounted on a lower end portion of a secondary, vertical exhaust duct or conduit 47. Atmospheric air, as indicated by the arrows c, may enter the vertical duct 47 between the portion 45c and the inlet flange 46a to mix with and cool the exhaust gases that are entering the conduit 47 to protect the exhaust fan 48.

A constant speed, back-pressure-providing, unidirectional exhaust fan 48, such as shown in the Garden City Fan Company catalog 565A, may be employed in this connection, see particularly the Class II construction of page 4 of such catalog. The fan 48 is provided with an electric driving motor 49 and an "on" and "off" push button switch 80 for controlling its energization. The motor 49 will be operated to drive the fan 48 at a constant speed during the full period of conditioning of charge materials within the conditioning unit B. A three horsepower motor, for a ten foot diameter conditioning container 10, has been found satisfactory for operating this fan at its constant speed to, not only positively draw off the exhaust gases through the duct 45 from the hood 40, but to also draw in tempering atmospheric air c through the annular passageway between the duct portion 45c and the flange or skirt portion 46a.

Referring particularly to FIGURES 4, 5, 6, and 7, I have illustrated a suitable butterfly type of damper or gas flow valve construction or unit 50 for controlling the flow of exhaust gases from the conditioning unit B and provide variable degrees of back pressure. The damper unit 50 comprises a flanged section or segment of conduit 51 which is securely connected between the horizontal portion 45b (as by flanges and bolts) and the upper end portion 45c of the conduit 45, and which carries a substantially cylindrical damper or valve plate 52. The damper plate 52 is provided with a central axis shaft 53 which is secured thereto to extend thereacross through rotatable mountings 54a and 54b at opposed ends of the conduit segment 51.

One end of the shaft 53 extends through a side sector plate 55, see FIGURES 1, 6, and 7, that is secured to the one side of the conduit segment 51 and that has a curved guide slot 55a. A swing arm 56 is at one end keyed or secured to the projecting end portion of the shaft 53 and has a guide cam 57 mounted thereon, adjacent to and in a spaced relation from the shaft 53, to move along the guide slot 55a of the sector plate 55 and control the amount of opening and closing of the plate 52 with respect to the conduit sector 51. In the position shown in FIGURE 7, the plate 52 fully closes off gas flow through the duct or conduit 45 and, when it is swung to a horizontal position in such figure, along the slot 55*a*, it is fully open to fluid flow. Between such extreme upper and lower positions of the cam 57 in the slot 55*a*, the plate valve or damper plate 52 provides a desired control of the flow of exhaust gases through the conduit sector 51 and thus, out of the conduit 45 into the stack duct or conduit 48.

A second or operating lever arm 60 is at its inner end keyed or secured on the other end of the shaft 53; and, at its extending end, is pivotally connected to a headed pin 62*a* of a swivel 62 and by clamping jaws of the swivel 62 to one end of a connecting rod 63. A second swivel 64 has clamping jaws secured on the other end of the connecting rod 63 and carries a crank pin 64*a* that pivotally or rotatably projects into the outer end portion of a crank 65. The inner end of the crank 65 is secured on the shaft of an electric motor 66, so that actuation of the motor 66 may be employed for moving the damper valve plate 52 between its fully open and closed positions within the conduit sector 51, as controlled by the guide slot portion 55*a* of the sector plate 55.

After the charge materials have been conditioned in the container 10, the hood 40 may be moved out of a cooperating closing-off relation with the open top end portion of the container by suitable means, such as a swing arm mounted on a post or upright as disclosed in my Patent No. 2,804,295. In this manner, the hood or lid 40 can be swung into and out of a closing-off relation with the container 10, between the top flange 11*c* of the container and the bottom flange of the duct portion 45*a*. Such means is not a part of my present invention, and it will be apparent to those skilled in the art that any suitable apparatus may be employed in this connection. Further, after the hood has been swung away from the container, if desired, the conditioned charge materials may be compacted by means, such as disclosed to the right of FIGURE 1 of the drawings of my patent, and before the charge materials are fed to the melting furnace C.

In FIGURE 1, I have shown an upright mount or post 75 on which an instrument panel 76 is mounted. Although not shown, indicating gauges for the indicators 70, 71, 72, and 73 may be positioned on the panel 76 for convenient reading by the operator.

Also, as shown in FIGURE 1, the motor 49 for actuating the fan 48 is energized by a suitable electric source E that has one lead directly connected through panel terminal 81*a* and cable 82 to motor terminal 49*a* and that has its other lead indirectly connected to motor terminal 49*b* through push button switch 80, panel terminal 81*b* and cable 82.

For controlling movement of the damper operating motor 66 (see FIGURE 4), I have shown an "on" and "off" push button switch 84 on the panel 76 (see FIGURE 1). One motor terminal 65*a* of the motor 66 is connected directly to the source E through panel terminal 85*a* and cable 86. The other motor terminal 65*b* is connected indirectly to the other side of the source E through push button switch 84, panel terminal 85*b* and cable 86. Since the motor 66 is a reduction gear type for relatively slow speed operation, the amount of turning of the damper plate 52 can be accurately governed by the time period.

Although for purposes of simplicity of illustration, I have shown a manual control for turning the plate 52 for controlling back pressure with reference to the positive flow of hot gases from the open top end portion of the container 10, I also contemplate the use of an automatic pressure controller, such as the type 11036 disclosed in the Leeds and Northrup catalog 177005 issue No. 3. In this connection, I will employ a recorder, such as disclosed in the catalog, either in place of or in combination with the pyrometer 72.

In carrying out an operation in accordance with my invention, about one third of the charge at the bottom of the container should comprise some material, particularly where scrap metal is being used, that will absorb the heat of the gas rapidly and at the same time allow it to pass freely. The remainder of the material or scrap need only be given reasonable attention to avoid jamming which is similar to the practice involved in connection with cupola and blast furnace practice. In accordance with my present invention, I avoid the tendency of the hot gas to short circuit along the outside perimeter of the charge. A controllable rate of the heating medium is maintained at all times, in order to get the heating started and at the best rate and to develop a reasonable uniformiy of temperature throughout the charge.

A variable speed exhaust fan 48, such as previously mentioned, which will resist a temperature of 700° up to about 1200° F., is satisfactory for positively drawing off the gas from a flow opening at the top of the container. Its control switch 80 is placed in a prominent position for ready utilization. Means is associated with exhaust ducting connected to the flow opening for tempering the exhaust gas with atmospheric gas before the gas reaches the exhaust fan to protect it from excessive temperatures.

In employing my construction, I have been able to eliminate a swinging crane, except for small foundries which have no available overhead crane. The body of the container 10 should be lined with about 4 to 6 inch thickness (depending on diameter of the container) of dense hard and first class fire brick, such as used for ladle lining and which can best resist scratching and erosion of scrap. The joints should be dipped and each fitted to its neighbor. The hood 40 may be lined with a semi-refractory cement of the 1400° F. classification.

As to the orifices of the grate 12, the special section portion *a* provides for free entry of the heating gases and the portion *b* may be easily enlarged by means of a thin emery wheel, as desired. This gives considerable flexibility to the heat distribution value of the grates, in that all of the orifices may be enlarged for greater heating capacity or certain of them in a given area may be enlarged to suit the load being handled. By employing a constant speed fan 48 in the exhaust from the container, having a suitable volumetric capacity depending on the size of the heater, and capable of withstanding a temperature of not less than 700° F. and further, by properly controlling the butterfly damper 50, I have been able to completely control the heating operation. If desired, an air pressure gauge may be positioned in the conduit 45 to automatically control the damper 50.

If a bolted connection is used between the flanges of the collar 43 and the duct 45, at the end of each seat, the hood 40 is swung around carrying with it the duct 45 and the pressure control (damper or valve 50). This movement indicates that the control panel be located adjacent to the swinging gear column, if one is used.

By way of example, in operating the apparatus, a pair of heating container units B and their swing gates are checked to assure that all orifices are clear. Then each heater is charged, beginning with a bottom layer of material representing the selected materials previously discussed, with the rougher materials added vertically thereto. The hood 40 is then swung into place and the constant speed fan motor is started. The butterfly valve 50 is at such time set at its fully open position. The burners 25 are previously lit to condition the containers and their operation is continued until the completion of the conditioning of the charge material which is added thereto. At such time, the hood 40 is removed from one container and such container is carried over, as by an overhead crane, in alignment with the vertical axis of the open mouth portion of a melting furnace C which has been fitted with suitable hooks to engage the grates. The container unit B is then raised with respect to the furnace C to open its gates and charge the pre-heated scrap material through its open mouth portion. The container is then immediately returned to its initial position over the combustion chamber. The operation is then repeated as to the second container to complete the charging of the furnace.

The overall efficiency of the pre-heating is greatly increased by maintaining an idling heat on the heater during the charging period, by immediately returning the empty container to the heater, and by maintaining a so-called idling temperature on the empty container up to the time when it is again charged (recharged). This retains the heat of the walls and the lining and sets up important channels for the heating means to pass through the charge or scrap mass as it is being introduced, as well as after it is completely charged, but before the exhaust fan takes over.

The interim idling step is important, not only in accomplishing the desired type of full heat flow through the full charge, but also in more efficiently and effectively bringing the charge up to full heat. Progressive portions of the charge are warmed as they are progressively introduced with minimized heat load on the equipment. Difficulties incident to a cold charge are avoided, a better heat economy is attained, wear and tear on the equipment is minimized, and a desired type of heat flow through the charge is accomplished. The idling temperature of the hot gas supplied by the heater A may correspond to the full operating temperature, but is preferably slightly lower, for example, in the neighborhood of 100° to 300° lower, where the full operating temperature is about 1400 to 1500° F. I employ this same principle in preliminarily heating the containers **10** up in starting the operation; and, during the first charging of the metal materials, I maintain the idling hot heating gas flow to set up proper flow channels or passageways through the materials.

What I claim is:

1. A method of pre-conditioning metal materials in the nature of scrap, sponge and briquettes within a conditioning chamber defined by the inner periphery of an upwardly-projecting enclosing container having a swingable bottom grate for maintaining the materials in position therein during their conditioning and for thereafter charging the materials into an open mouth of a melting furnace which comprises, inducing a velocity flow of hot gases uniformly upwardly through a central area of the bottom grate in an inwardly-spaced relation from the inner periphery of the container into the lower end of the conditioning chamber; flowing the hot gases substantially uniformly upwardly along the conditioning chamber and out of the upper end of the container, while progressively charging the metal materials downwardly through the upper end of the container along the conditioning chamber into a supported relation on the grate until the chamber is fully charged with the materials, and while establishing flow channels for the hot gases through the materials; then placing a hood over the upper end of the container and applying a controlled positive upward drawing-off force to the hot gases through the hood, while maintaining an upward flow of the hot gases along the established flow channels through the materials until the materials in the conditioning chamber are fully heated-up and conditioned; and finally, swinging the bottom grate to an open position and directly charging the heated and conditioned materials into the open mouth of the melting furnace.

2. A method as defined in claim 1 wherein, the positive upward drawing-off force applied to the hot gases through the hood is controlled to maintain the grate within a maximum temperature of about 1550° F., to maintain the temperature of the hot gases within the conditioning chamber at about 1400° to 1450° F., and to assure a maximum efficiency of utilization of the heat of the hot gases in heating up and conditioning the material in the conditioning chamber.

3. A method as defined in claim 1 wherein the hot gases are introduced into the conditioning chamber through a plurality of transverse rows of orifices in the grate that are spaced inwardly from the inner periphery of the container, the control of the positive upward drawing-off force applied to the hot gases is accomplished by periodically taking mean temperature readings of the hot gases in the conditioning chamber and adjusting the size of a flow opening from the hood in accordance therewith to maintain an effective conditioning of the metal materials and conserve the heat of the hot gases during the heating and conditioning of the materials, and the maximum temperature of the hot gases that are being flowed through the grate is controlled to prevent damage to the grate.

4. Apparatus for pre-conditioning metal charges in the nature of scrap, sponge and ore briquettes and for charging pre-conditioned metal materials into a melting furnace comprising, in combination, an elongated container having an open upper end for receiving the metal materials, having a heat-resistant wall defining an enclosing chamber for conditioning the metal materials, and having an open lower end for dicsharging conditioned metal materials therefrom; a grate positioned on said container for opening and closing movement at the open lower end thereof to, when closed, define a retaining grate for supplying conditioning heat to the metal materials in the enclosing chamber and to, when opened, discharge conditioned metal materials from the open lower end of said container into the melting furnace; a hot-gas-generating base unit having an open upper end for discharging hot gases upwardly therefrom and for removably-supporting the lower end of said container thereon with said grate extending over the open upper end thereof to receive hot gases therefrom, said base unit having means for supplying the hot gases at a substantially uniform elevated temperautre upwardly through said grate into the open lower end of said container; means removably connected to the open upper end of said container for positively drawing the hot gases from said base unit upwardly through said grate and for controlling the rate of withdrawal of the gases from the open upper end of the container, substantially uniformly through the metal materials within the enclosing chamber, and in a partially cooled condition out through the open upper end of said container; means for moving said container after the metal materials have been conditioned within the enclosing chamber from said base unit into an aligned position with the melting furnace, and means cooperating with said container for swinging said grate to an open position to discharge the conditioned metal materials into the melting furnace.

5. Apparatus for pre-conditioning metal charge materials in the nature of scrap, sponge and ore briquettes for introduction into an open mouth of a melting furnace which comprises, an elongated container having an open upper end for receiving the metal materials, having a heat-resistant wall defining an enclosing chamber for conditioning the metal materials, and having an open lower end for discharging conditioned metal materials therefrom; a grate swingably positoned on said container for opening and closing movement at the open lower end thereof to, when closed, define a retaining grate for supplying conditioning heat to the metal materials in the enclosing chamber and to, when opened, discharge conditioned metal materials from the open lower end of said container into the melting furnace, means connected to said grate and operatively positioned on said container for opening and closing said grate, and said means has portions to centrally-cooperatively-align said container with and above the open mouth of the melting furnace before said grate is opened to discharge the conditioned metal materials therein.

6. Apparatus for pre-conditioning metal charge materials in the nature of scrap, sponge and ore briquettes for introduction into a melting furnace which comprises, a vertically-elongated container having an open top end for receiving the metal materials, having a heat resistant wall defining an enclosing chamber for conditioning the metal materials, and having an open lower end for discharging conditioned metal materials therefrom; a partible grate, means swingably mounting said grate at the open end of said container and normally biasing it towards a closing position with respect to said container, means for supplying conditioning heat up through said grate when it is in its closed position for conditioning metal materials in the enclosing chamber; and operating means carried by said container, operatively connected at one end to said grate, and constructed for pulling movement at its opposite end to open said grate against the normal closing bias of said first-mentioned means and discharge conditioned metal materials from said container into the melting furnace when said container has been moved into alignment with the melting furnace.

7. Apparatus for processing metal charge materials in the nature of scrap, sponge and ore briquettes for introduction into an open mouth of and for melting in a furnace which comprises, a pre-conditioning container having open upper and lower end portions and having a heat-resistant wall for receiving the metal charge materials and pre-conditioning them therein, a partible grate swingably mounted on said container at the lower end portion thereof for movement between open and closed positions with respect thereto, means for normally maintaining said partible grate in a closed position, said grate having flow orifices therein to by-pass hot treating gases therethrough, an upwardly-open combustion-chamber-defining base having wall portions for removably receiving and supporting said container when said partible grate is in its closed position and for supplying hot combustion gases upwardly through said grate into said container to pre-condition the metal charge materials therein, means for positively drawing the hot gases upwardly along said container through the metal charge materials therein and out of the open upper end portion of said container, and means for indicating and controlling the temperature of the hot gases moving through said grate to prevent overheating of said grate and for indicating the mean temperature of the metal charge materials in said container and controlling the outflow of the gases from the upper open end portion of said container to assure an effective pre-conditioning of the metal charge materials within said container.

8. Apparatus for pre-conditioning metal materials in the nature of scrap, sponge and ore briquettes for introduction into an open mouth of a melting furnace which comprises, an upwardly-elongated container having upper and lower open end portions and having heat-resistant walls defining an enclosing chamber for receiving metal charge materials therein, a partible grate swingably mounted at the open lower end portion of said container to normally move to a closed position for receiving the metal charge materials thereon, a hot-gas-generating base positioned to removably receive the bottom end portion of said container thereon and to supply hot treating gases upwardly through said grate into said container and through the metal charge materials therein to pre-condition them, means for lifting said container off said base after the pre-conditioning of the metal charge materials therein and for moving said container into a cooperating position with the open mouth of the melting furnace, and means carried by said container and cooperating with the melting furnace for centering the bottom end portion of said container above the open mouth of the furnace and for then swinging said partible grate to an open position to discharge the pre-conditioned materials into the melting furnace.

9. Apparatus for pre-conditioning metal charge materials in the nature of scrap, sponge and ore briquettes and for introducing them when pre-conditioned into an open mouth of a melting furnace which comprises, a vertically-elongated conditioning container having an open lower end portion and having a heat-resistant enclosing wall defining a conditioning chamber for the metal charge materials therein, a partible grate operatively carried by said container for swinging movement between a closed position with respect to the open end lower portion of said container to support the metal charge materials therein and to an open position to charge pre-conditioned metal materials into the open mouth of the furnace; a combustion-chamber-defining base for receivably-supporting said container and said grate when said grate is in a closed position and for supplying hot conditioning gases through said grate into the chamber of said container and upwardly through the metal charging materials therein for pre-conditioning them, said base having an outer wall defining a combustion chamber and a centrally-projecting wall defining a central support for said grate, means for lifting said container and said grate off said base and into a position above the open mouth of the furnace, and means cooperating with said last-mentioned means for positively centrally aligning said container with and above the open mouth of the furnace and for swinging said partible grate into an open position to discharge pre-conditioned metal charge materials therein.

10. Apparatus for pre-conditioning metal charge materials in the nature of scrap, sponge and ore briquettes and for charging the pre-conditioned metal materials into an open mouth of a melting furnace which comprises, an elongated conditioning container having a heat-resistant wall defining a conditioning chamber for receiving the metal charge materials therein and having an open lower end portion, a partible grate, means swingably mounting said grate on said container and balancing said grate for normally maintaining it in a closing-off position with respect to the open lower end portion of said container and for utilizing the weight of the charge materials to support the metal charge materials therein, means for conditioning the metal charge materials within said container, and means associated with said container for opening said partible grate to discharge pre-conditioned metal charge materials therefrom into the open mouth of the melting furnace when said container has been removed from said base.

11. Apparatus as defined in claim 10 wherein said means for opening said partible grate comprises, swing arms carried by said container and operatively connected to side portions of said grate, lifting lugs projecting outwardly from end portions of said partible grate, and cable means operatively connected to said lifting lugs for swinging said partible grate outwardly on said container to open it on said container.

12. Apparatus as defined in claim 10 wherein, lugs are carried by the furnace, and said cable means is provided with means for detachable-connection with said last-mentioned lugs to open said grate when said container is lifted away from the furnace.

13. Apparatus for pre-conditioning metal charge materials in the nature of scrap, sponge and ore briquettes and for charging the pre-conditioned metal materials into an open mouth of a melting furnace which comprises, an elongated conditioning container having a heat-resistant wall defining a conditioning chamber for receiving the metal charge materials therein and having an open lower end portion, a partible grate, means swingably mounting said grate on said container and balancing said grate for normally maintaining it in a closing-off position with respect to the open lower end portion of said container to support the metal charge materials therein, said grate having a closed-off outer peripheral flange portion that defines a closed-off area about the inner periphery of said container and also having a plurality of elongated

flow orifices through its inner transverse portion to define a central area for passing hot gases in velocity streams upwardly substantially uniformly into the conditioning chamber of said container and away from outer peripheral portions of the charge materials in the chamber, a gas generating base for removably supporting said container and said partible grate and for supplying hot conditioning gases upwardly through the flow orifices of said grate into the conditioning chamber of said container through the metal charge materials therein for pre-conditioning them, and means associated with said container and the melting furnace for opening said partible grate to discharge pre-conditioned metal charge materials therefrom

into the open mouth of the melting furnace when said container has been removed from said base.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,180,724 April 27, 1965

Frank W. Brooke

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 12, line 51, for "seat" read -- heat --.

Signed and sealed this 21st day of September 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents