April 1, 1969 R. E. ZINN 3,436,061

ROTATING SECTIONED FURNACE

Filed May 25, 1967 Sheet 1 of 4

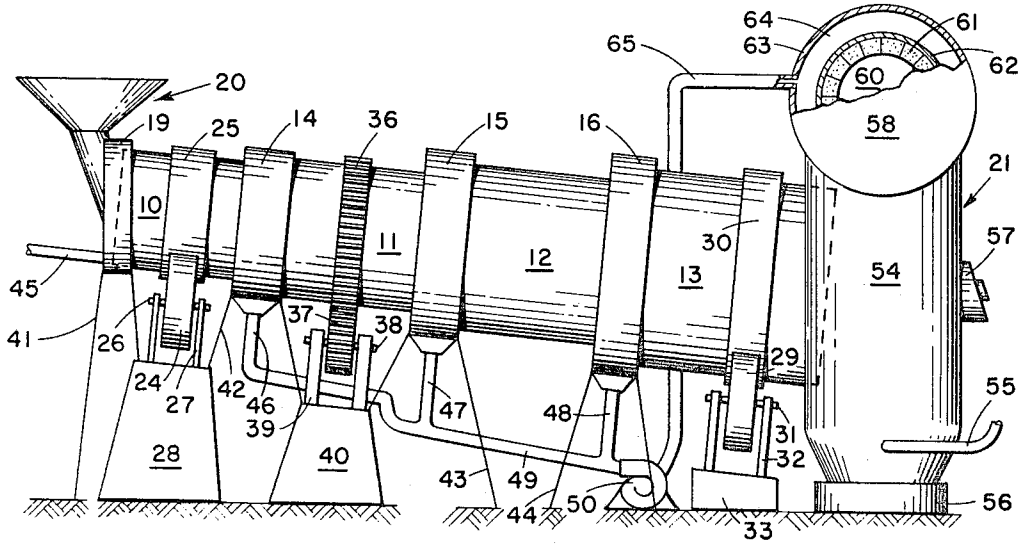


Fig. 1

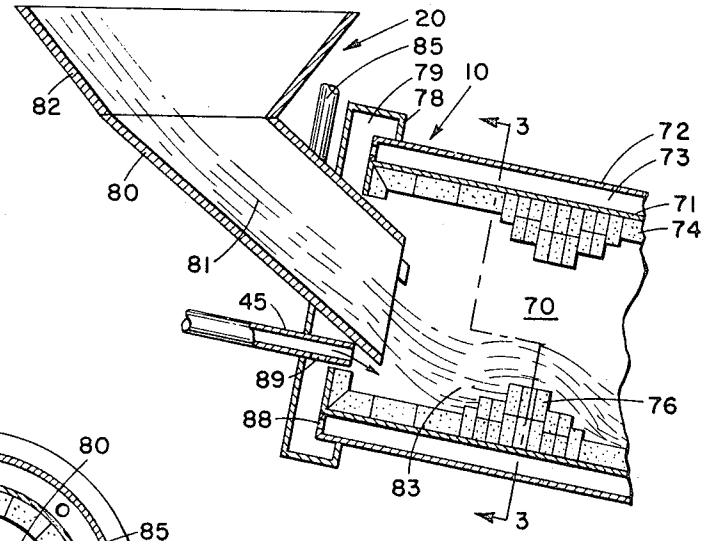


Fig. 2

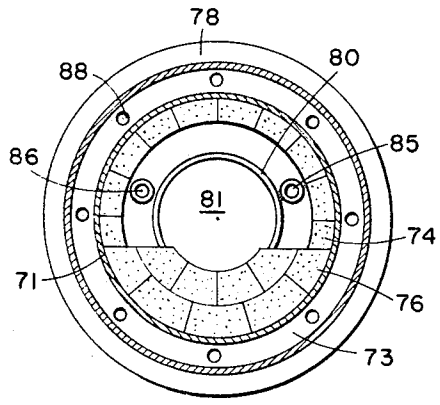


Fig. 3

Robert E. Zinn
INVENTOR.

BY Bruce A. Lyon

Attorney

April 1, 1969 R. E. ZINN 3,436,061

ROTATING SECTIONED FURNACE

Filed May 25, 1967 Sheet 2 of 4

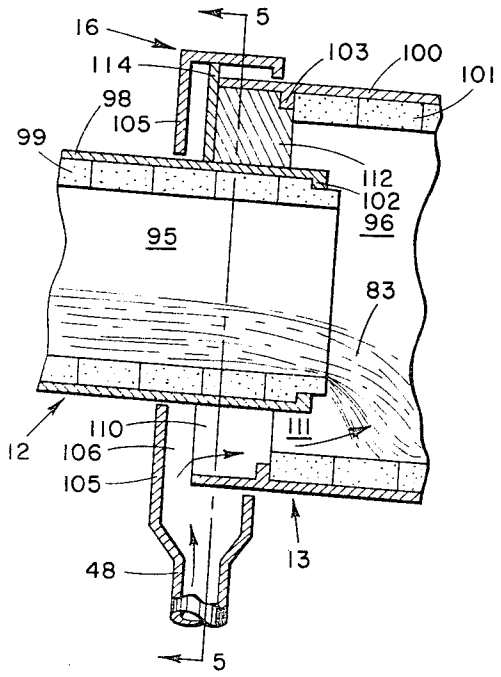


Fig. 4

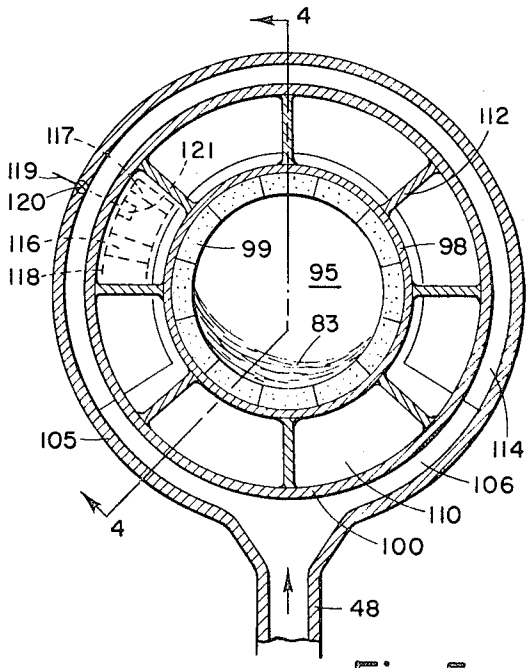


Fig. 5

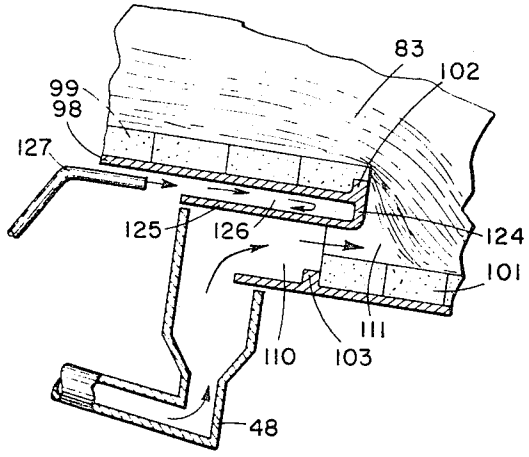


Fig. 6

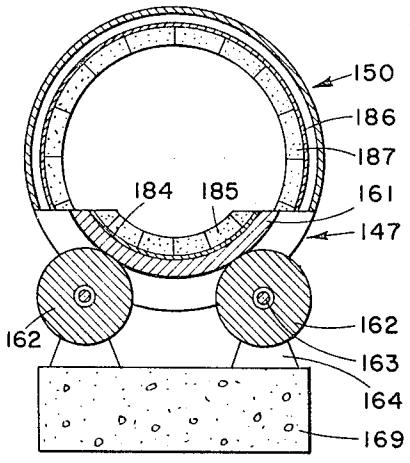


Fig. 9

Robert E. Zinn
INVENTOR.

BY Bruce A. Lyons

Attorney

April 1, 1969 R. E. ZINN 3,436,061

ROTATING SECTIONED FURNACE

Filed May 25, 1967 Sheet 3 of 4

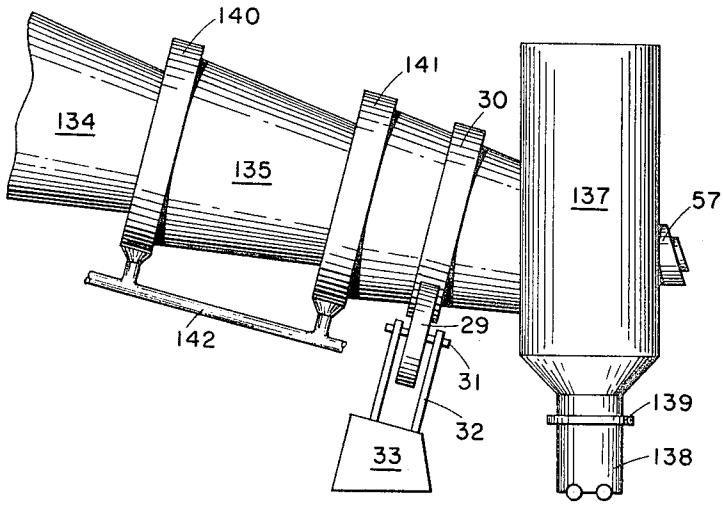


Fig. 7

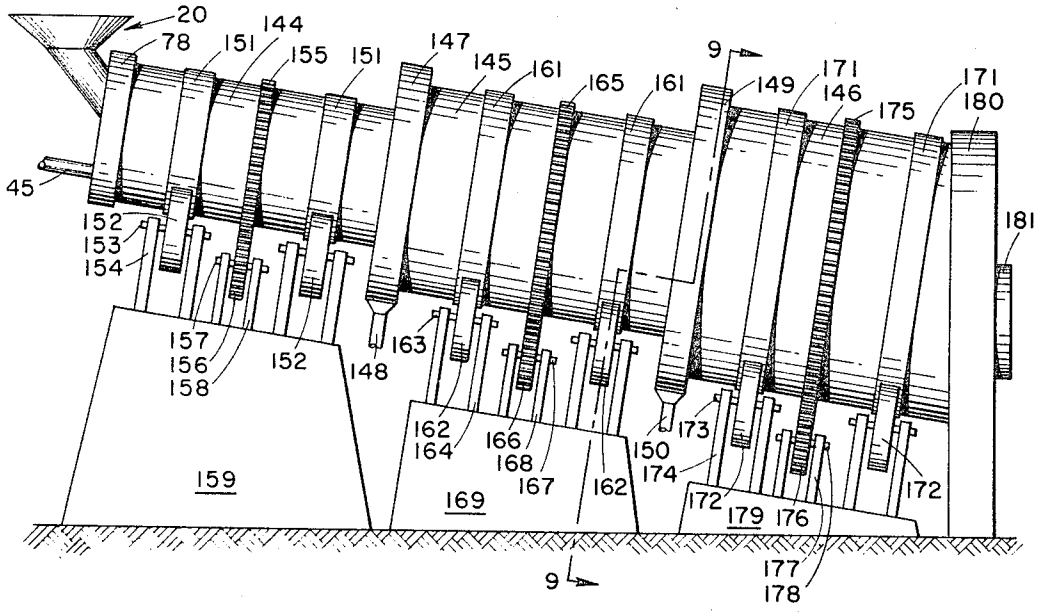


Fig. 8

Robert E. Zinn
INVENTOR.

BY Bruce A. Lepper
Attorney

April 1, 1969 R. E. ZINN 3,436,061

ROTATING SECTIONED FURNACE

Filed May 25, 1967 Sheet 4 of 4

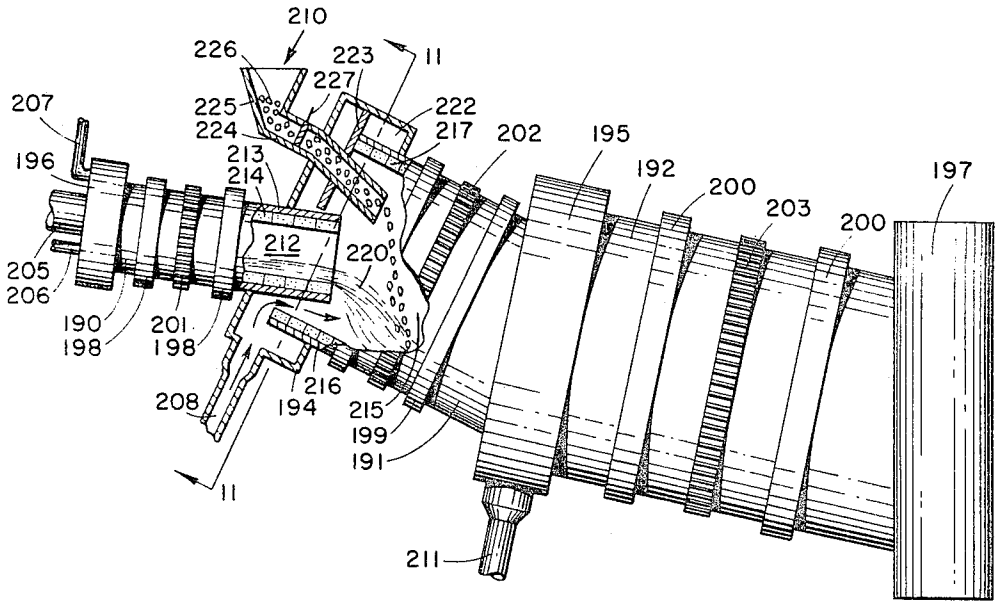


Fig. 10

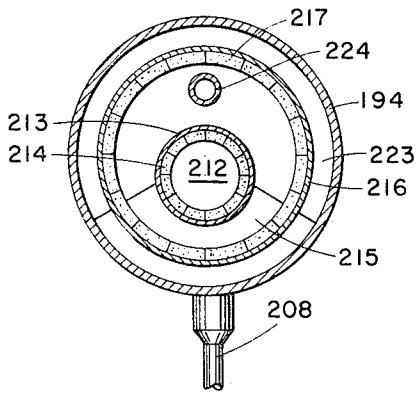


Fig. 11

Robert E. Zinn
INVENTOR.

BY Bruce A. Lyon

Attorney

United States Patent Office

3,436,061

Patented Apr. 1, 1969

3,436,061

ROTATING SECTIONED FURNACE

Robert E. Zinn, Lexington, Mass., assignor to Arthur D. Little, Inc., Cambridge, Mass., a corporation of Massachusetts

Filed May 25, 1967, Ser. No. 641,322
Int. Cl. F27b 7/36, 7/02
U.S. Cl. 263—32
23 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to a furnace adapted to effect reactions between solid matter, or semi-solid matter, and a fluid. The furnace is particularly suited to burning or reacting those solid materials which could plug or damage a grate by overheating, oxidation or otherwise. The furnace is constructed of segments in telescoping relationship positioned at an angle with the horizon. The segments may or may not be axially aligned. Each segment is rotated for stoking action and discharges the solid material by gravity into the succeeding segment in a manner to permit the introduction of fluid under the solids as they are transferred from segment to segment. The furnace is particularly suited for use as an incinerator or as a pyroprocessing kiln, including reduction and oxidation as well as many additive reactions involving gases, liquid and solid reactants.

It is often necessary to be able to burn or otherwise react solid materials, or semi-solid materials, with a fluid, e.g., dry air, air which may contain water vapor, or other fluids such as Cl_2, SO_2, HF, SO_3, P_2O_5, etc. As an example, in burning refuse it is necessary to supply air to burn the refuse. This is generally done in stationary combustion chambers or in kilns. In combustion chambers, it is customary to employ moving grates of various designs to advance the solid materials during its burning or reaction, and, if desirable, to supply air below and above the grates. There is, however, a number of classes of refuse or waste which can be burned only with difficulty in combustion chambers having grates; for such materials as plastics, metal foil, glass, etc., can melt and plug or jam the grates. Moreover, when such material melts it runs through the grate and burns under the grate with damage to the grate and fire box. Finally, some reactions are highly corrosive to grate metals.

Rotary kilns without grates have been used as incinerators but they provide no way in which a fluid; e.g., air, can be introduced under the solid material. This in turn means that it is very difficult, if not impossible, to obtain complete reaction between the fluid and solid components and the stoking action is limited to the rotating action. In rotary kilns, it is customary to introduce all or almost all of the air with the charge into the kiln; and this may require the introduction of an excess of air which can quench the initial flame or reaction, or produce intolerable hot spots. Fluid can also, of course, be introduced at the discharge end to flow countercurrent to the direction of solids flow. However, in incinerators this can result in the distillation of undesirable vapors and odors, with their discharge into the atmosphere through the discharging end, which are too cool to react, or oxidize, without the use of an afterburner.

There is therefore a need for a furnace which does not have grates but which has stoking action and which permits introducing the reacting fluid to mix thoroughly with the solid matter at controlled points, as well as over the solid materials, if desired. By introducing the fluids or gases concurrently with the solid material to be burned or reacted, there is no opportunity, as would be with

countercurrent gas feed, to distill out vapors or odors which would be carried through the charging end of the furnace since each reaction may be completed at a predetermined point.

It is therefore a primary object of this invention to provide an improved furnace adapted for reacting solids or semi-solids with fluids, the reaction conditions (reactant ratios and temperatures) being controlled throughout the entire length of the furnace. It is another object of this invention to provide a furnace of the character described which is particularly well suited for burning refuse which can plug or jam grates, or which would be destructive to the grates through corrosive action or the creation of hot spots under the grates. It is another object of this invention to provide a grateless furnace which achieves a stoking action. It is yet another object to provide a furnace of the character described which is adaptable to the addition of solid reactants. It is still another object of this invention to provide a furnace of the character described which prevents the quenching of the initial reaction or flame and permits the complete control of the character and quantity of fluids or solids which are introduced for reacting with the solid material.

Other objects of the invention will in part by obvious and will in part by apparent hereinafter.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which

FIG. 1 is a side elevational view of one embodiment of the furnace constructed in accordance with this invention providing integrated cylindrical segments rotated as a single unit;

FIG. 2 is a longitudinal cross sectional view of the charging end of the furnace in FIG. 1;

FIG. 3 is a cross section of the charging end taken along line **3—3** of FIG. 2;

FIG. 4 is a detailed cross section of the joining of two of the sections of the furnace such as sections **12** and **13** of FIG. 1;

FIG. 5 is a cross section of the joining portion including the hood taken along line **5—5** of FIG. 4;

FIG. 6 is a fragmentary detailed cross section showing a modification of the joining of the two segments of the furnace;

FIG. 7 is a side elevational view of a modification of the furnace providing integrated frustoconical segments rotated as a single unit;

FIG. 8 is a side elevational view of another embodiment of the furnace of this invention providing axially aligned segments which are separately rotated;

FIG. 9 is a cross section of the furnace of FIG. 8 taken along line **9—9** of FIG. 8;

FIG. 10 is a side elevational view partly in cross-section of an embodiment of the furnace wherein the segments are separately rotated and positioned at different angles and means are provided for introducing solid reactants; and

FIG. 11 is a cross section of the furnace of FIG. 10 along line **11—11** of that figure.

Summary of the invention

The furnace of this invention is constructed of a plurality of rotatable sections which are normally but not necessarily in axial alignment and which are in telescoping relation with each other. These segments join

in overlapping relationship and at the point of overlap there is positioned a fluid inlet hood. The solid material within the rotating sections is moved along by gravity, and stoking action is accomplished through the rolling action induced by the rotation of the sections as well as through the spilling of the material from section to section. Underfire air, or other fluid, is introduced into the solid material as it drops by gravity from one section to another. Provision is also made, if desired, for providing overfire air, or other fluid, along the length of the furnace as well as for introducing liquid fuel or liquid residue at the charging end of the furnace. Solid reactants may also be introduced into one or more of the segments.

FIG. 1 is a side elevational view of a furnace constructed in acordance with the teaching of this invention. It will be seen that the furnace is made up of four axially aligned segments or sections **10**, **11**, **12** and **13**. It is, of course, possible to use any number of segments, e.g., two or more. These four segments of FIG. 1, as will be described below in connection with FIGS. 4 and 5, may be joined so that they are in effect one integrated rotatable furnace. Where the segments are joined through overlapping, there are provided hoods **14**, **15** and **16** which are adapted to introduce air or other fluids and/or solids at controlled points into each of the succeeding segments. The charging end is capped with an appropriate stationary end hood **19** which has associated with it a charging means **20**; and the discharging end has a stationary discharge receiving means **21**, both of which will be described in detail below.

Means are supplied for rotating the integrated segmented furnace. Such means can be a pair of rollers **24** which engage tire **25** affixed to section **10** to support the charging end of the furnace. These rollers are rotated on a shaft **26** which is in a bearing support **27** mounted on a suitable contoured foundation **28**. In keeping with customary engineering practice, means will be provided to counteract the thrust forces resulting from the angled position of the tire and rollers. The discharging end of the furnace is similarly supported on two rollers **29** (one of which is shown) engaging tire **30** affixed to section **13**. These rollers **29** rotate on shaft **31** mounted on a bearing support **32** which in turn is also located on a suitably contoured foundation **33**. In keeping with normal practice the furnace may be rotated by the use of a driven gear **36** which is permanently attached to the outer surface of the furnace and engages a driving gear **37** mounted on shaft **38** mounted in a support and bearing **39** which in turn is positioned on a suitably contoured foundation **40**. Finally, suitable supporting means are provided, such as frameworks **41**, **42**, **43** and **44**, to maintain the stationary hoods in position.

As will be pointed out below, it is possible to use the furnace of this invention not only as an incinerator but as a kiln or as a reaction zone or as a series of different reaction zones. However, for convenience in describing the furnace, particularly with reference to FIGS. 1–7, it will be assumed that it is to be used as a means for incinerating certain types of refuse. This means that the fluid introduced will be air for combustion which may or may not contain a certain amount of moisture or water fog.

The combustion air is supplied to the charging end of the furnace through a fluid inlet conduit **45**. There are also provided fluid supply lines **46**, **47** and **48** which are associated with hoods **14**, **15** and **16**, respectively. These are all connected to a common supply manifold line **49** which in turn is connected to a fluid pump **50**.

In the embodiment of FIG. 1 there is shown a stationary chamber **54** associated with the discharge end of the rotating furnace and serving as the discharge receiving means **21**. If it is desired, some combustion or reaction with volatiles may take place in chamber **54** and there is therefore provided a fluid feed line **55** for introducing additional air. This furnace is equipped with a solids collector **56** and an inspection door **57**. The embodiment of FIG. 1 may also have a secondary combustion chamber **58** which is designed to burn volatile and oxidizable materials in the flue gases which may be discharged from the rotating furnace. As an alternative to this secondary combustion chamber, the hot gases from chamber **54** may be introduced into a waste-heat boiler. This secondary combustion chamber, shown partially in cross section, is seen to have a combustion zone **60** defined by a refractory lining **61** enclosed in an inner main shell **62**. In the secondary combustion chamber of FIG. 1 there is provided optional means for preheating the combustion air which is to be used in the rotating furnace and introduced through the hoods **14**, **15**, **16** and through **55**. This is done by providing an outer shell **63** around and spaced from the main shell **62**. Between these two shells there is defined an annular passage **64** into which the combustion air is introduced and preheated prior to its being withdrawn through line **65** into pump **50** for introduction into the hoods **14**, **15** and **16** by way of line **49** and then branch conduits **46**, **47** and **48**.

FIG. 2 is a cross section of one embodiment of the charging end of the furnace of this invention, such as the charging end of section **10** of the furnace of FIG. 1. Within section **10** (and in each succeeding section) there is defined a combustion area **70**. Section **10** is formed of a primary steel shell **71** and an outer steel shell **72** which define between them an annular passage **73** for circulating combustion air for preheating. The second or outer shell **72** is optional and in many cases it will be desirable not to include the preheating passage **73** and permit the furnace wall **71** to be cooled by radiation to the surrounding atmosphere. The section is lined by a suitable refractory material **74** over the inner wall of the steel shell **71**. It will, of course, be necessary to place such a refractory lining anywhere in the furnace where high temperatures are to be encountered. In order to keep the solid matter from being carried along too rapidly and in order to control the amount of solid material which is fed into the remaining sections of the furnace there may be included in this embodiment a dam **76** which is designed to control the flow of solid material **83** through at least the first section of the furnace.

The feed end of the furnace is capped with a stationary hood **78** which defines a fluid passage **79** therein. As an alternative to the hood arrangement of FIG. 2, a vertical stationary end hood **19** may be used as shown in FIG. 1. The charging means **20** comprises a charging conduit **80** which defines a charging channel **81** providing communication between the feed hopper **82** and the combustion area **70**. Combustion air is introduced under the solid material **83** as it leaves channel **81** through the air conduit **45**. It may also be introduced adjacent to the solid material as it enters area **70**. Additional combustion air, fuel, liquid refuse, solids, or a mixture of these (whichever is desirable) is introduced over the solid material through conduicts **85** and **86** which lead from the exterior of the furnace down through the stationary hood **78** into the combustion area **70**. Any number of these auxiliary feed lines may be used; they may also be omitted if desired. Preheated air from channel **73** enters fluid passage **79** through ports **88**.

Turning to FIG. 4 it will be seen how the two aligned sections are joined and the manner in which the hood is used to introduce air at the desired points in each section. In this embodiment the preheating passage and outer shell are not used. It will be appreciated that the details of FIG. 4 are applicable to each of the section overlaps and the hood which covers such overlaps. Furnace sections **12** and **13** define within them combustion zones **95** and **96**. Section **12** is formed of a shell **98** which is lined with refractories **99**. These refractories preferably extend somewhat beyond the end of the shell in order to protect the steel walls and are anchored by means of a key **102**. In like manner, section **13** is formed of a

shell 100 and lined with refractory material 101 which in this case extends somewhat beyond the corresponding point at which the shell 98 and refractories 99 of section 12 overlap. These refractories are held in place by means of a retaining ring 103. The hood 16 is formed of a stationary housing 105 which will be seen to fit closely over the two sections 12 and 13. It is not necessary that a fluid-tight seal be made at this point and this eliminates any wear which might be experienced between the outer surface of the rotating furnace sections and the stationary hood. The hood defines within it an annular passage 106 which is in fluid communication with the feed line 48. There is defined between the two sections 12 and 13 of different diameters an annular passage 110 communicating with area 111 which is directly under the solid material as it flows from the combustion zone 95 to the combustion zone 96. The two shells 98 and 100 which form the outer walls of the two sections 12 and 13 are joined through a series of radial supports 112. Thus, in this way the entire furnace is made into an integrated rotating device on a single common axis. Since it will normally be desirable to introduce the major portion of the air or other combustion gas under the solid material through passages 110 into area 111, it will be necessary to control or completely block off the flow of gas into the upper portion of the rotating furnace. This is done through the use of a web 114 which, as will be seen in FIG. 5, extends around the upper part of the hood and is affixed to the hood wall. However, it may be desirable to introduce some overfire air and to be able to control the amount of this overfire air introduced. This is done by the use of ports 116 in the web which have associated with them dampers 117 operating in suitable tracks system 118. Only one of these is shown in FIG. 5. However, any number of dampers and ports may be used. To each of the dampers is hooked a radial rod 119 which passes through a seal 120 in the hood wall and is affixed to the damper 117 through a suitable trunnion device 121 shown schematically. Other means for moving the dampers may also, of course, be used.

FIG. 6 illustrates a modification of the discharge end of a segment shell. In this modification means are incorporated for cooling the discharge end of the furnace segment. To do this an annular channel 126 is provided and it is defined by an end wall 124 and an outer ring 125. Into the channel 126 cooling air, or other fluid, is introduced through line 127. Thus, this end of the section may be controlled with respect to its temperature.

FIG. 7 is another embodiment of the furnace of this invention showing the use of frustoconical sections in place of the cylindrical sections of the furnace of FIG. 1. In this embodiment, the sections are all of a similar size and configuration and aligned so that the smaller diameter end of the frustoconical section is inserted in telescoping relationship into the larger end of the succeeding section. The hood design and the manner in which the furnace is rotated and operated is essentially the same as that for FIG. 1. In the embodiment of FIG. 7, the secondary combustion chamber is omitted and there is supplied a collection means 137 for accumulating solid materials which can be discharged periodically into a suitable receiving means 138 by opening the gate 139. It is also, of course, within the scope of this invention to make the frustoconical sections of increasing size if desired.

FIG. 8 is another embodiment of a furnace constructed in accordance with this invention. This embodiment does not have a secondary combustion chamber nor a solids collector associated with it. It differs from the furnace of FIG. 1 in that means are provided for rotating each of the sections individually, thus making it possible to treat the solid material differentially in each of the rotating segments. It is possible in the arrangement of FIG. 8 to rotate the sections either at different speeds or in different directions, or both, as may be desired; and also to introduce different fluids into each of the sections, or the same fluid at different rates. In the furnace of FIG. 8 there are provided three axially aligned sections 144, 145 and 146. At the point where these are joined there are provided a hood 147 which receives a fluid through line 148 and a hood 149 which receives a fluid through line 150. The hoods, as well as the construction of the sections, are essentially those which are shown in FIGS. 4 and 5 except that the radial supports 112 are not present inasmuch as the sections are not joined to form an integral component.

The arrangement of the furnace in FIG. 8 requires that each section be provided with a suitable means for rotating it. This is done by providing section 144 with suitable supporting means which include two pairs of rollers 152 which engage tires affixed to the outside of section 144. Only one of the rollers of each pair is shown at each end. These rollers rotate in shafts 153 supported on bearing supports 154 which are mounted on a foundation 159. Also mounted on the foundation is the mechanism for the rotation of the section. This constitutes a driven gear 155 affixed to section 144 and a driving gear 156 along with its shaft 157 and support 158.

In like manner, section 145 is supported on two pairs of rollers 162 engaging tires 161 and rotating on shafts 163 which are mounted on suitable supports 164 which rest on a contoured foundation 169. There is also provided a driven gear 165, a driving gear 156 rotating on shaft 167 in support 168. And finally, section 146 has supports which comprise two pairs of rollers 172 engaging tires 171 and rotating on shafts 173 mounted in supports 174 affixed to a contoured foundation 179. There is also a driven gear 175, a driving gear 176 rotating on a shaft 177 and mounted on a support 178 for rotating section 146. The embodiment of FIG. 8 is provided with a discharge hood 180 and a gate 181 adapted for removing solid materials arriving at or accumulating in the discharge end of section 146.

The embodiment of FIG. 8 permits the rotation of each of the sections at different speeds or in different directions or a combination of both of these forms of operation. Different gases or reactant fluids may be introduced into the different sections and the fluid flow rates may be controlled to make each section, if desired, a separate furnace. The furnace shown in FIG. 8, and in cross section in FIG. 9, would be particularly suitable for calcining materials or reacting solid materials with gaseous reactants where the temperatures and reactant ratios must be controlled for a series of succeeding processing steps.

The furnaces in FIGS. 1–9 have illustrated various embodiments in which the segments are mounted and maintained in axially alignment. However, there may be applications for the furnace of this invention wherein it is desirable to maintain and rotate each segment at a different angle from that of the adjacent segments. In some reactions it will be desirable to control the residence time of the material in each different reaction zone (segment) and this can be done by adjusting the angle of the segment with the horizon and the speed of rotation, or a combination of these. It may also be necessary or desirable to introduce solid reactants into one or more of the reaction zones. In addition to making it possible to handle such solid reactants, this would permit, in the case of free-flowing feedstocks, the achieving of significant changes in the effective length of the furnace. The modifications of the furnace illustrated in FIGS. 10 and 11 incorporates both varying-angle segments and means for feeding solids into a reaction zone.

The furnace of FIG. 10 is formed of three segments 190, 191 and 192, each mounted at a different angle to the horizon. Whether the angle of mounting is the same for each of the furnace segments as in FIGS. 1, 7 and 8 or different for each segment as in FIG. 10, it may be defined as a small acute angle (e.g., under 15°)

with respect to the horizontal plane on which the furnace is placed. The segments **190**, **191** and **192** are joined through hoods **194** and **195** and closed at the charging end by stationary end hood **196** and at the discharging end by a stationary collection means **197**. Each section has a set of tires **198**, **199** and **200** for sections **190**, **191** and **192**, respectively. These are, of course, mounted on rollers such as shown in FIG. 8 and driven by means of a suitable mechanism as discussed previously. In FIG. 8 the segments are shown to have driven gears **201**, **202** and **203** affixed to them; the driving gears and the mounting means are not illustrated inasmuch as they are similar to those shown in FIGS. 1 and 8.

The material to be charged into the furnace may be in the form of a fluid (gas or liquid) or a solid, or a combination of both. There are therefore provided a solid charging line **205** and two fluid charging lines **206** and **207** which are affixed to stationary hood **196**. Means are provided for introducing a gaseous reactant under and into the solid material **220** as it spills from reaction zone **212** in section **190** to reaction zone **215** defined in section **191**. Such a means comprises a gaseous conduit **208** which serves as a communication between a source (not shown) of the gaseous reactant and the passage **222** defined by hood **194**. A means for handling solid feed **210** is also provided. The hood has affixed within it a web **223** to control the point or points at which the gaseous reactant enters the furnace segment. This web is similar in function to web **114** of FIG. 4, and like that web it may have ports and dampers to permit controlled overfire gas introduction. The solid feed means comprises a feed channel **224** terminating in a hopper **225** and the solid reactant feedstock **226** is fed by gravity into zone **215**. A gate **227** may be placed in the channel **224** to control the solid feedstock rate.

The furnace segments of FIGS. 10 and 11 are preferably constructed in the manner illustrated in FIGS. 2 and 4. In the partial cross section, for example, section **190** is seen to be formed of a shell **213** having a refractory lining **214** and section **191** of a shell **216** with refractory lining **217**.

It will be appreciated that the various modifications illustrated may be applied to each of the various embodiments. For example dams, such as dam **76** of FIG. 2, may be used in one or more of the segments of any of the furnaces; the means for feeding solids, such as shown in FIG. 10, may be incorporated into any of the hood assemblies; the cooling device of FIG. 6 may be a part of the discharge end of any of the sections or segments; the frustoconical sections (FIG. 7) need not be in axial alignment but may be arranged as the cylindrical sections of FIG. 10; and the stationary end hoods and solids receiving means of FIGS. 1, 2 and 10 may be replaced by a discharge hood such as shown in FIG. 8. Further examples of modifications which may be made include the integration of less than all of the sections of a furnace and the aligning of more than one but less than all of the sections along a common axis. Various systems for supporting and rotating the segments, either as an integrated furnace or as separate entities, will occur to those skilled in the art and it is meant to include all such suitable devices for achieving these functions within the scope of this invention, those shown in the drawings being illustrative only.

It will be seen from the preceding description that the furnace of this invention provides stoking action without any grates, and makes it possible to provide fluid and solid reactants at desired points in the reaction zone as well as to control reaction conditions in each section of the furnace. Thus, there is offered a wide latitude in the operational parameters.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim:

1. A grateless furnace adapted to provide a plurality of reaction zones into which reactants may be controllably introduced, comprising in combination:

(a) a plurality of rotatable sections maintained in telescoping relationship with each other such that the charge end of each section, except the first, forms an overlap and surrounds the discharge end of the preceding section and defines therewith an annular passage which is parallel to the wall defining the overlapping section; the axis of each of said sections from its charge end to its discharge end forming a small acute angle with the horizon whereby each of said sections is adapted to feed solids by gravity to a succeeding section;

(b) separate stationary hood means surrounding and enclosing each of said overlaps and defining with at least a portion of said annular passage a fluid passage adapted to introduce fluid at least under and into said solids as they are transferred from section to section;

(c) means for conducting said fluid into said hood means;

(d) means for supporting said sections for rotating;

(e) means for rotating said sections;

(f) means for introducing reactants, including said solids, into the charge end of the first of said sections thereby forming furnace charging means; and

(g) means for withdrawing and receiving reaction products from the discharge end of the last of said sections thereby forming furnace discharging means.

2. A furnace in accordance with claim **1** wherein said sections are axially aligned.

3. A furnace in accordance with claim **1** wherein the axes of said sections form different angles with the horizon and separate means are provided for rotating each of said sections.

4. A furnace in accordance with claim **3** wherein said sections are of frustoconical configuration.

5. A furnace in accordance with claim **1** wherein said sections are of a cylindrical configuration of increasing diameter from the charging end to the discharging end of said furnace.

6. A furnace in accordance with claim **1** wherein said sections are of frustoconical configuration.

7. A furnace in accordance with claim **1** wherein said sections are axially aligned and affixed to each other thereby to form an integrated rotatable furnace, and a single means is provided for rotating said sections.

8. A furnace in accordance with claim **1** further characterized by having web means within said hood means, said web means being adapted to control the points at which said fluid is introduced into that section into which said solids are transferred.

9. A furnace in accordance with claim **1** further characterized by having means within at least one of said sections adapted to retard the flow of said solids through said section.

10. A furnace in accordance with claim **1** wherein said furnace charging means comprise means for introducing fluid under and into said solids and means for introducing fluid above said solids.

11. A furnace in accordance with claim **1** wherein said sections are steel shells lined with a refractory material.

12. A furnace in accordance with claim **11** further char-

acterized by having means associated with the discharge end of said sections adapted to cool said steel shells.

13. A furnace in accordance with claim **1** wherein there are provided separate means for rotating each of said sections.

14. A furnace in accordance with claim **1** further characterized by having means associated with said hood means for controllably introducing a solid reactant into said solids within said section.

15. A furnace in accordance with claim **1** further characterized by having means for preheating said fluid prior to its introduction into said hood means.

16. A grateless incinerator particularly adapted to burn refuse containing solid materials which melt during burning, comprising in combination:

(a) a plurality of rotatable, axially aligned sections maintained in telescoping relationship with each other such that the charge end of each section, except the first, forms an overlap and surrounds the discharge end of the preceding section and defines therewith an annular passage which is parallel to the wall defining the overlapping section; the axis of said incinerator from its charge end to its discharge end forming a small acute angle with the horizon whereby each of said sections is adapted to feed said refuse by gravity to a succeeding section;

(b) separate stationary hood means surrounding and enclosing each of said overlaps and defining with at least a portion of said annular passage an air passage adapted to introduce air at least under and into said refuse as it is transferred during burning from section to section;

(c) stationary end means adapted to close said first section;

(d) means associated with said end means for introducing said refuse and air into said first section;

(e) stationary discharge receiving means enclosing the discharge end of the last of said sections;

(f) means for introducing air into said hood means;

(g) means for supporting said sections for rotating; and

(h) means for rotating said sections.

17. An incinerator in accordance with claim **16** wherein said stationary hood means has means for introducing air into said sections above said refuse at predetermined points.

18. An incinerator in accordance with claim **16** wherein said sections are affixed to each other thereby to form an integrated rotatable incinerator, and a single means is provided for rotating said incinerator.

19. An incinerator in accordance with claim **16** including means for preheating at least a portion of said air prior to its introduction into said incinerator.

20. An incinerator in accordance with claim **16** wherein said sections are of cylindrical configuration of increasing diameter.

21. An incinerator in accordance with claim **16** wherein said sections are of frustoconical configurations.

22. An incinerator in accordance with claim **15** wherein said sections are formed as refractory-lined steel shells.

23. An incinerator in accordance with claim **15** including means for introducing auxiliary fluids along with said refuse into said first section.

References Cited

UNITED STATES PATENTS

3,042,389	7/1962	Gieskieng	110—14 X
3,116,055	12/1963	Pixley et al.	263—32
3,242,888	3/1966	Klovers et al.	110—14
3,295,930	1/1967	Swanson et al.	263—32 X
3,357,382	12/1967	Matteini	110—14
3,360,250	12/1967	Malmberg	263—32

JOHN J. CAMBY, *Primary Examiner.*

U.S. Cl. X.R.

110—14