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Hamilton

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[54] **GAS PRODUCER HAVING ASH REMOVAL PLATES WITH INDIVIDUAL TEMPERATURE SENSING**

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[52] **U.S. Cl.** ..... **48/76,** 23/277 R, 48/87, 48/203, 110/31

[51] **Int. Cl.** **C10j 3/52**

[58] **Field of Search** ..... 48/67, 68, 69, 76, 203, 48/101, 113, 77, 87; 209/355, 389, 28, 29; 110/31; 23/277 R

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[57] **ABSTRACT**

There is provided an improved large diameter vertical gas producing apparatus which is characterized by a grate and ash removal system which facilitates production of gas from solid carbonaceous material in a large diameter furnace. The improved grate/ash removal system is characterized by a plurality of concentrically disposed tubular members having their proximal extremities extending into the lower region of said furnace. These tubular members are individually supported at different levels and guide the ash produced onto axially displaced concentric annular rings. Individually rotatable ash scrapers coact with each of said annular rings to guide the accumulated ash off of the annular ring for collection in a conventional ash cone. The rate at which the ash removal scrapers remove ash from the concentric annular rings is variable and may be in response to temperatures sensed near the grate and in the upper region of the tubular members to aid in maintaining across the large diameter control of burning.

6 Claims, 3 Drawing Figures

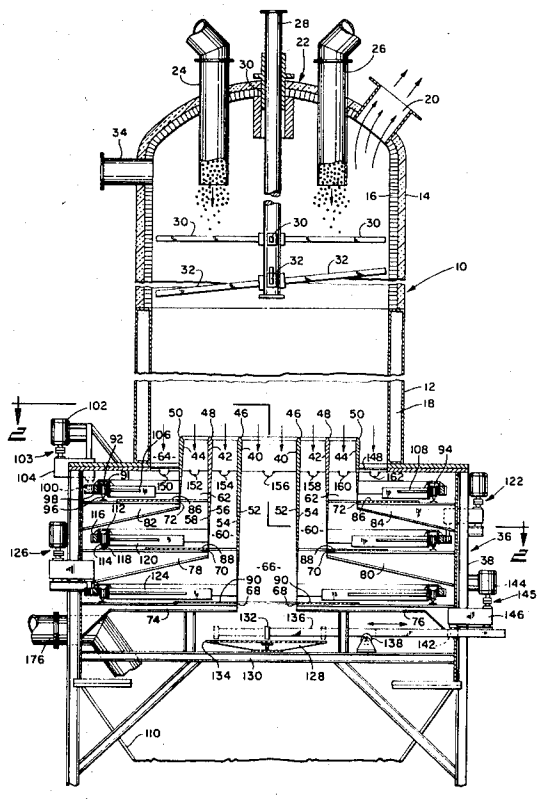
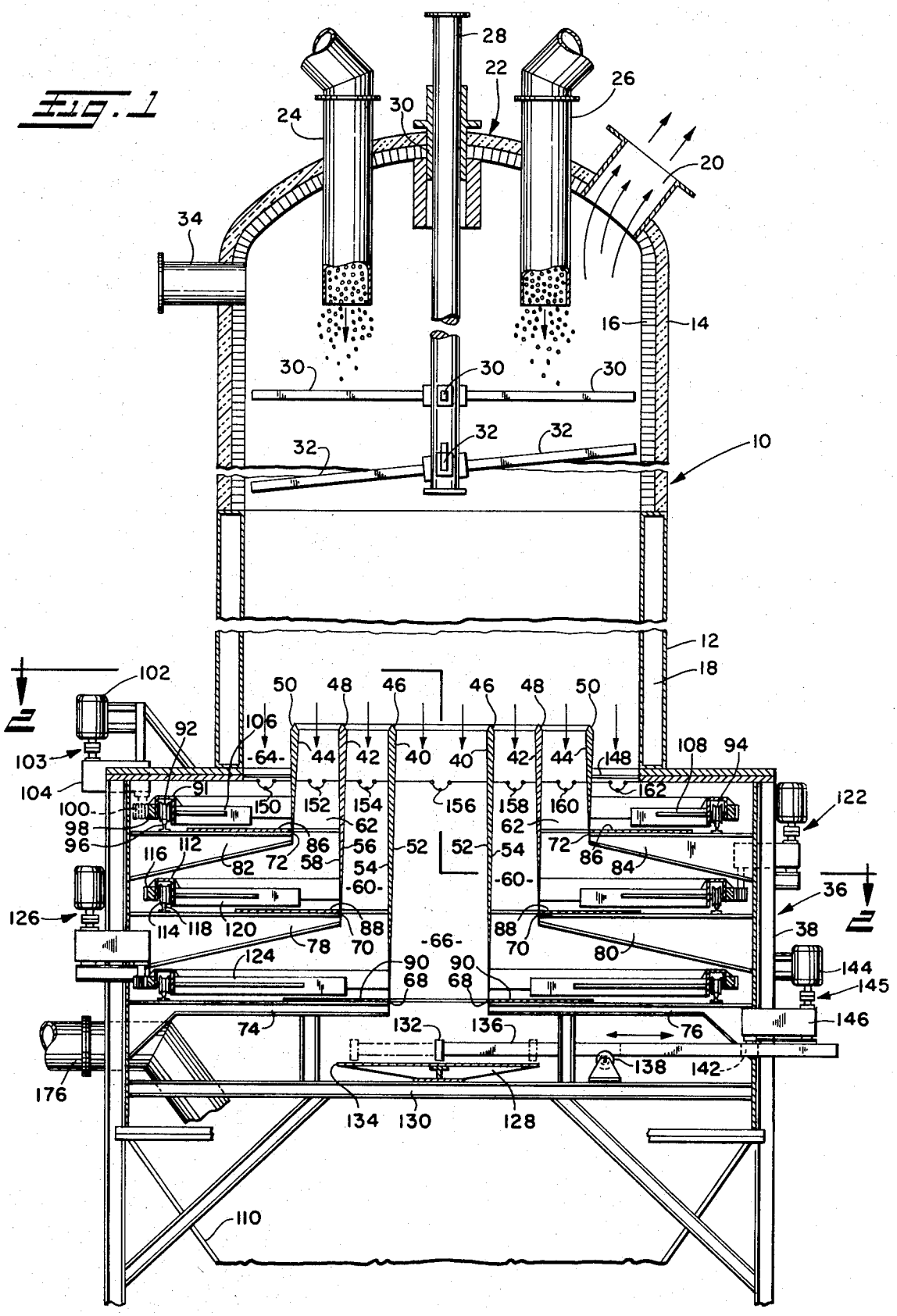


Fig. 1


28
22
26
24
30
20
34
16
14
30
30
30
32
32
32
10
12
18
102
50
48
46
46
48
50
92
106
103
64
44
42
40
40
42
44
148
108
94
104
91
150
152
154
156
158
160
162
122
100
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96
62
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84
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36
126
114
118
120
88
78
70
66
88
70
80
38
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136
76
146
138
142
176
134
130
128
110

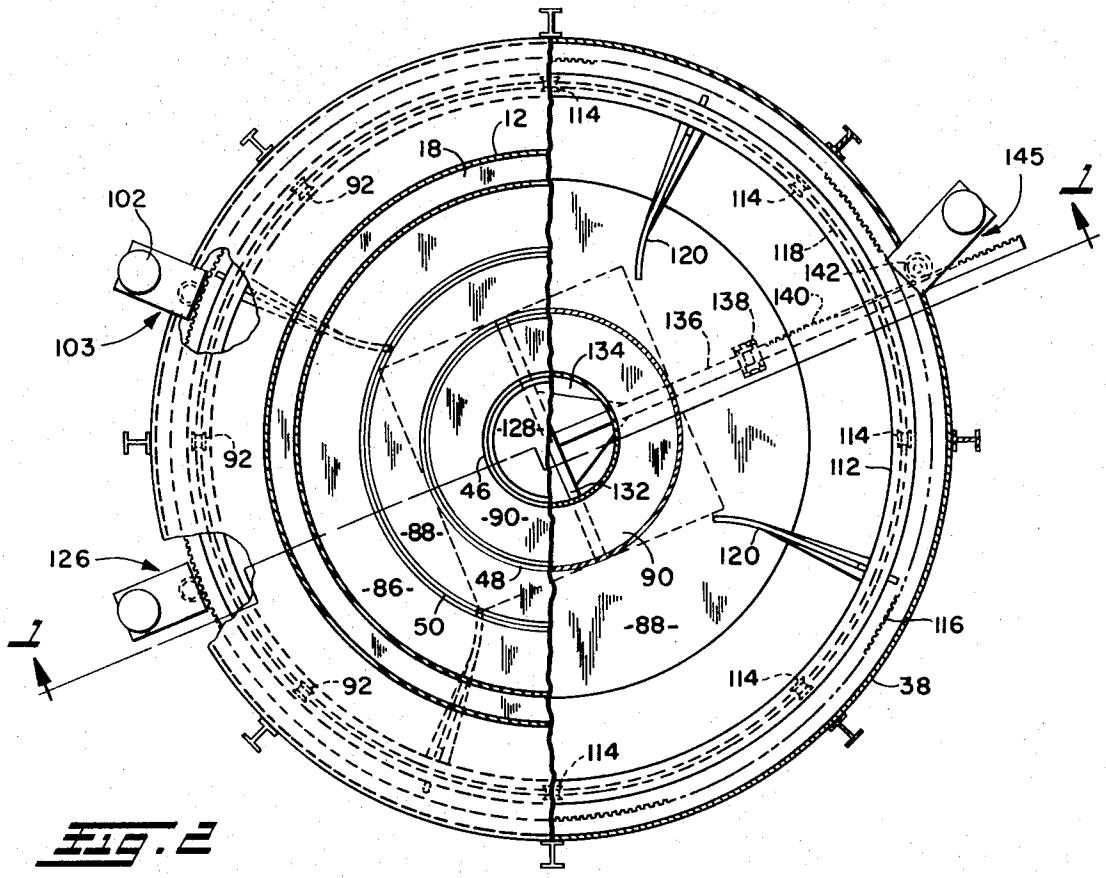

12
114
18
92
102
145
1
114
120
118
142
140
138
136
103
134
128
92
114
112
46
132
-90-
-88-
126
120
90
48
-86-
50
-88-
116
1
92
114
38
114

Fig. 2

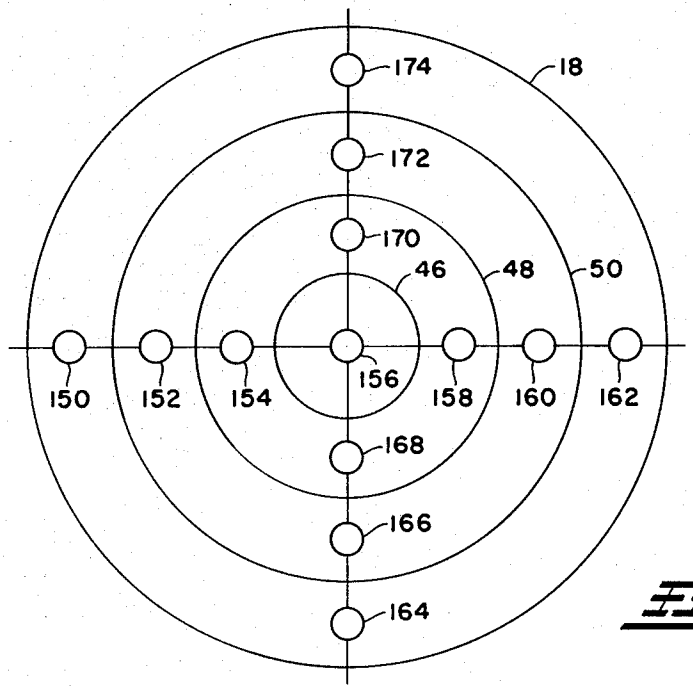

174
18
172
170
46
48
50
150
152
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160
162
168
166
164

Fig. 3

GAS PRODUCER HAVING ASH REMOVAL PLATES WITH INDIVIDUAL TEMPERATURE SENSING

BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention is particularly useful in conjunction with gas producers. The furnace configuration above the grates and ash pit is conventional and includes, for example, stirring means of various types, refractory brick lining, water jacket means, coal introduction means, gas off-take means, and other structure commonly associated with a gas furnace. See, for example, U.S. Pat. No. 2,816,823 to Galusha.

The demand for fuel gases from coal is great, particularly at a time of "energy crisis" such as is currently being experienced. Coal is available in large amounts, and its utilization in the production of fuel gases is of current interest. Large capacity devices are required to meet needs and, therefore, furnaces of greatly expanded sizes are contemplated. Increase in the physical dimensions, particularly the diameter, however, introduces problems in combustion and ash control not otherwise encountered or of sufficient magnitude to require special attention.

One system of improving combustion heretofore has utilized a rotary grate (U.S. Pat. No. 2,952,357). The present invention subdivides the cross section of the furnace into zones, each yielding ash and depositing the ash onto a series of stationary plates. The ash collected on the plates is removed by ash removal means individually operable relative to each plate. Since the rate of ash removal affects combustion in the particular zone, control over the combustion within the furnace can now be maintained through means for varying the rates of ash removal in the respective zones. These means are responsive to a combustion condition, e.g. temperature.

BRIEF STATEMENT OF THE INVENTION

Briefly stated, the present invention is in a gas producing apparatus including in combination means for transversely subdividing a shaft type furnace into a plurality of zones adjacent the ash pit, separate means for removing ash from each of said zones, and means for controlling the rate of ash removal from each of said zones.

More specifically, the present invention is in an ash removal assembly for a gas producer apparatus which is characterized by an ash pit assembly including an ash pit section, a plurality of concentrically disposed tubular members having their distal extremities extending into the lower portion of said burden, and their proximal extremities being in axially stepped relation, the innermost tubular member being the longer, means coacting between the pit section and the proximal extremities of each of the tubular members for supporting the tubular members in the concentric, axially stepped relation. Axially stepped concentric ash supporting ledges are provided carried by the support means and underlying the spaces created by the tubular members with respect to the furnace wall, each other, and the circular space defined by the innermost tubular member. Means are also provided for removing ash from the ledges. It has been found that, by individually controlling the rate at which ash is removed from the respective annular spaces, one is able to control the rate of burning in the combustion zone. Control of burning across the entire diameter of the furnace within a relatively fixed combustion zone is essential to improve the efficiency of operation and combustion in large diameter furnaces.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood by having reference to the annexed drawings wherein:

FIG. **1** is a cross-sectional view of one embodiment of the present invention showing a typical shaft-type furnace having the ash removal system of the present invention.

FIG. **2** is a cross-sectional view of the apparatus as it appears in the broken plane indicated by the line **2—2** of FIG. **1.**

FIG. **3** is a diagrammatic illustration of the location of temperature-sensing means for control of the ash removal apparatus hereof.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now more particularly to FIGS. **1** and **2** of the annexed drawings illustrating one embodiment of the invention, adapted for operation at elevated pressures, e.g. 300 psi., it will be observed that the furnace portion of the apparatus generally indicated by the numeral **10** is of conventional shaft furnace structure and includes an outer steel shell **12,** an insulation layer **14,** and a refractory brick layer **16.** Adjacent the hot zone, there is provided a water jacket **18** as a convenient mode of construction in lieu of refractory material. A gas off-take **20** for exhausting the generated gas, e.g. producer gas, is provided through the end closure generally indicated at **22.** Also extending through the end closure **22** are inlet conduits **24** and **26** for the introduction of solid carbonaceous material to be burned, for example coal or coke or bricketted carbonaceous material. Extending centrally into the upper portion of the furnace **10** is a stirring mechanism including a shaft **28** mounted for rotation in a bearing **30** and having at its inner portion stirring arms, e.g. arms **30** and **32,** extending radially therefrom and rotatable therewith for agitating the carbonaceous charge. A pressure relief tube and valve assembly **34** is also desirably provided. The foregoing portion of the apparatus forms no part of the present invention and, as indicated above, is shown for environmental purposes. As indicated, the present invention is in the ash removal system coacting with a plurality of zones transversely of the shaft furnace.

Whereas heretofore the diameter of the gas producer furnaces has been fairly well limited to from 6 to 12 feet in diameter, the problems experienced in uneven burning of a carbonaceous burden within the furnace manifest themselves to a higher and intolerable degree when the internal diameter of the apparatus exceeds about 12 feet, for example 25 feet. The burning rate tends to be higher centrally of the burden because of the reduced opportunities for heat transfer away from the combustion zone. However, adjacent the sidewalls of the apparatus, heat transfer occurs more readily and the burning rate and degree of completion tends to be slowed. Also, during the traverse of the burden in a downward way and in spite of the presence of agitation means, such as provided by the stirring rod **28** and the radially extending arms **30** and **32,** channels may be formed within the burden through which combustion

inducing gases may flow more rapidly than through adjacent portions of the burden, causing local cooling and hence less efficient burning. Also, it has been found that fines are collected in pockets within the burden creating less permeable regions, hence adversely affecting gas flow and coal combustion. In order to reduce the carbonaceous material to an ash and to prevent fusion thereof into unmanageable clinkers, the time of exposure to oxidizing gases must be controlled, and this is best accomplished by controlling the rate of downward flow. Although this principle has been practiced heretofore utilizing the rate of downward movement of the burden to control the degree and efficiency of combustion, it has never been done by controlling separate zones within the superposed burden in a single furnace.

To the accomplishment of this end, then, there is provided in the illustrative embodiment an ash pit assembly generally indicated at **36** including a closed sidewall **38** and mounted below the furnace portion **10.** There are provided a plurality of concentrically disposed zone defining tubular members, for example inner tubular member **40,** intermediate tubular member **42,** and outer tubular member **44.** The distal extremities of each of the tubular members **40, 42,** and **44** are provided conveniently with a tip, for example tips **46, 48,** and **50** which are desirably of triangular crosssection. The tips **46, 48,** and **50** extend into the bottom or lower portion of the burden where combustion thereof is complete. As is shown best in FIG. **1,** the tubular members **40, 42,** and **44** are provided with tapered sidewalls, for example sidewalls **52** and **54,** on tubular member **40** which diverge in a downward direction. As indicated, the tubular members **40, 42,** and **44** are preferably concentrically arranged and the tapered effect of the sidewalls, such as sidewalls **52** and **54,** provide in combination with the adjacent sidewalls **56** and **58,** for example, an annular space or zone **60** which expands slightly in a radial direction as one proceeds in an axial direction. This tends to minimize jamming of ash and clinker particles within the annuli, e.g. annulus **60.** Tubular members **48** and **50** define an annulus or zone **62,** and tubular member **44** in combination with the overlapping portion of the sidewall of jacket **18** defines an annular portion or zone **64.** The tubular member **40** being the innermost defines no internal annulus but a tapered cylindrical portion or zone **66.**

The proximal extremities **68, 70,** and **72** of the tubular members **40, 42,** and **44,** respectively, are in axially stepped relation, the innermost tubular member **40** being the longest in an axial direction, the intermediate member **42** being of intermediate axial length, and the outer or largest diameter tubular member **44** being of the shortest axial length. In the preferred embodiment, the geometric surface in which the proximal extremities of the tubes **40, 42,** and **44** lie is an inverted cone. This is convenient for fabrication purposes although not an essential relationship.

The proximal extremities **68, 70,** and **72** of the tubular members **40, 42,** and **44** are supported by suitable support means such as radially inwardly extending supports **74** and **76** for tubular member **40;** radially inwardly extending support arms **78** and **80** for intermediate length tubular member **42;** and radially inwardly extending support arms **82** and **84** for tubular member **44.** The number of such radially inwardly extending support arms for any given tubular member may readily be determined by engineering considerations but usually four such arms or six such arms at each level will suffice. The arms also support concentric annular plates for collection of ash from each zone. Thus, the radially inwardly extending arms **82** and **84** support an annular ash collecting plate **86** which underlies the annular zone **64** defined by the tubular member **44** and the water jacket **18.** In like manner, the radially inwardly extending arms **78** and **80** support an ash collecting plate **88** which underlies the zone **62** defined by the tubular members **42** and **44.** Still further, the radially inwardly extending arms **74** and **76** support an annular ash collecting plate **90** underlying the zone **60** defined by tubular members **40** and **42.** In the absence of any means for continuously removing ash material from under each of the zones **60, 62,** and **64** and, as will hereinafter be pointed out, the central portion **66,** the apparatus would become a batch apparatus and fail to perform after a certain point until the ash accumulation was manually removed.

To this end, therefore, ash removal means are provided dependent upon relative rotation between the plates and such removal means, e.g. scrapers.

As shown in FIGS. **1** and **2,** a preferred form of ash removal means includes a body such as the body **90** in the first ash level formed as an annular ring and supported on a plurality of circumferentially spaced wheels such as wheels **92** and **94** which are supported on and guided by circular rail **96** which is in turn supported on radially inwardly extending support arms, such as support arms **82** and **84.** The ring **90** carries on its outer surface a ring gear **98** which is adapted to be driven by pinion **100** driven by a motor **102** through a reduction box **104.** At circumferentially spaced intervals, the housing **90** also carries scraper blades **106** and **108.** While such blades are shown in FIG. **2** to be disposed at 90° intervals whereby four such scrapers are provided for each level, the number of such scrapers is not critical and may be any convenient number. The scrapers such as scrapers **106** and **108** extend radially inwardly and, as best shown in FIG. **2,** are desirably configured with a curved inner edge to aid in urging the ash radially outwardly for cascading over the outermost edge of the ash collecting plate, e.g. plate **86,** and downwardly by gravity into the ash cone, e.g. ash cone **110.** The ash cone receiving and discharging mechanism again forms no part of the present invention and may be of any suitable conventional structure for gas producing apparatus.

In like manner, the second level or intermediate level ash zone in FIG. **1** includes separately operable ash removing means of similar construction to that shown for the first level. Thus, there is provided a housing ring, wheels such as wheel **114,** a ring gear such as ring gear **116,** a separate circular rail **118,** and radially inwardly projecting scraper arms such as scraper arm **120.** The scraper arm agains coacts with the ash receiving plate **88** and removes ash generated in the intermediate zone **62.** In the same manner as provided for the first ash removal level, independent driving means generally indicated at **122** are also provided for driving the housing **112** carrying the ring gear **116** and the scrapers such as scraper **120** in a rotatory manner to urge ash collected on the annular plate **88** toward the outer edge thereof for cascading into the ash cone **110.** Also in like manner, a similar structure for supporting and rotating scraper arms **124** for coaction with ash receiving annu-

lar plate **90** is provided. Separate drive means generally indicated at **126** are also provided for driving the ash removal assembly of the third layer. The motor and drive mechanism in the second and third levels is essentially the same as that described for the first level.

The innermost core or zone **66** deposits the ash generated in this region upon a fixed plate **128** carried by suitable framework **130** within the ash pit assembly **36.** Instead of an annular scraper, a transaxially movable plow **132** is provided for reciprocation to and fro across the surface of the ash collecting plate **128** to urge ash so collected off the edge, for example edge **134** for cascading into the ash cone **110.** The plow **132** is mounted on an arm **136** supported on a roller **138** which is in turn mounted on the frame **130.** The outer extremitiy of the arm **136** includes a rack **140** which is mounted for coaction with a pinion **142** and driven by motor **144** through a reducer **146** in similar manner to the aforesaid driving means. Driving means **103, 122, 126,** and **145** are independently controllable so that the rate with which each ash removal means at each of the four levels is driven may be made responsive to conditions within the furnace **10.**

In the apparatus shown, conditions at the bottom of the burden are sensed for providing the signal to which the individual drive means **103, 122, 126,** and **145** are responsive. Since temperature is a convenient parameter for sensing, a support **148** is provided for supporting temperature sensing means such as thermocouples **150, 152, 154, 156, 158, 160,** and **162** across a diameter of the furnace **10.**

FIG. 3 shows in diagrammatic form the tubular member **18, 50, 48,** and **46,** and the location of temperature sensing means **150, 152, 154, 156, 158, 160,** and **162.** For better control, a corresponding set of temperature sensing means **164, 166, 168, 170, 172,** and **174** are provided along a 90° related diameter. For convenience, temperature may be recorded according to the following sequence, the numbers in the following table referring to the numbers appearing on the drawing:

162	156	164	156
160	154	166	170
158	152	168	172
156	150	156	174

By correlating the temperature sensed in accordance with the foregoing recording sequence, the rate at which the individually operable drive means **103, 122, 126,** and **145** are operated may be set according to a predetermined value. Thus, if the temperature sensed in the first zone **64** is too low, the rate at which the drive **103** is operated is decreased so that the temperature has an opportunity to be elevated to the desired combustion temperature.

Air for combustion is introduced through a blast inlet **176.** The nature of the oxidizing gas is conventional and its traverse through the furnace is also conventional. Steam or water vapor may be introduced as is well known. There has been provided an apparatus and method for exercising control of burning in especially large diameter furnaces and involving the sensing of a condition obtaining within the furnace to drive individually operable ash removal means and thus control the rate of burning in given zones so as to maintain the hot high temperature combustion zone at a relatively uniform location axially of the furnace. Although the apparatus described herein is especially adapted for use under elevated pressures, e.g. from superatmospheric to as high as 2,000 psi or more, the principles of this invention are applicable as well to operation at lower pressures, e.g. atmospheric pressure. The apparatus hereof while illustrated in conjunction with gas producer apparatus is useful as well in other types of shaft furnaces in which a charge is oxidized or otherwise reacted with a gas.

What is claimed is:

1. A furnace apparatus comprising in combination:
a. a shaft furnace body having a central axis;
b. means for transversely subdividing said furnace into a plurality of zones adjacent the lower end thereof including a plurality of concentrically disposed tubular members having as their common axis the central axis of the shaft furnace;
c. each of said tubular members having adjacent its lower end a horizontal plate for collection of ash from the corresponding zone, said horizontal plates being in axially stepped relation, the plate for the innermost zone being at the lowest step;
d. separate means for removing ash from each of said plates;
e. means in each tubular member for sensing temperature;
f. and separate means responsive to said temperature sensing means for independently controlling the rate of ash removal from each of said zones, respectively.

2. A furnace apparatus in accordance with claim **1** wherein the separate ash removal means includes scraper means coacting with said horizontal plates for removing ash therefrom, and means for causing relative rotation between said plates and said scraper means.

3. A furnace apparatus in accordance with claim **1** wherein the ash removal rate control means includes individual drive means responsive thereto for driving said ash removal means.

4. In a gas producer apparatus including a large diameter vertically axised shaft furnace, means for introducing particulate carbonaceous material, means for maintaining combustion of the carbonaceous material in a downwardly moving burden, means for introducing an oxidizing gas; means for removing fuel gas from said furnace, and means for removing ash from the base of said furnace, the improvement which comprises in combination:
a. an ash pit assembly including a pit housing at the lower end of said shaft furnace;
b. a plurality of concentrically disposed tubular members having their distal extremities extending into the lower portion of said burden, and the proximal extremities being in axially stepped relation, the innermost tubular member being the longer, and extending into said pit housing, and having as their common axis the vertical axis of said shaft furnace, said concentrically disposed tubular members defining separate zones;
c. means coacting between the pit housing and the proximal extremities of each of said tubular members for supporting said tubular members in said concentric axially stepped relation;
d. axially stepped concentric ash supporting ledges carried by said support means and underlying the space between adjacent tubular members and a lower ash supporting platform underlying the central tube;

e. means in each separate zone for sensing temperature; and

f. separate means responsive to temperature in each of the zones defined by said concentric tubular members for independently removing ash from said ledges and platform, respectively.

5. An apparatus in accordance with claim **4** including temperature sensing means for sensing ash temperature adjacent the distal extremities of said tubular members.

6. An apparatus in accordance with claim **5** wherein individual temperature sensing means are located between adjacent tubular members, between the outermost tubular member and the furnace wall, and centrally of the innermost tubular member.

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