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Wolf et al.

[11] **3,760,151**

[45] **Sept. 18, 1973**

[54] ARC DETECTING MATERIAL ADMISSION APPARATUS FOR USE IN COMBINATION WITH AN ELECTRIC ARC HEATER

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[73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.

[22] Filed: **Aug. 11, 1972**

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[52] **U.S. Cl.** ..... **219/383**, 219/121 P, 219/75

[51] **Int. Cl.** **H05b 7/18**

[58] **Field of Search** ..... 219/383, 121 P, 74, 219/75, 76; 313/231

[56] **References Cited**

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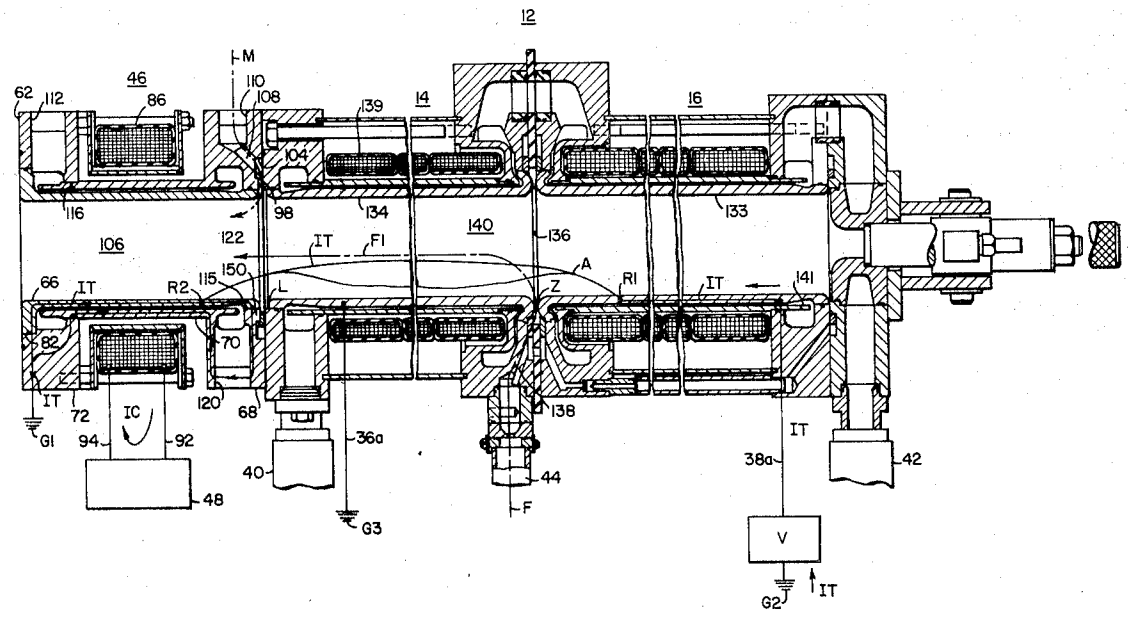
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Primary Examiner—J. V. Truhe
Assistant Examiner—Gale R. Peterson
Attorney—A. T. Stratton et al.

[57] **ABSTRACT**

A materials admission or quench tube assembly disposed downstream of an electric arc heater, this assembly being disposed adjacent to the downstream electrode of the electric arc heater but insulated therefrom, the assembly having the capability of admitting quench material to a stream of gas which has been previously heated by an arc in the upstream heater or being capable of providing process material to that stream or both, the materials admission and quenching assembly having as an integral part thereof an electrical current transformer electrically connected to an indicating or control means. In the event a root of an electric arc which normally resides or strikes against the downstream electrode in the arc heater strikes against an internal portion of the materials admission and quenching tube the electrical current flowing from the root of the arc which has struck the internal portion of the materials admission and quenching tube will flow through the region enclosed by the current transformer and returned to ground through a suitable ground connection. The flow of current through the region enclosed by the current transformer will energize the current transformer to an extent sufficient to cause the indicating or control means electrically connected to the current transformer to reach to the current and therefore provide an indication of the fact that the root of an arc has struck an internal part of the materials admission and quenching structure and compensate therefor if desirable.

16 Claims, 5 Drawing Figures



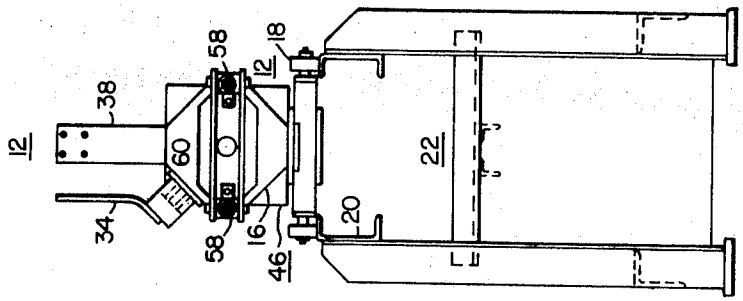

12
38
60
34
58
16
46
58
12
18
20
22

FIG.2

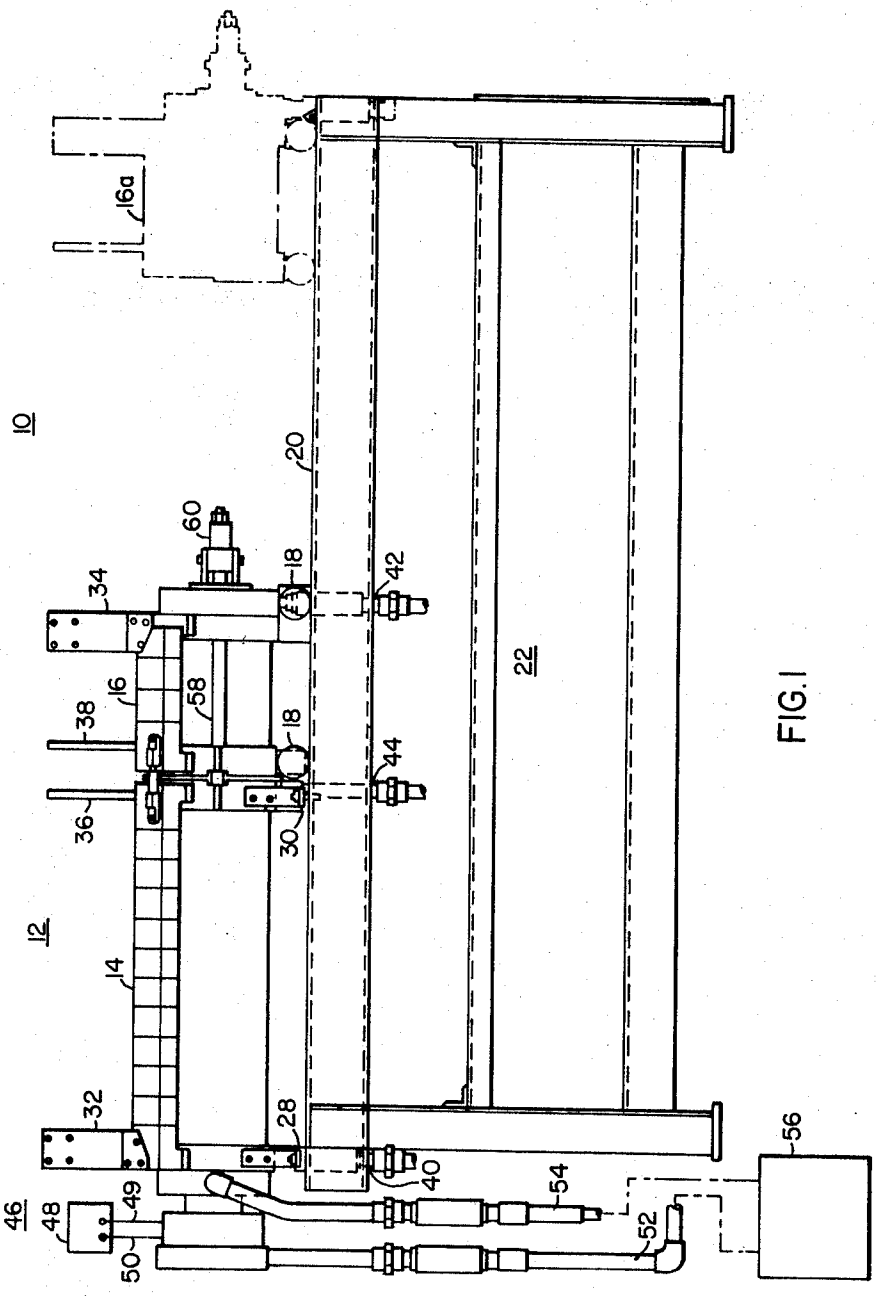

10
16a
20
60
18
42
34
22
16
58
38
18
44
36
30
12
14
32
28
40
54
56
46
48
49
50
52

FIG.1

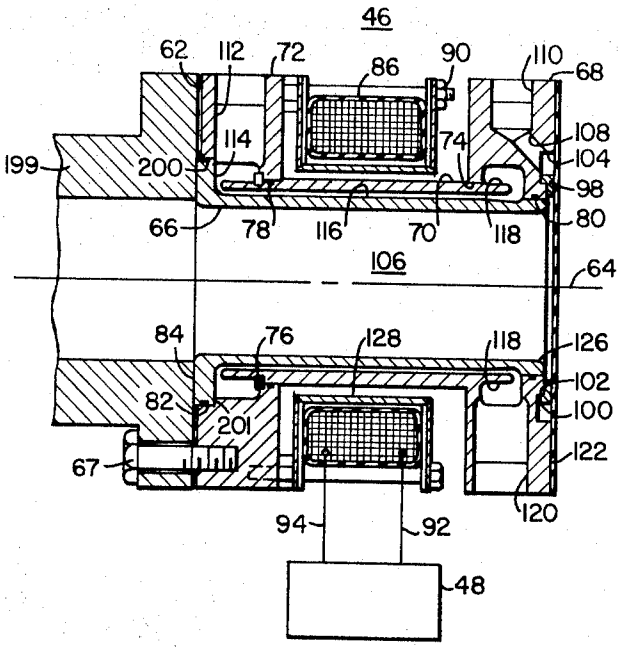

46
62
112
72
86
90
110
68
114
74
108
104
199
200
98
66
78
116
70
118
80
106
64
84
76
128
118
126
102
82
201
100
67
122
120
94
92
48

FIG.3

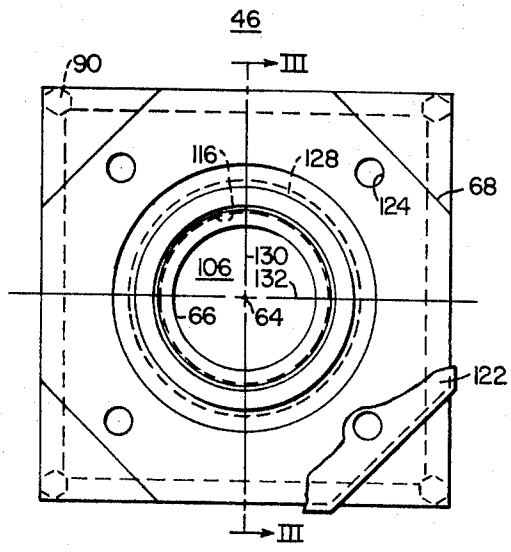

46
90
III
116
128
68
124
106
130
132
66
64
122
III

FIG.4

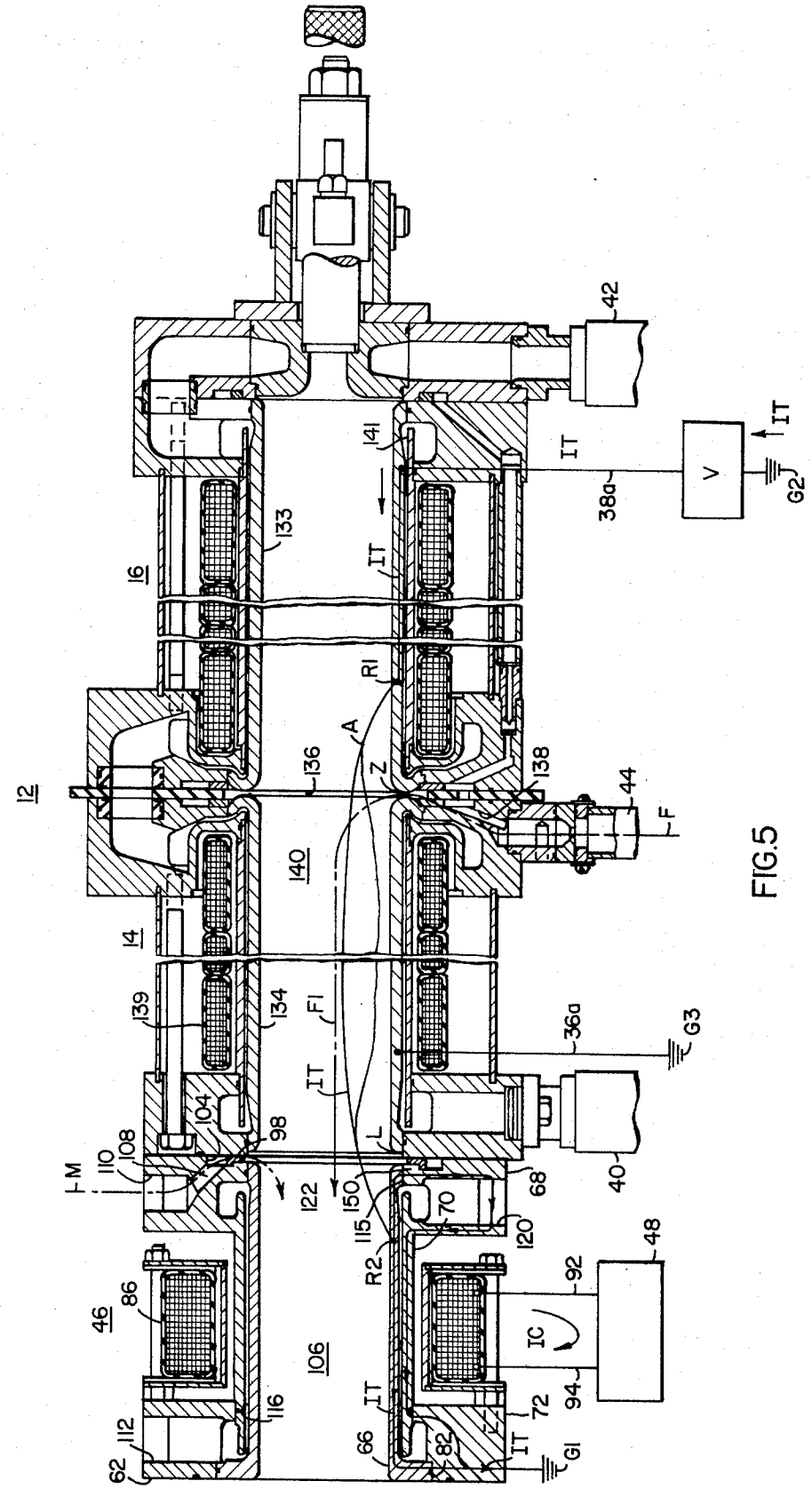

42
141
IT
38a
V
G2
133
16
R1
A
Z
136
138
44
F
12
140
14
139
134
F1
36a
G3
104
98
L
108
110
M
122
150
115
70
68
40
120
R2
48
92
86
46
IC
106
94
116
72
112
66
82
62
G1

FIG.5

ARC DETECTING MATERIAL ADMISSION APPARATUS FOR USE IN COMBINATION WITH AN ELECTRIC ARC HEATER

CROSS REFERANCE TO RELATED APPLICATIONS

Certain inventions related to those disclosed in the present application are disclosed and claimed in copending U.S. Pat. application Ser. No. 279,895, filed concurrently by M. G. Fey and assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to quenching or material admission assemblies for electric arc heaters and it has particular relation to materials admission and quenching assemblies having integral arc detecting means therein.

Chemical processes are frequently carried out by passing a gas or other material through an electric arc and then quenching the gas or other material very quickly after it leaves the region of the arc thus freezing the high temperature equilibrium products. In other processes, process material may be admitted into heated gases or other flowing materials after the gases have passed through the arc thus avoiding the problem of overheating the process fluid or material. In a hydrocarbon processing operation overheating may result in the production of excessive carbon which is detrimental. When quenching or when admitting process material to the previously heated gas or material it is desirable to have the admission point as close to the arc zone as possible for greater efficiency. However, if the apparatus or structure for admitting processed material or quench material is located close to the downstream electrode in an electric arc heater, electric arcing or flashover to this materials admission and quenching structure is likely to occur, it being realized that electric arcing of this nature is detrimental as it may erode or otherwise electrically destory or incapacitate part of the quenching and materials admission means.

Prior art devices which have some relationship to the structures taught by this invention are shown in U.S. Pat. Nos. 3,075,065 issued Jan. 22, 1963 to A. C. Ducati et al., 3,179,782 issued Apr. 20, 1965 to L. Matvay, 3,235,700 issued Feb. 15, 1966 to G. Mondain-Monval et al. and 3,387,110 issued June 4, 1968 to F. Wendler et al. The Wendler et al. patent describes a downstream emission tube for feeding powder into an arc produced plasma but the arc produced is generated by a radial arc producing means including a center electrode and the means for feeding the powder includes no arc detecting means. The Ducati et al. patent also shows a downstream admission tube for injecting gases into a plasma torch but this patent shows no arc detecting means integral therewith nor does it show a structure other than the previously described tube for admitting or injecting gases or powders to the plasma torch. The Mondain-Monval et al. patent discloses a powder admission conduit positioned downstream of an electric arc but it also does not disclose an arc detecting means integral therewith. The Matvay patent describes a pitot tube positioned in an apparatus to deliver work material to a critical point in an arc region downstream of a rod electrode. However, as with the others this does not show an arc detecting means integral with a means for admitting quenching fluids or process material. All of the above described patents have certain disadvantages or problems. None of them describe a single integrated structure for admitting process or quench material to a stream which has been preheated by an electric arc in an arc heater which structure is electrically insulated from the electrodes in the arc heater and is easily removable therefrom for cleaning, servicing or replacing. In addition, none of the prior art structures include an electrical arc detecting means so that an arc root which should normally reside upon an electrode near the admission structure but which nevertheless for a period of time resides upon a portion of the admission structure is detected.

SUMMARY OF THE INVENTION

In accordance with the invention a materials admission and quenching means having an integral arc detector therein is combined with existing arc heating apparatus of the type employing a plurality of electrodes to generate an electric arc to thereby heat a stream of material flowing therethrough. The adjacent materials admission and quenching structure is electrically insulated from all of the electrodes but disposed to the arc region so that the material heated by the arc has very little opportunity to cool before the quenching material or process material is provided thereto. The material admission and quenching structure has an integral arc detecting means and is adapted to be combined with existing arc heater structures described in patents and patent applications assigned to the assignee of the present InVention. As an example, U.S. Pat. No. 3,629,553 issued Dec. 12, 1971 to Maurice G. Fey, Westinghouse Case 41,450, Ser. No. 15,446, filed Mar. 2, 1970 by C. B. Wolf and M. G. Fey; and U.S. Pat. No. 3,522,015, issued July 28, 1970 by D. A. Maniero and C. B. Wolf. In addition, the previously described apparatus for detecting arc and providing quench and process material to heated gas from an electric arc heater is suitable for use with an electric arc heater of the type described in U.S. Pat. No. 3,663,792 issued May 16, 1972 to M. G. Fey. It should be realized that although the previously described apparatus for detecting arcs and providing quench and process material has been described as usable in combination with the previously described patents and applications related to structure, processes or methods assigned to the assignee of the present application it is also applicable for use with other processes and structures performing in a similar manner. In one operative embodiment of the invention an annular brass flange is provided with an annular concentric copper tube or sleeve at the inner portion thereof, which tube or sleeve communicates with the annular opening of an arc heater so that arc heated gases may flow through the tube or sleeve. The copper tube is cooled by a cooling fluid such as water, flowing through ducts or openings in the brass flange or between parts of the brass flange and the outer perimeter of the copper tube or sleeve. The cooling fluid as the name implies cools the copper tube or sleeve so that the high temperature gases passing through the annular opening formed by the copper tube or sleeve do not raise the temperature of the annular sleeve to such an extent as to melt it or destroy it or render it inoperative. The flange has disposed in one portion thereof a generally concentric coaxial admission ring for admitting the previously described process or quench material to the re-

gion of the heated process material in the copper tube or sleeve for processing or quenching purposes. This annular ring is disposed adjacent the copper tube or sleeve and brass flange so that it may communicate with a manifold in the flange and with the region surrounded by the copper tube or sleeve. At another portion of the flange the previously mentioned copper tube or sleeve is secured or held snugly into a groove in the flange thereby creating a low resistance electrically conducting path between the copper tube and the brass flange. At the other end of the flange an electrically insulating gasket is disposed adjacent that portion of the copper tube or flange which is to mate or link up with the arc heater so as to electrically insulate the material admission and quenching means from the arc heater. Disposed within a portion of the brass flange and generally coaxial with the copper tube and the admission ring as well as the annular flange member is a circular annular current transformer having the electrical leads therefrom connected to an indicating or control means. When the materials admission and quenching means with integral arc detector is combined with an arc heater and when an electrical ground connection is established to the materials admission means brass flange any portion of the electrical arc which normally resides in the arc heater but which jumps across the previously describd insulation onto the inner surface of the copper tube or sleeve must complete its electrical current path through the copper tube, through one of the junctions between the copper tube and the brass flange to the electrical ground connection. However, in so doing the electrical current must flow through the region enclosed by the current transformer and consequently excite the current transformer to cause electrical current to flow therein and thereby provide a signal to the previously described indicating or control means electrically connected thereto. The electrical indicating means may then provide an indication of the presence of an electric arc or may be electrically connected to various kinds of control devices for controlling the electric arc or for controlling process material supplied to any portion of the combined electric arc heater and materials admission and quenching structure.

For example, it would be possible to regulate the flow of gas through the arc heater so that the root of the arc is generally very close to the admission point, and only strike the internal tube of admission apparatus a small percentage of the time.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention reference may be had to the preferred embodiments exemplary of the invention shown in the accompanying drawings, in which:

FIG. 1 is a view in side elevation of an arc heater and support structure including in combination therewith a materials admission and quenching structure with integral arc detector;

FIG. 2 is another view in elevation of the arc heater shown in FIG. 1 as viewed from the rear;

FIG. 3 is a view in elevation and section of a materials admission and quenching structure with integral arc detector;

FIG. 4 is a front elevation of the structure shown in FIG. 3; and

FIG. 5 is a side elevation partially broken away and in section of a portion of an arc heater and integral materials admission and quenching structure with arc detecting means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and FIG. 1 in particular, an arc heater station **10** including a matter or materials admission and quenching means with integral arc detector and the associated support structure is shown. The arc heater apparatus **12** comprises a stationary portion **14** and a movable portion **16** which movable portion **16** is disposed on wheels **18** so that movable arc heater section **16** may be moved to the right to a position indicated by **16A** Wheels **18** are supported upon and movable on rail section **20** of a frame assembly **22.** When in the operating or closed position the movable arc heater portion **16** is joined to the stationary arc heater portion **14** and secured by a lock assembly (not shown). There also may be included therewith an adjustment assembly (not shown) such as described in previously referred to U.S. Pat. No. 3,629,553 it being realized that the locking and adjusting assemblies are not limited to these structures. The stationary part **14** of the arc heater assembly **12** is secured to the rail **20** of frame **22** by securing and adjusting means **28** and **30.** Arc heater assembly **12** may have two field coil power connectors **32** and **34** for the connection of electrical power to magnetic field coils in the arc heater which are not shown but are positioned therein for the purpose of rotating an electrical arc which may be established between electrodes in the arc heater assembly **12.** Also included in the arc heater assembly **12** are two main power connections **36** and **38** which may be connected to a source of power for energizing the electrodes within the arc heater assembly or apparatus **12** for the purpose of establishing an arc between the electrodes. Also included as part of the arc heater assembly **12** are pipe or fluid carrying assemblies **40** and **42** for providing cooling fluid to the electrodes of the arc heater assembly, one pipe being used as an input port for cooling fluid and the other pipe being used as an output port for cooling fluid. The cooling fluid reservoirs are not shown. A pipe assembly **44** is shown for providing input fluid to the region of the gap between the two previously described electrodes which fluid may be useful for providing process material to the region of the arc or for providing a gaseous or fluid substance into the vicinity of the gap between the electrodes to blow the arc out into the center of the arc heater assembly, or both. Ports for field coil cooling fluid are not shown for convenience of illustration.

Adjacent the left side of the arc heater assembly **12** and included as a part thereof for certain operational functions is a materials admission structure with integral arc detector **46,** which may be hereinafter referred to as the arc detector structure, for the purpose of simplicity of description. Arc detector structure **46** has connected thereto an output indicating or control means **48** connected to electrical leads **49** and **50** which are in turn connected to the arc detector portion of arc detector structure **46.** Means **48** may be an output signal indicator, a meter or a portion of a control sytem. However, it is not limited to these structures and functions. The arc detector structure **46** which may also be known in some instances as a quench tube as-

sembly has connected thereto a piping system comprising an input quench tube coolant pipe **52** and an output quench tube coolant pipe **54** which may communicate jointly with a reservoir of quench tube coolant fluid **56**, it being understood that the directions of the materials shown flowing in pipes **52** and **54** may be reversed without changing the operating characteristics or functions of the apparatus **46**. Also connected to arc detector structure or assembly **46** but not shown in FIG. **1** is a port for the entrance of quench material or process material which may be provided to the internal portions of arc detector structure **46**.

Referring now to FIG. **2**, another view of the apparatus shown in FIG. **1** is depicted. Specifically, part of arc heater apparatus **12** is shown disposed upon structural support means **22** by way of wheels **18** disposed upon tracks **20**. The rear or movable portion **16** of arc heater structure **12** is most easily seen in FIG. **2**. In addition, electrical connectors or electrodes **34** and **38** are shown. In addition, the end portions of rods **58** also shown in FIG. **1** are depicted adjacent either side of arc heater assembly **12**. Rods **58** cooperate with the previously described adjusting mechanism or structure **26** to position the movable portion **16** of arc heater assembly **12** with respect to the stationary portion **14**. Also shown is an end plug assembly **60** which may be removed for the insertion of a third electrode or for the cleaning or inspection of internal portions of the rear or movable portion **16** of the arc heater assembly **12** or for other good reasons. In addition, end plug assembly **60** may be removed for the purpose of supplying process material of any kind through the opening therein and into the region of the arc in the arc heater assembly **12**.

Referring now to FIG. **3** a sectioned side elevation of arc detector assembly **46** is shown. Structural member **46** includes in one embodiment of the invention a substantially brass annular flange assembly **62** having a central opening therein it has a center line **64** with center line **64** being aligned with the center line of the arc heater apparatus **12** depicted in FIG. **1** when structure **46** is used in combination therewith. Arc detector structure **46** includes as part thereof a primarily copper tube or sleeve **66** which is annular and has the same common center line as flange **62**. Copper tube or sleeve **66** is disposed internal to the annulus of flange **62** and is adjacent thereto radially. Flange member **62** comprises three sections known respectively as the front section **68**, the central section **70** and the rear section **72**. Front section **68** comprises a radial plate or disc having a central hole therethrough. Front section **68** also includes various entry ports and channels for the conduction of fluids and particulate matter under certain circumstances to various parts of the arc detector and quenching apparatus **46**. Brazed to an inner lip or portion **74** of front flange **68** is one portion of the outer periphery of brass tube **70** which is also known as the central flange portion. Adjacent the other end of cylindrical central flange portion **70** and connected thereto by way of retaining seal and ring **76** and **78**, respectively, is the last-mentioned part of flange assembly **62**, namely, rear flange portion **72** having disposed therein various openings, grooves, holes or ducts for the conduction of certain fluid and particulate matter which may be useful in the operation of the arc detector assembly **46**. The copper annular sleeve or inner cylindrical portion **66** of the arc detector assembly **46** is secured or fastened to two portions of the flange assembly **62**, namely, front inner surface **80** of the front flange assembly **68** and rear lip **82** of the rear flange portion **72**. The tube **66** is held in place by the down stream adjacent part **195** being secured to flange **62** by bolt **67**. There is an O Ring (20D) to make the seal. Flanged portion **84** is pushed axially against flange **62** to **201** as shown in the magnified sketch as tube **66** is slightly longer axially than flange **62**. This connection or clamping insues or provides a very good low resistance electrical path between sleeve **66** and flange assembly **62**. On the other hand, sleeve portion **66** is connected or secured to surface **80** of front flange portion **68**. It should be understood that these methods of joining tube **66** to flange **72** is not limiting and other methods of joining are possible including varying the amount of pressure fit between the front and rear flanges **72** and **68** of the flange assembly **62** and the tube **66**, respectively are possible. Arc detecting means or current transformer **86** which may be toroidal is fastened or secured to the rear portion **72** of flange assembly **62** by way of bolts or fastening means **90**. The electrical turns or insulated windings in compact coil or arc detecting means **86** may be visualized as being concentric about center line **64**. Two electrical leads **92** and **94** are shown connected to the windings of the electrical conductors in current transformer **86** so that electrical current may flow into the arc detector **86** in one case and away from it in another case. An electrically responsive readout and control means **48** which is also depicted in FIG. **1** is shown electrically connected to the leads **92** and **94** so that electrical current flowing in leads **92** and **94** may energize the readout or control means **48**, it being understood that readout or control means **48** may be used to indicate the presence of current in the leads **92** and **94** or may be used to cause certain portions of the arc heater assembly or associated equipment to respond through a control function initiated in means **48**. For example, by controlling the amount of electrical current in or voltage at leads **32** and **34** or leads **36** and **38** as shown in FIG. **1** or the amount of fluid flowing in pipes **44** or **40** and **42**. Adjacent the front portion of flange **68** and copper sleeve or tube **66** is an arc resistant admission ring for secondary fluid, quench fluid or reactant material any of which may be fluid or particulate in nature. Ring **98** may in a preferred embodiment of the invention include a lip **100** radially abutable with a corresponding lip **102** in the front portion **68** of flange assembly **62** for securing ring **98** thereto and holding it in position. Ring **98** may have radially protruding and circumferentially spaced openings, orifices, holes or ducts therein, not shown, for the admission of particulate or fluid matter from the region of manifold **104** to the central portion **106** of arc detector assembly **46**. Manifold **104** communicates by way of a passageway or duct or series of ducts **108** with an admission port **110** for secondary fluid, quench fluid or reactant material, it being understood that the reactant material is supplied by suitable ducting to the port **110** under suitable pressure whereupon it is conducted through duct or ducts **108** to manifold **104** where it is thereby forced through the ducts, slits, holes or orifices in admission ring **98** into the reaction chamber **106** of arc detector and quench assembly **46**. It is also to be understood that the holes or openings previously described in materials admission ring **98** must be suitably large to allow the movement of the

particular kind of material sought to be provided into reaction zone **106.** Flange assembly **62** has disposed or placed in the front flange portion **72** an input cooling fluid port **112** which communicates with a front flange manifold **114** which in turn communicates with a sleeve cooling chamber, duct or path **116** which in turn communicates with a forward flange assembly manifold **118** which finally communicates with an output coolant port **120.** Consequently coolant fluid may be provided to port **112** whereby it may circulate through manifold **114** and path **116** for a purpose of cooling the rear wall portion of sleeve **66** which may have been heated by hot materials or reactions taking place within reaction zone **106.** The heated cooling fluid may then enter manifold portion **118** whereafter it is removed through the coolant output port **120** to a suitable reservoir for possible return to port **112.** It is to be understood that port **112** may be the output coolant port and port **120** may be the input coolant port in which case the direction of cooling fluid as previously described is reversed. In addition, multiple cooling ports may be added to those shown as single cooling ports. It will be noted that at various points in the arc detector and quench assembly **46** proximate to the various fluid conducting paths are positioned seals for the purpose of providing fluid tight joints or connections in the arc detector assembly **46.** Adjacent the front portion of arc detector assembly **46** is an insulating layer of material which may be similar to a material sold under the trademark TEFLON which provides an insulating barrier between the arc detector assembly **46** and the front portion **14** of the arc heater assembly **12** as shown in FIG. **1.** Consequently, in the preferred embodiment of the invention arc detector assembly **46** is electrically insulated from arc heater assembly **12.**

Referring now to FIG. **4** a rear elevation of the arc detector assembly **46** shown in FIG. **3** is depicted. A section of electrically insulating material **122** is shown adjacent a portion of the rear wall portion **68** of arc detector assembly **46,** it being realized from viewing FIG. **4** that in at least one embodiment but not limited to that, that the rear wall of arc detector **46** is an octagon in shape to correspond with the octangon shape of the arc heater assembly which may best be viewed by reference to FIG. **2.** For securing or fastening purposes four holes **124** are provided in spaced locations around a portion of arc detector assembly **46** for securing arc detector assembly **46** to the nozzle or front region **14** of arc heater assembly **12** as shown in FIG. **1** and for the positioning sandwiching or compressing of the insulating material **112** therebetween. The bolts **90** for securing arc detector means or current transformer **86** to the front portion **72** of flange **62** which is not necessarily octogonal in shape, are also depicted in FIG. **4.** The forward streamlined or beveled leading edge of sleeve **66** is also shown forming the annular circular reaction region **106.** Also shown in the dotted outline is the rear portion of the cylindrical path **116** provided behind the outer wall of sleeve **66.** The innermost annular cylindrical shell **128** for the disposition of the windings in the field coil **86** are shown in FIG. **4.** The various ports **112, 110** and **120** as depicted in FIG. **3** are not shown in FIG. **4** for simplicity of illustration. The inter-section of quadrant lines **130** and **132** as shown in FIG. **4** form one point of center line **64** which traverses the plane of FIG. **4.**

Referring now to FIG. **5,** an operative arc heater assembly including an adjacent, electrically insulated arc detector and materials admission means is shown. In this figure, **12** represents an arc heater apparatus and **46** represents an arc detector and materials admission means used in combination therewith. Arc heater apparatus **12** may be of the type disclosed in copending application Westinghouse Case U.S. Pat. No. 43,735 Ser. No. 279,895 and which is also shown in FIGS. **1** and **2.** It should be understood however that the arc heater apparatus such as represented by **12** is not limiting and any suitable arc heater apparatus adapted for heating process or other material or feed stock in an electric arc is suitable for use with the arc detector **46.** In this case, arc heater apparatus **12** is provided with two annular axially aligned electrodes **133** and **134.** The electrical conductor **38a** schematically shown represents the electrical path of terminal **38** as shown in FIG. **1** and is connected to electrode **133.** Similarly, schematically shown connector or lead **36*a*** is shown connected to electrode **134.** In this particular representation, the schematically shown lead **36*a*** is connected to a ground point **G3.** The lead **38*a*** is shown connected to the high voltage side of a potential source V, the low voltage side of which is grounded at **G2.** Note, however, lead **32*a*** may be directly connected to the other side of source V from lead **34*a*** so that a grounded system is not necessary in all instances. As can be seen, arc heater **12** comprises a left and right section **14** and **16** which correspond to the relatively stationary and movable sections **14** and **16** respectively shown in FIG. **1.** Upon joining of the two sections an annular gap **136** is formed through which a fluid F such as a gas may flow by first causing the fluid F to flow through pipe assembly **44** and then through internal ducting **138** of the arc heater apparatus **10** and then through the gap **136** whereupon it may act to enlarge or stretch an arc A into the region between the two annular electrodes which may be known as an arc chamber **140** whereupon the gas may move downstream where it is identified as F1 towards the reaction chamber **106** of arc detector means **46** which reaction chamber **106** communicates with arc chamber **140.** It should be noted that fluid F may comprise a gas, a liquid or a finely pulverized particulate material. Annularly located or positioned around the electrodes **133** and **134** are field coils **139** the purpose of which is to assist in some cases in the rotating of the arc A so that the roots R1 and R2 of the arc upon electrode **134** move continuously around the inner surface of the annular electrodes **133** and **134.** This avoids erosion and deterioration of the electrode surface due to the hot spots generated at the roots of the arc, A. It should be noted that arc root R2 is meant to remain within the longitudinal limits described by the two reference figures L and Z on the inner surface of electrode **134.** It being realized that Z is the furthest rightmost extension of electrode **134** and that the point L is the furthest leftmost extension of electrode **134.** Insulating barrier **122** separates the electrode surface of electrode **134** from the conducting sleeve or tubing **66** of the arc detector apparatus **46.** It should also be noted with respect to arc heater apparatus **10** that coolant fluid piping **40** and **42** as shown in FIG. **1** communicate wth certain internal coolant ducting such as shown at **141** so that the electrodes **133** and **134** may be cooled during operation of the arc heater

apparatus **10.** Field coils **139** may be cooled by separate ducts now shown.

OPERATION OF THE ARC HEATER AND ARC DETECTOR IN COMBINATION

As can be seen by examining FIG. **5,** there are occasions when the leftmost root or downstream root R2 of arc A may extend past the desired boundary L and encroach upon or strike the copper sleeve or tube **66** in the arc detector **46.** For purposes of illustration, an arc root R2 is shown in FIG. **5** impinging upon one part of sleeve **66** it being understood that the root may impinge or reside anywhere on the inner surface of the copper tube or sleeve **66** and the arc detector will nevertheless function for the purpose intended. This is because the current path of the electrical circuit including the power supply V for the electrode **133,** the schematically shown lead **38***a*, the electrode **133,** the current in the arc A, the various electrical paths designated I1 and I2 in the flange **72** and sleeve **66** of the arc detector **46,** the ground connection G1 and the ground connection G2 all carry the same current namely IT when the arc A impinges upon any portion of the inner surface of the copper sleeve or cylinder **66.** Such being the case, the current transformer **86** which is exemplary of an operational arc detector means will have flowing through the enclosed central region a component of electrical current IT. This component of electrical current IT will by necessary and well known electrical interaction induce a corresponding transfer of energy preferably in the form of the flow of electric current IC in a circuit including the turns of windings of transformer **86,** the line or lead **92,** the detector control means **48** and the line or lead **94.** This current will represent the presence of current IT flowing through the central region or measurement region of the compact coil **86.** It will be noted that even if the root R2 of arc A strikes the surface of sleeve or electrical conductor **66** to the right of the region of arc detector coil **86,** electrical current in the form of components I1 and I2 which algebraically equal the current value IT must flow through the region of measurement of the coil **86,** it being noted that electrical current cannot traverse the insulating wafer, shim or seal **122** which is interposed to electrically insulate the arc detector and materials admission and quench means **46** from arc heater apparatus **12.** In one possible current path, current I1 flows through the electrical conductor comprising sleeve or tube **66** and preferably thereafter through the low resistance electrically conducting juncture **82** between copper sleeve **66** and primarily brass flange region **72** of the support flange **62.** From thence it must flow to the ground connection G1 which is purposely provided to the arc detector apparatus **46.** In some cases, a component of current I2 which is preferably smaller than component I1 and which may be zero, flows into flange member **68** through the relatively poorer electrically conducting joint or juncture **115** between the forward portion of sleeve or electrically conducting tube **65** and the forward flange portion **68** of the arc detector means **46.** From thence it will flow through the central portion **70** of the flange member **62** to the rear portion **72** where it will then flow to the ground strap or connection G1. Note that in most instances I1 may be greater than I2 and I2 may even be zero.

OPERATION OF THE ARC DETECTOR — MATERIALS ADMISSION MEANS IN COMBINATION WITH ARC HEATER APPARATUS FOR THE ADMISSIONS OF MATERIAL TO THE REACTION ZONE

In addition to performing as an arc detection means apparatus **46** performs the function of providing process quench or other material from an outside source or reservoir to the internal part of the combination arc detector materials admission means **46,** it being realized that portions of the ducts and paths for the flow of process quench or other material and portions of the paths or ducts for the flow of coolant material are formed by the electrically conducting portions of flange member **62** and sleeve **66.** The electrically conducting portions referred to therefore provide a dual purpose of serving as the side walls for channels or ducts and as the main electrically conducting paths for the flow of electrical current during an arc detecting operation.

Process quench or other material generally designated M which may be provided to orifice or opening **110** from an external reservoir or source of material not shown flows into duct **108** and from there into the manifold **104** which is annular and which communciates with the materials admission ring **98.** The materials admission ring it being remembered, has communicating holes therein between the manifold **104** and the reactant zone or region **106.** In a typical operation, heated process fluid such as F1 flows out of the arcing zone or arc chamber **140** of the arc heater apparatus **110** through an opening in the end thereof formed by the left annular portion of electrode **134** and thence into zone **106.** The material F1 may comprise a heated gas, heated particulate matter or a heated fluid, it being understood that in a preferred embodiment of the invention the primary heating function occurs in zone **140** in the vicinity of the gap **136.** Material M which may be additional process material may then be added to the previously pyrolyzed material F1 for combination therewith in a chemical reaction or material M may be quench material to quickly cool stabilize or "freeze" the materials represented by identification symbol F1 to thereby preserve certain ascertainable chemical and physical properties of the material represented by the flow vector F1. Of course it is to be realized that the material F1 and the material M are not limited to the narrow paths as shown in FIG. **5** but may fill the entire volume of regions **140** and **106** depending upon other characteristics of the material in the arc heater and arc detector means. It is also to be understood that although quenching and the addition of feed stock materials are two purposes for the material admission means other purposes may be accomplished. It is also to be understood that the material M may be fluid such as a gas or liquid or may be particulate matter of sufficiently small size relative to the openings in the admission ring **98.**

Arc detector materials admission means **46** is normally cooled by providing coolant fluid as previously described through entrance port or porthole **112,** internal ducting or cooling channels **116** and exit port porthole or manifold opening **120.** As was described previously this material may be water or some other cooling

material and may be provided to a heat exchanger means or reservoir in a closed loop so that warmed or heated material which may exit porthole **120** will be cooled by the exchanger means, not shown in FIG. **5** and resupplied again as cooler material to porthole **112** for a continuous repetition of the cycle. In another embodiment the cooling fluid need not be recycled. It is also to be understood that the device or mean generally designated **48** and hence forth described as a readout device or control system device may have many useful purposes and in general readout device or control system device **48** may be thought of as providing an indication of the presence or recent presence of an arc impinging upon the annular inner surface of tube **106** or it may be thought of as recording or presence of the recent presence of such arc or it may be thought of as providing a control function in response to the presence of the arc which will act to prevent the arc from impinging upon the inner surface of tube or electrical conducting sleeve **66.** It may act to indicate the percentage of time to sleeve **66** or it may perform other useful functions for controlling the arc, the electrical parameters of either the electrical system associated with the arc detector means or the electrical system associated with the arc heater means or the fluid systems including the materials provisions systems and the coolant systems associated therewith.

It is also to be understood that the arc heater and the materials admission means need not be insulated electrically from each other provided at least a small component of current flows through the enclosed region of the detecting means.

The apparatus embodying the teachings of the present invention have many advantages. It allows the materials admission or quench material zone to be positioned proximate to the arc heating zone to increase the efficiency of the arc heater apparatus, it provides a dual function integral unitary piece of electrical apparatus which can both supply material to a reaction zone and also detect the presence of an electrical arc root present therein. It also has the advantage of allowing for a feedback control system for controlling certain physical and electrical parameters of the arc heater apparatus in response to the impingement of an arc in the arc detector means. It also has the advantage of extending the reaction zone of the arc heater apparatus by providing a similar communicating annular region or volume **106** into which the continuity of the processes occurring in the arc heating zones **140** may continue.

What we claim is:

1. An arc heater apparatus of the type including a plurality of spaced electrode means between which an electric arc is struck for heating a proximately situated gas, comprising:

an arc detector-and-material admission means disposed adjacent one of said spaced electrodes for providing material to said heated gas to interact therewith including integral means for electrically detecting the impingement of an electric arc near said arc detector-and-material admission means.

2. The combination as claimed in claim **1** wherein said gas flows, said arc detector and material admission means is disposed downstream of said one adjacent electrode means as determined by the direction of flow of said gas.

3. The combination as claimed in claim **1** wherein said arc detector-and-material admission means is electrically insulated from said one of said spaced electrodes.

4. The combination as claimed in claim **1** comprising cooling means for cooling said arc detector-and-material admission means.

5. The combination as claimed in claim **4** wherein said cooling means comprises:

a cooling channel integral with said arc detector-and-material admission means; and

a heat exchanger means spaced from said arc detector-and-material admission means but communicating with said cooling channel to form a closed system for supplying a cooling medium to said arc detector-and-material admission means and for removing the relatively warmer cooling medium therefrom after it passes through said channel, the heat from said relatively warmer cooling medium being cooled by said heat exchanger means to thereby provide said cooling medium for return to said cooling channel.

6. The combination as claimed in claim **5** wherein said cooling medium comprises water.

7. The combination as claimed in claim **1** wherein said plurality of spaced electrode means comprise a pair of annularly shaped electrodes disposed axially along a common central axis, said arc detector-and-material admission means being disposed along said common central axis.

8. The combination as claimed in claim **7** wherein said gas flows, said arc detector-and-material admission means is in electrical contact with said adjacent one of said spaced electrodes and is disposed downstream therefrom as determined by the direction of flow of said gas comprising:

a cooling channel integral with said arc detector-and-material admission means; and

a heat exchanger means spaced from said arc detector-and-material admission means but communicating with said cooling channel in a closed system for supplying water to said arc detector-and-material admission means for cooling said channel and for removing relatively warmer water therefrom, the heat from said relatively warmer water being cooled by said heat exchanger means to thereby provide said cooling water for return to said cooling channel.

9. The combination as claimed in claim **8** including means for indicating the presence of an electric arc on said arc detector-and-material admission means, wherein said integral means for electrically detecting the impingment of an electric arc upon said arc detector-and-material admission means comprises an electrical current transformer electrically communicating with said means for indicating the presence of an arc upon said arc detector-and-material admission means, said current transformer being annular and concentric about said common axis and disposed to detect electrical current flowing in said arc detector-and-material admission means from the point of arc impingment on said arc detector-and-material admission means to said adjacent one of said electrodes.

10. The combination as claimed in claim **8** wherein said arc detector-and-material admission means comprises a material admission structure having generally radially spaced openings therein past which said heated gas flows, said spaced openings communicating with a

source of material to provide material to said heated gas to interact therewith.

11. The combination as claimed in claim **10** including means for indicating the presence of a spurious arc on said arc detector-and-material admission means, wherein said integral means for electrically detecting the impingement of an electric arc upon said arc detector-and-material admission means comprises an electrical current transformer electrically communicating with said means for indicating the presence of an arc upon said arc detector-and-material admission means, said current transformer being annular and concentric about said common axis and disposed to detect electrical current flowing in said arc detector-and-material admission means from the point of arc impingement thereon to said adjacent one said electrode.

12. The combination as claimed in claim **11** wherein said material comprises process material.

13. The combination as claimed in claim **11** wherein said material comprises quenching material.

14. The combination as claimed in claim **11** wherein said material comprises a fluid.

15. The combination as claimed in claim **14** wherein said fluid comprises a gas.

16. The combination as claimed in claim **9** wherein said means for indicating said impingement of said arc provides a control function of said arc heater apparatus.

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