US 20100159409A1

(19) **United States**

(12) **Patent Application Publication**

RICHARDSON et al.

(10) **Pub. No.: US 2010/0159409 A1**

(43) **Pub. Date: Jun. 24, 2010**

(54) **NON-CENTRIC OXY-FUEL BURNER FOR GLASS MELTING SYSTEMS**

(76) Inventors: **Andrew P. RICHARDSON**, Clinton, NJ (US); **John Allen Wainford**, Shirley (GB); **Neil Simpson**, Ayton (GB)

Correspondence Address:
The BOC Group, Inc.
575 MOUNTAIN AVENUE
MURRAY HILL, NJ 07974-2082 (US)

(21) Appl. No.: **12/651,506**

(22) Filed: **Jan. 4, 2010**

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/446,738, filed on Jun. 5, 2006.

Publication Classification

(51) **Int. Cl.**
F23C 5/08 (2006.01)
F23D 14/20 (2006.01)

(52) **U.S. Cl.** **431/181**; 431/186

(57) **ABSTRACT**

A burner for use in a combustion chamber of a furnace or a forehearth includes a gas delivery member for delivering a gaseous oxidant, a fuel delivery member for delivering a fuel and having a portion disposed at an interior of the gas delivery member and offset from a longitudinal axis of the gas delivery member, and a flange assembly mechanically associated with the gas and fuel delivery members, the flange assembly adapted for rotational movement to releasably secure the gas and fuel delivery members with respect to each other to provide a flame footprint at a select location in the combustion chamber.

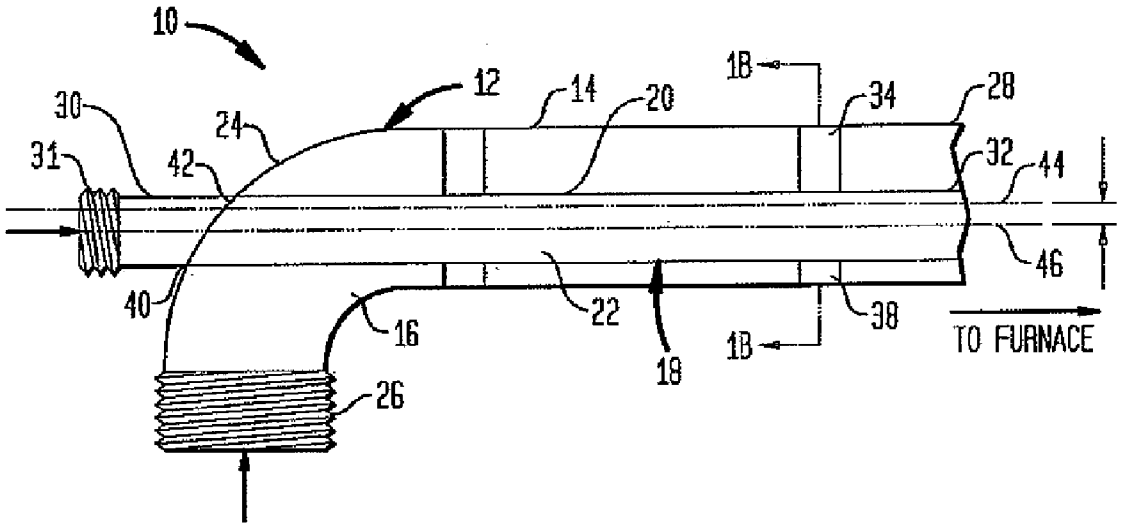


FIG. 1A

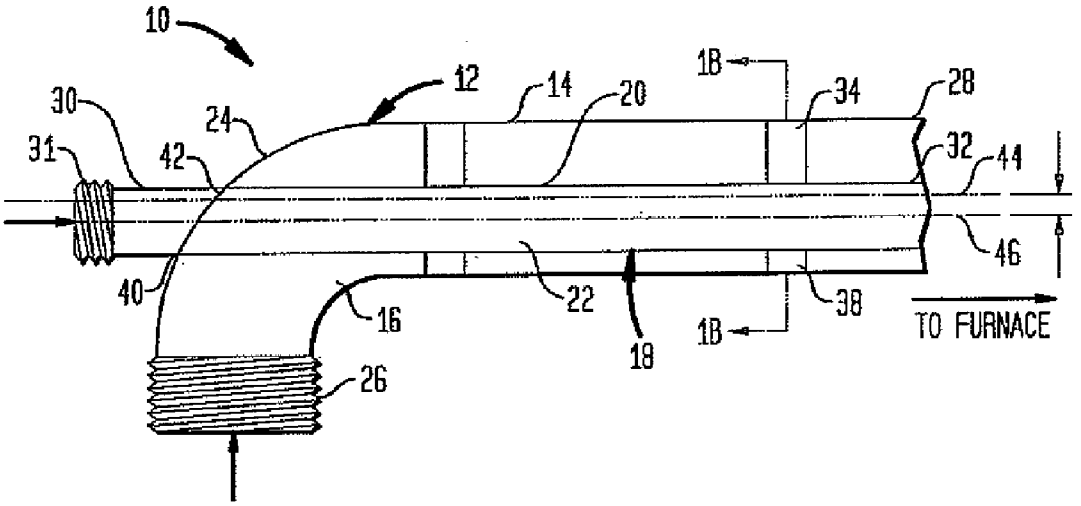

10
12
14
20
1B
34
28
30
24
31
42
32
44
46
40
22
16
38
1B
TO FURNACE
18
26

FIG. 1B

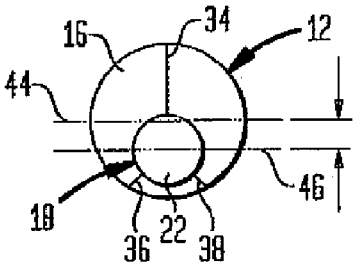

16
34
12
44
46
18
36
22
38

FIG. 2A

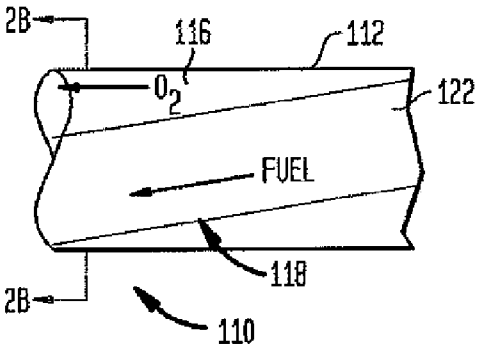


FIG. 2B

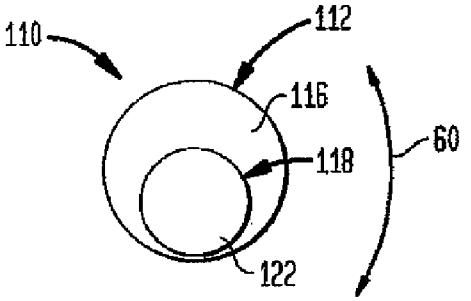


FIG. 3A

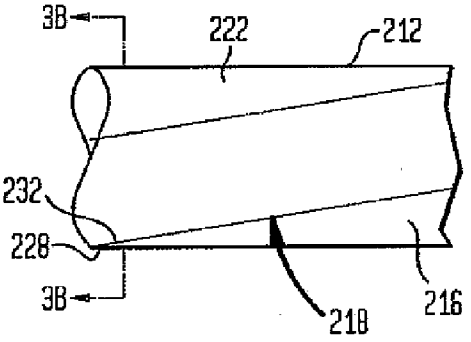


FIG. 3B

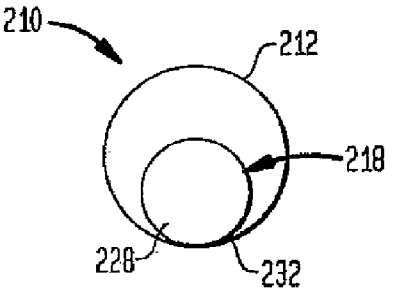


FIG. 4

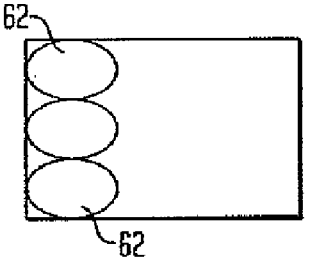


FIG. 5A

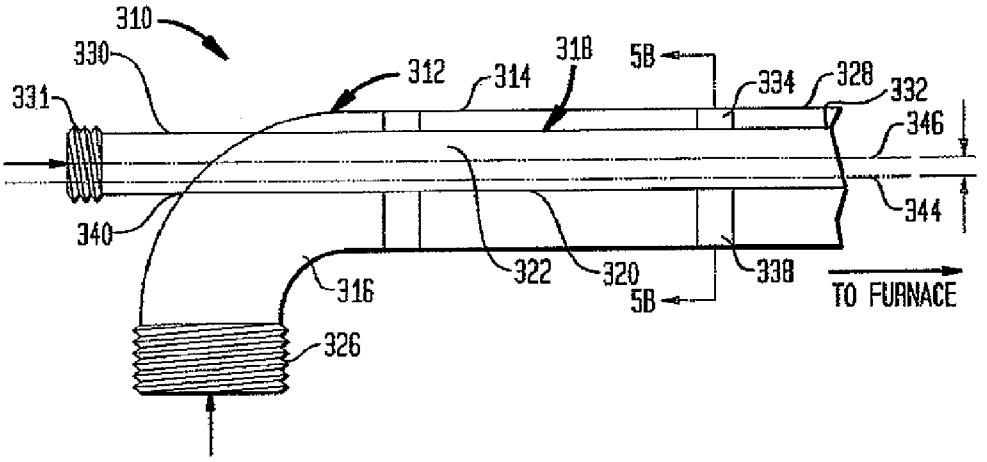

310
330
331
312
314
318
5B
334
328
332
346
344
340
316
322
320
338
5B
TO FURNACE
326

FIG. 5B

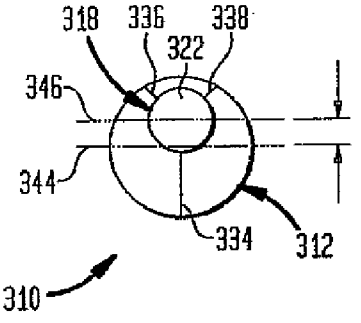

318
336
338
322
346
344
334
312
310

FIG. 6A

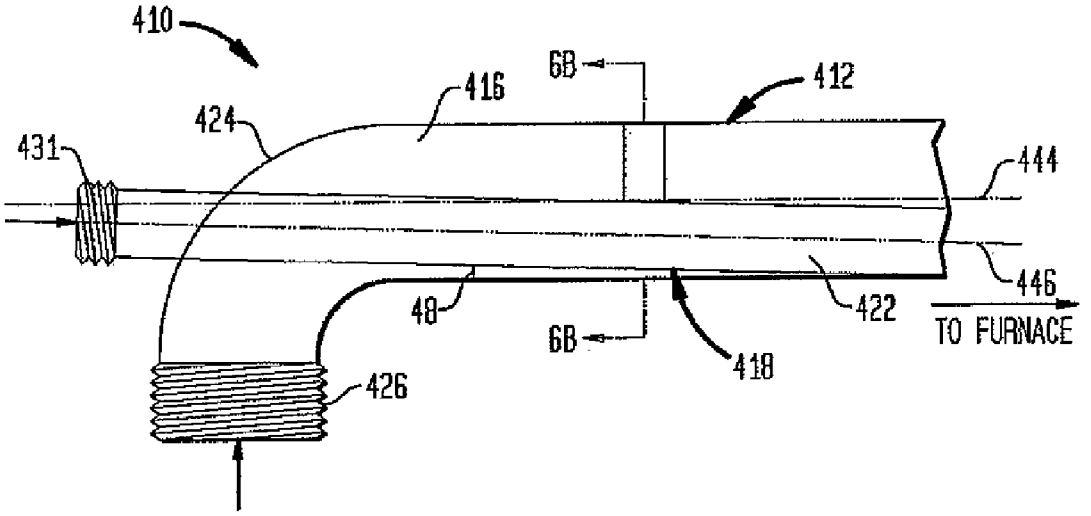

410
6B
416
412
424
431
444
446
48
422
6B
418
TO FURNACE
426

FIG. 6B

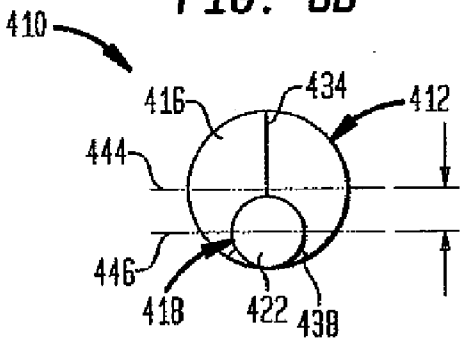

410
434
416
412
444
446
418
422
438

FIG. 7A

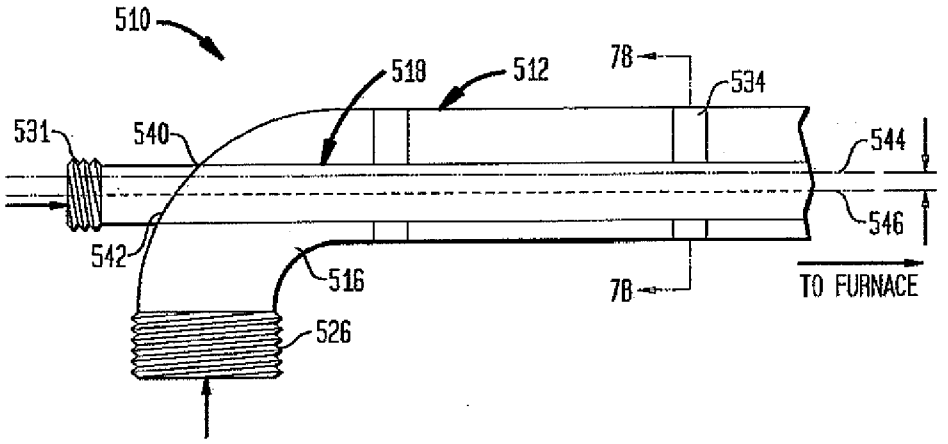

510
518
512
7B
534
531
540
544
546
542
516
7B
TO FURNACE
526

FIG. 7B

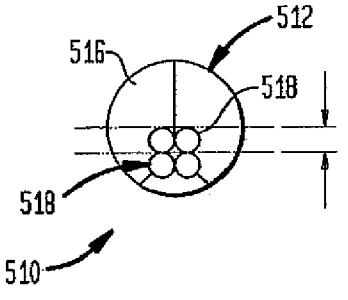

512
516
518
518
510

FIG. 8A

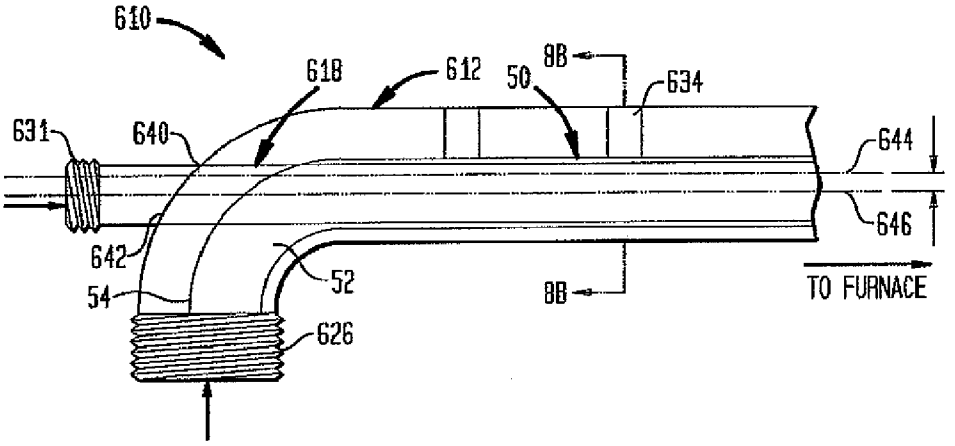

610
618
612
50
8B
634
631
640
644
646
642
54
52
626
8B
TO FURNACE

FIG. 8B

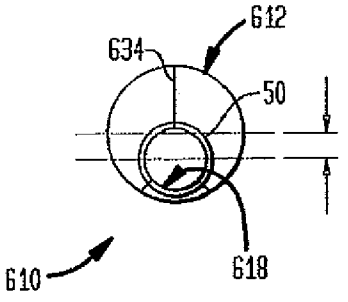

612
634
50
618
610

FIG. 9

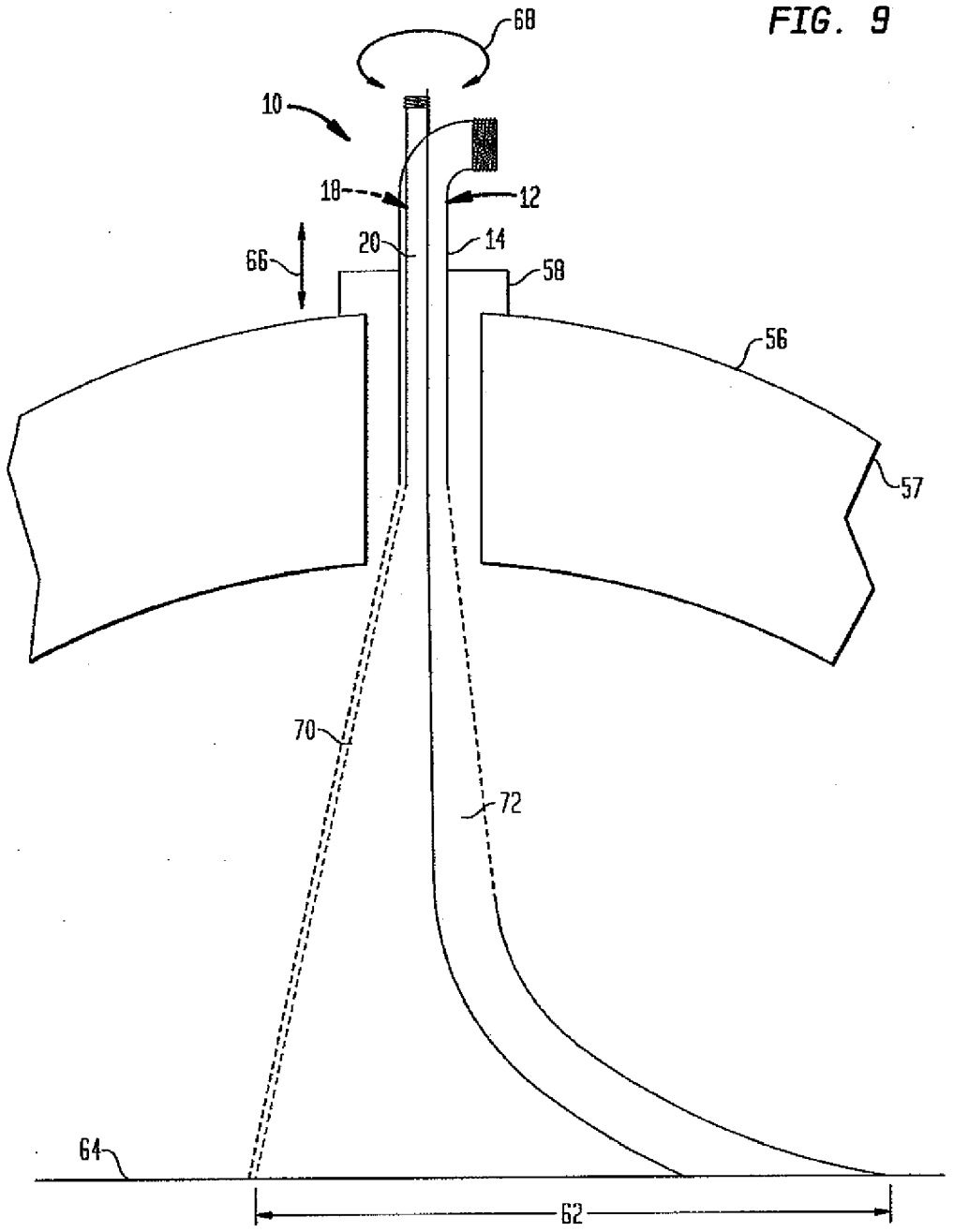
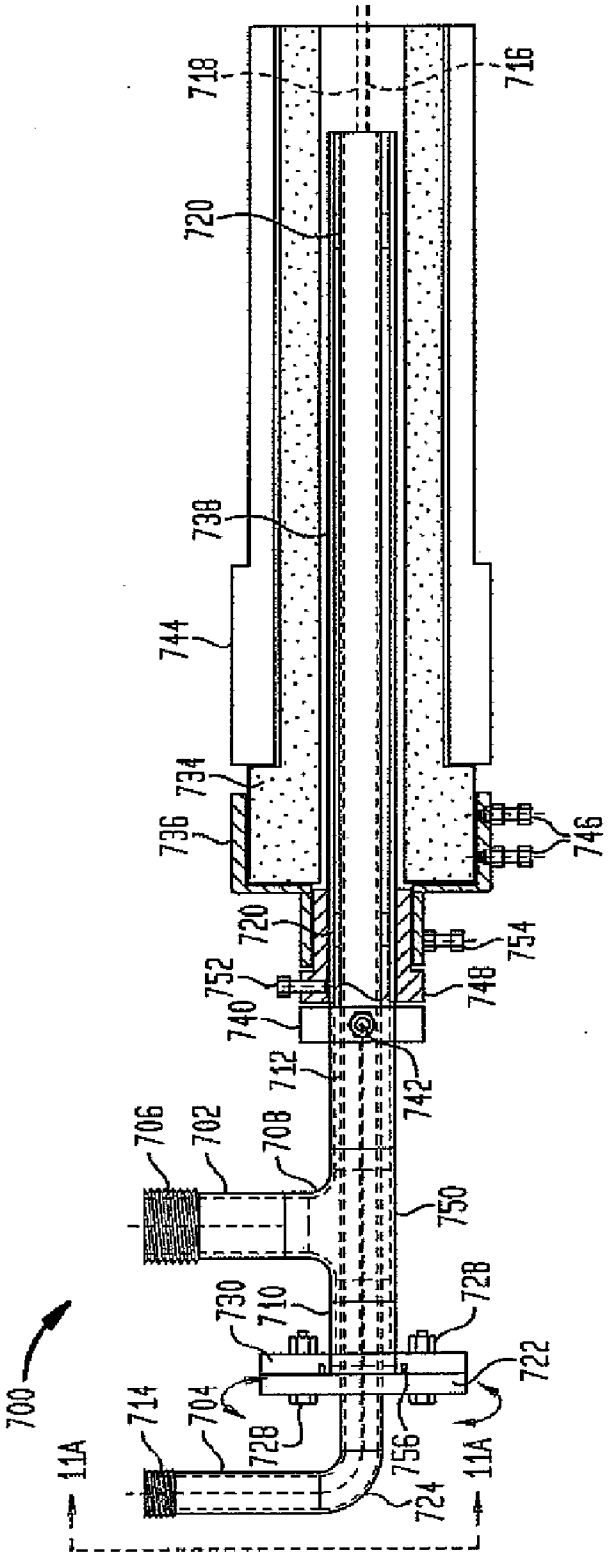


FIG. 10


718
716
720
738
744
734
736
746
720
754
752
748
740
712
742
706
702
708
750
730
710
728
722
700
714
704
728
756
724
11A
11A

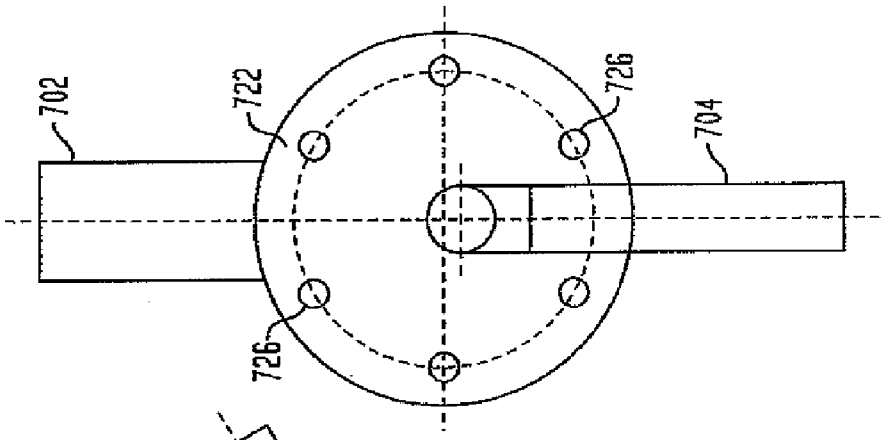


FIG. 11C

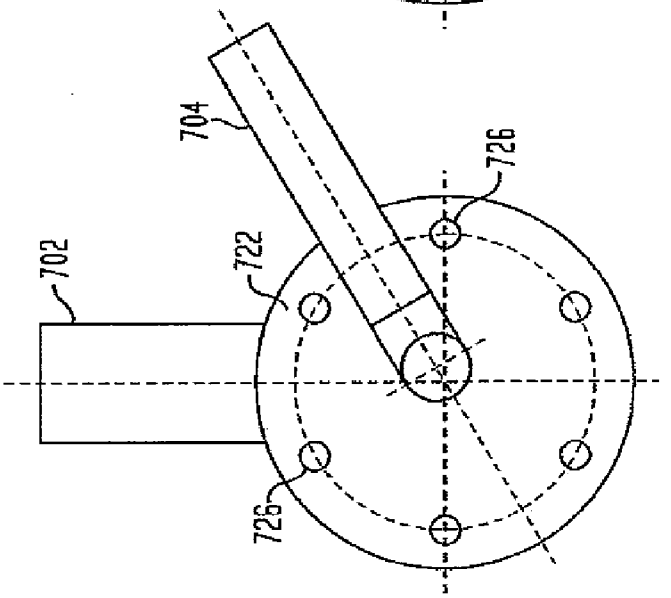


FIG. 11B

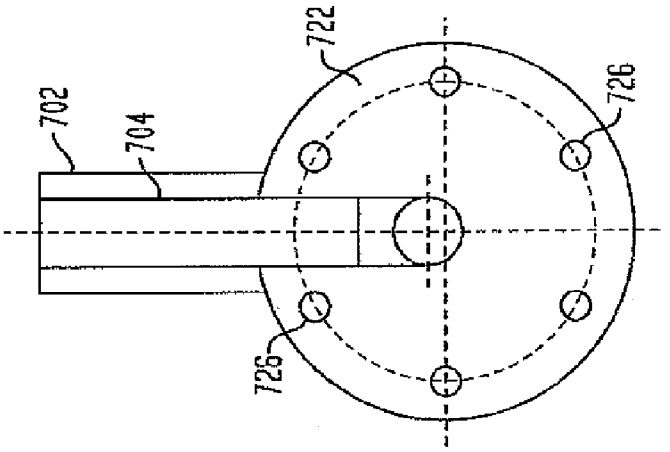


FIG. 11A

FIG. 12A

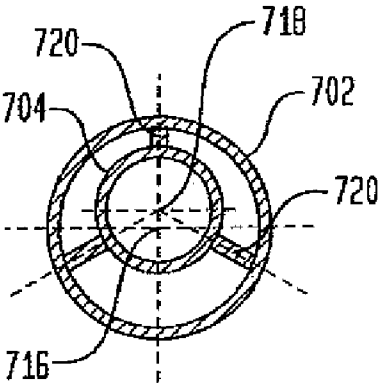


FIG. 12B

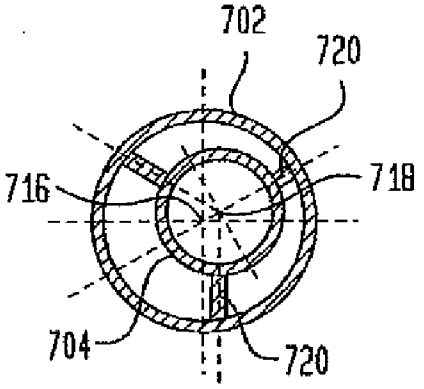


FIG. 12C

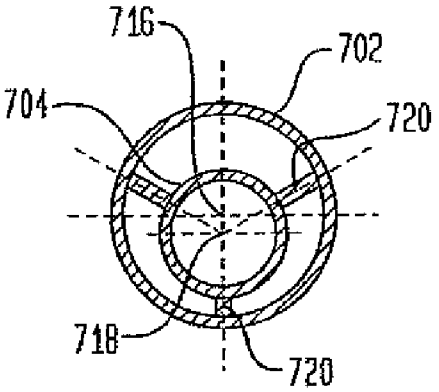


FIG. 13

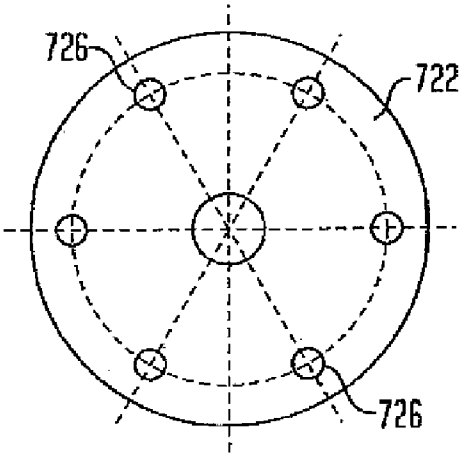


FIG. 14

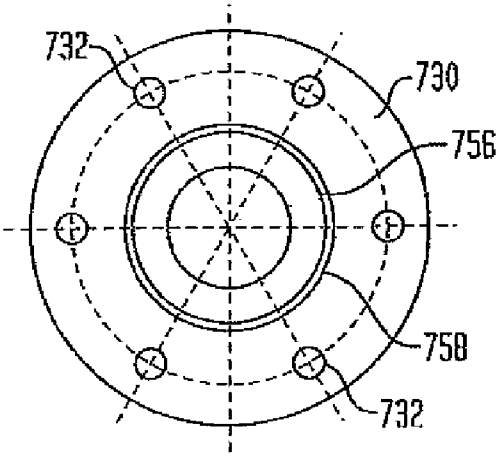


FIG. 15

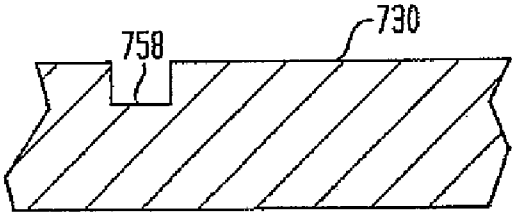
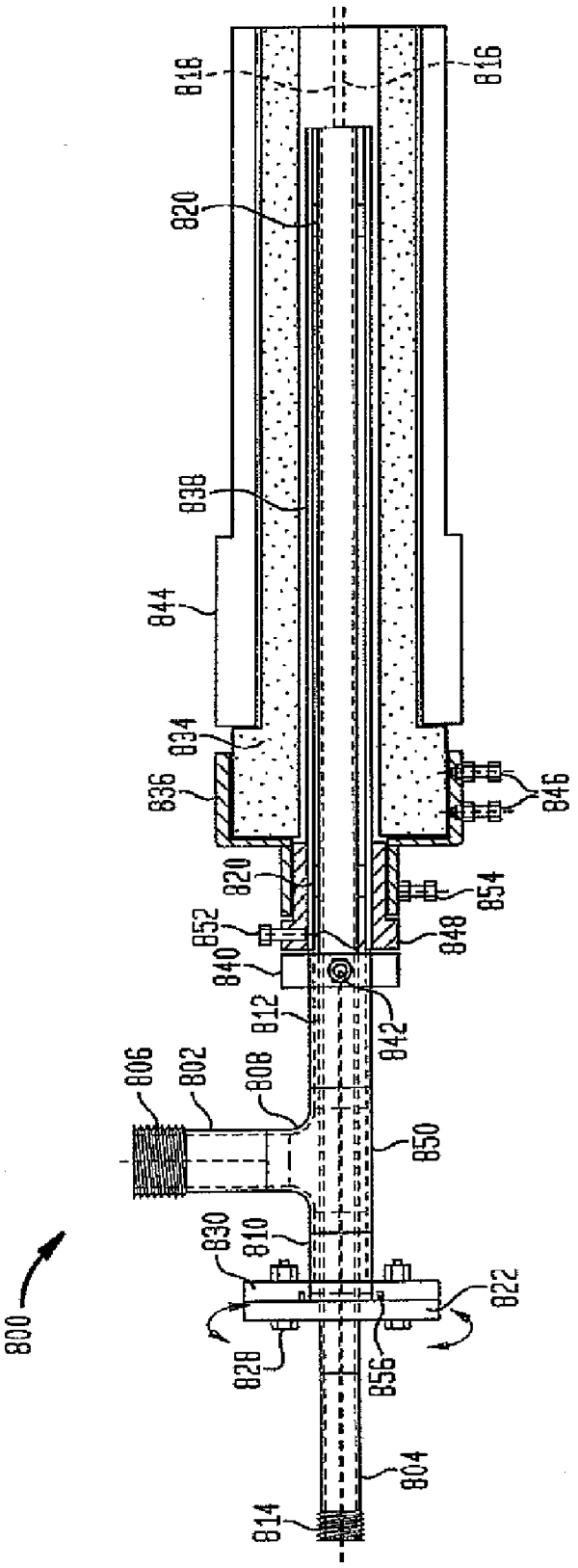


FIG. 16


800
804
806
802
808
812
814
816
818
820
822
828
830
834
836
838
840
842
844
846
848
850
852
854
856
810

NON-CENTRIC OXY-FUEL BURNER FOR GLASS MELTING SYSTEMS

BACKGROUND OF THE INVENTION

[0001] The invention relates to burners for furnaces and furnace systems.

[0002] Conical concentric oxy-fuel burners have been used in the crown of glass melting furnaces to melt batch in the furnaces. Once a pre-positioned hole is drilled in the furnace crown and a burner block is installed in the hole, there is limited if no ability to change the direction of the turbulent flame being emitted from the burner. If a different direction is required for the flame, it is required to drill and install an alternate (different) burner hole in order to re-position the burner and hence the flame. Existing furnace designs, with their steelwork and crown expansion joints, frequently limit the location that burners can be installed in the furnace and as a result optimum flame coverage is not always achieved or blocks are angled excessively so that the burner flame is less effective. Concentric oxy-fuel burners produce conical flames perpendicular to the melt which in turn produce circular flame patterns at the melt. The resulting flame pattern produced by a plurality of spaced apart burners limits the total flame coverage at the surface of the melt. Concentric burners combust uniformly in the combustion space above the melt. This uniformity and intensity of combustion can provide excessive combustion in the free space between the crown and the melt resulting in less than optimum heat transfer and higher oxides of nitrogen (NOx) at the melt surface. The aforementioned limitations and disadvantages occur also with horizontal burners and burners used in forehearths of furnaces.

SUMMARY OF THE INVENTION

[0003] A burner such as an oxy-fuel burner is provided for a furnace or a forehearth, and which includes a gas delivery member, and a fuel delivery member having a portion disposed at an interior of the gas delivery member and offset from a longitudinal axis of the gas delivery member.

[0004] There is also provided a method for combusting product in a furnace or a forehearth, comprising providing a flow of gaseous oxidant along a first flow path to the furnace or the forehearth; providing a flow of gaseous fuel along a second flow path offset from the first flow path to the furnace or the forehearth; exposing the first flow path to the second flowpath; and combusting the gaseous oxidant and the gaseous fuel to provide a non-circular burn area.

[0005] There is also provided a burner, whereby one or more of the gas and fuel delivery members may be rotated along their respective longitudinal axes to control an angle of discharge of the burner flame and the resulting non-circular burn area.

[0006] There is further provided a flange assembly for orienting the gas delivery member and the fuel delivery member with respect to each other, and securing the members in a fixed position with respect to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a more complete understanding of the present invention, reference may be had to the following Figures, taken in conjunction with the detailed description, of which:

[0008] FIG. **1**A discloses a partial cross-sectional plan view of a burner of the present invention for use with a furnace.

[0009] FIG. **1**B discloses a cross-section of the burner taken along line **1**B-**1**B of FIG. **1**A.

[0010] FIG. **2**A discloses a diagram of another embodiment of a burner of the present invention.

[0011] FIG. **2**B discloses a cross-section diagram taken along line **2**B-**2**B of FIG. **2**A.

[0012] FIG. **3**A discloses a diagram of another embodiment of a burner of the present invention.

[0013] FIG. **3**B discloses a cross-section diagram taken along line **3**B-**3**B of FIG. **3**A.

[0014] FIG. **4** discloses a flame footprint provided by the burners of the present invention.

[0015] FIG. **5**A discloses a diagram of another embodiment of a burner of the present invention.

[0016] FIG. **5**B discloses a cross-section diagram taken along line **5**B-**5**B of FIG. **5**A.

[0017] FIG. **6**A discloses a partial cross-sectional plan view of another embodiment of the burner of the present invention for use with a furnace.

[0018] FIG. **6**B discloses a cross-section of the burner taken along line **6**B-**6**B of FIG. **6**A.

[0019] FIG. **7**A discloses a partial cross-sectional plan view of still another embodiment of the burner of the present invention for use with a furnace.

[0020] FIG. **7**B discloses a cross-section of the burner taken along line **7**B-**7**B of FIG. **7**A.

[0021] FIG. **8**A discloses a partial cross-sectional plan view of another embodiment of the burner of the present invention for use with a furnace.

[0022] FIG. **8**B discloses a cross-section of the burner taken along line **8**B-**8**B of FIG. **8**A.

[0023] FIG. **9** discloses a partial cross-sectional plan view of a burner of the present invention mounted in a burner block of a furnace.

[0024] FIG. **10** discloses a partial cross-sectional plan view of another burner embodiment for use with a furnace.

[0025] FIG. **11**A discloses a view taken along line **11**A-**11**A of FIG. **10**.

[0026] FIGS. **11**B and **11**C show schematic views of elements of FIG. **11**A arranged in different positions.

[0027] FIGS. **12**A-**12**C show schematic views corresponding to that of FIGS. **11**A-**11**C, respectively.

[0028] FIGS. **13**-**15** show components of a flange assembly for the burner embodiments of FIGS. **10** and **16**.

[0029] FIG. **16** shows a partial cross-sectional plan view of another burner embodiment for use with a furnace.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Referring to FIGS. **1**A and **1**B, there is shown a burner **10** of the present invention for use with a furnace, such as for example an oxy-fuel glass melting furnace or a forehearth of the furnace. Reference to use of the burner with a furnace also includes use of the burner with forehearth. The burner **10** consists of a gas pipe **12** or conduit, for delivering gaseous oxygen for example, having an exterior sidewall **14** constructed and arranged for disposition in a burner block of a furnace. The gas provided to and delivered in the gas pipe **12** is a gaseous oxidant such as for example gaseous oxygen at a purity level of 85%-100%; where less than 100% oxygen, the balance may be nitrogen and/or other noble gases, and combinations thereof. An internal space **16** of the gas pipe **12** is of

sufficient size and shape to receive a fuel pipe **18** or conduit disposed therein. The fuel pipe **18** has an exterior side wall **20** and internal space **22**.

[0031] The gas pipe **12**, or oxidant pipe for example, is bent thereby providing an elbow **24** in the gas pipe **12**. The pipe **12** is in fluid communication with a gas supply (not shown). A threaded exterior end **26** of the gas pipe **12** provides for releasable connection to the gas supply. An opposite or distal end **28** of the gas pipe **12** terminates in a burner block of the furnace (not shown) and is disposed at a select position above product melt in the furnace. Gaseous oxidant provided may be a single type of oxidant, such as for example oxygen, or selected from a composition of gases as well.

[0032] The interior **16** of the gas pipe **12** is sized and shaped to receive the fuel pipe **18** to be disposed therein, as shown in FIGS. **1**A and **1***b*. The fuel pipe **18** is constructed of a material conducive to being exposed to the oxidant in the gas pipe **12**. The fuel pipe **18** has an end or proximal end **30** extending from proximate the elbow **24** of the gas pipe **12**, while an opposed or distal end **32** of the fuel pipe **18** terminates at approximately the same position as the end **28** of the gas pipe **12**. The gas pipe **12** and fuel pipe **18** may terminate at the same location. The fuel pipe **18** is in fluid communication with a supply of gaseous fuel, such as for example natural gas, propane, liquid petroleum gas (LPG), synthetic gas (derived from organic solid, liquid and or gaseous sources, or combinations thereof), and combinations thereof. The fuel used may consist of a single gaseous fuel or a composition of fuels. The end **30** of the fuel pipe **18** projecting from the gas pipe **12** may also be threaded **31** for releasable connection to a source (not shown) of gaseous fuel.

[0033] Spacing or support members **34**, **36**, **38** are provided to support the fuel pipe **18** within the gas pipe **12** and provide the spaced relation therebetween without interrupting the flow of gas through the gas pipe **12**. A weld or seal **40** is provided to seal the circumference of an inlet **42** in the gas pipe **12** through which the fuel pipe **18** is inserted.

[0034] Referring also to FIG. **1**B, the disposition of the fuel pipe **18** at the interior **16** of the gas pipe **12** is more clearly shown. The gas pipe **12** and fuel pipe **18** are substantially parallel to each other from a point where the gas pipe **12** transits from the elbow **24** to a linear arrangement. It can be seen however that the disposition of the fuel pipe **18** within the gas pipe **12** is non-concentric; i.e., the gas pipe **12** and the fuel pipe **18** do not share a common longitudinal axis. Rather, a longitudinal axis **44** of the gas pipe **12** is offset with respect to a longitudinal axis **46** of the fuel pipe **18**, as will be further discussed below, to provide a burner flame and flame footprint area for the particular furnace and product to be melted within the furnace. The burner can be adjusted to alter the flame footprint. This is accomplished because the gas pipe and fuel pipe are adapted, such as by construction and arrangement of their components, to be rotated about their respective longitudinal axes **44**, **46**.

[0035] The burner **10** of FIGS. **1**A and **1**B may also be constructed as an integral unit, thereby permitting rotation of the combined gas pipe and fuel pipe unit in the burner block to selectively control the disposition of the flame footprint area being emitted from the burner **10** into the furnace.

[0036] Other exemplary embodiments of a burner constructed in accordance with the present invention are illustrated in FIGS. **2**A, **2**B; **3**A, **3**B; **6**A, **5**B; **7**A, **7**B; and **8**A, **8**B, respectively. Elements illustrated in those Figures which correspond to the elements described above with respect to FIGS. **1**A, **1**B have been designated by corresponding reference numerals increased by one hundred, two hundred, three hundred, four hundred, etc., respectively.

[0037] FIGS. **2**A and **2**B show schematics of another embodiment of the burner **110** of FIGS. **1**A, **1**B. In FIGS. **2**A and **2**B, the fuel pipe **118** is disposed in the gas pipe **112** in an angled relationship, i.e. not parallel, such that the flame emitted from the burner into the furnace also provides a non-circular footprint at the melt in the furnace. The burner **110** may have the gas pipe **112** and fuel pipe **118** formed as an integral unit, whereby rotation of the unit as represented by arrow **60** can occur to provide the flame footprint at select positions on the melt within the furnace. Rotation of the burner unit can be done through 360°. FIG. **2**A shows the gaseous oxidant flow, for example, and gaseous fuel flow to the furnace.

[0038] The fuel pipe **218** may also be angled sufficiently in the gas pipe **212** such that a distal end **232** of the fuel pipe contacts a distal end **228** of the gas pipe **212**. Such an arrangement is shown in FIGS. **3**A and **3**B.

[0039] In FIG. **4** there is represented a plurality of flame footprints **62** that are provided by the burner **10** (**110**, **210**, etc.) embodiments in the Figures. Each non-circular footprint **62** or burn area represents the footprint from its respective burner.

[0040] Referring to FIGS. **5**A and **5**B, the burner **310** is shown having the disposition of the fuel pipe **318** at the interior **316** of the gas pipe **312**. The offset of the fuel pipe **318** with respect to the gas pipe **312** is shown in FIG. **5**B.

[0041] In FIGS. **6**A and **6**B, the burner **410** is similar to the burner **110** diagram shown in FIGS. **2**A and **2**B. In particular, the fuel pipe **418** is introduced into the gas pipe **412** at an angle **48** such that the straight or linear portion of the gas pipe **412** and fuel pipe **418** are not parallel and are non-concentric. The offset of the fuel pipe **418** with respect to the gas pipe **412** is shown in FIG. **6**B.

[0042] FIGS. **7**A and **7**B disclose a plurality of fuel pipes **518** disposed in a gas pipe **512**. The plurality of fuel pipes **518** may be disposed as separate and discrete pipes or alternatively formed or arranged as a nested array or integral unit of fuel pipes, such as shown in FIG. **7**B. The arrangement of the fuel pipes **518** in FIG. **7**A are parallel with respect to each other and to the linear portion of the gas pipe **512** in which the fuel pipes **518** are disposed therein. As with other embodiments of the invention, the plurality of fuel pipes **518** and the gas pipe **512** can be formed as an integrated unit for being mounted in the burner block and subsequent rotation within the burner block to control the flame footprint area **562** at the melt in the furnace. The offset of the fuel pipes **518** with respect to the gas pipes **512** is shown in FIG. **7**B. The array of fuel pipes **518** may share a common threaded portion **531** to releasably connect the fuel pipes **518** to a source of fuel.

[0043] In FIGS. **8**A and **8**B, there is shown a fuel pipe **631** disposed in concentrically arranged gas pipes. That is, a primary outer gas pipe **612** has an interior sized and shaped to receive a secondary inner gas pipe **50** therein. The inner gas pipe **50** has an interior **52** sized and shaped to receive the fuel pipe **618** therein. The inner gas pipe **50** has an inlet **54** in registration with the inlet **642** of the outer gas pipe **612** so that the fuel pipe **618** can be inserted into the inner gas pipe **50**. In FIGS. **8**A, **8**B, the inner gas pipe **50** and fuel pipe **618** have a common longitudinal axis **646** along a back portion of each and are therefore concentric. The orientation of the fuel pipe **618** and the gas pipes **612**, **50** is also shown in FIG. **8**B. As

with other embodiments of the present invention, the burner **610** of FIG. **8**A may be formed as an integral unit for being mounted in the burner block of the furnace. The offset of the fuel pipe **618** with respect to the gas pipes **612**, **50** is shown in FIG. **8**B.

[0044] Referring to FIG. **9**, there is shown a portion of a crown **56** of a furnace **57** in which a burner block **58** is mounted. The burner **10** of FIG. **1**A is disposed within the burner block **58**. It should be understood that other embodiments of the burner (**110**, **210**, **310**, **410**, **510**, **610**) disclosed herein may be mounted in the burner block **58** as well. The burners **10**, etc. are adapted to move in the direction of arrows **66**, **68**. With respect to the arrow **66**, the burner **10** can be moved into a select position depending upon the amount of combustion that is desired to occur in the burner block **58**. The distal ends of the fuel pipe **18** or pipes and gas pipe **12** or pipes terminate within the burner block **58** as shown, otherwise heat of the furnace atmosphere would melt the pipes if such were exposed from the burner block **58**. Positioning the burner **10** in the burner block **58** effects combustion in the block **58**, which in turn impacts the momentum and thrust of the flame provided by the burner **10**. A higher momentum flame produces a smaller footprint **62** area, while a lower momentum flame produces a larger footprint **62** area. There is a lower oxidant concentration at area **70**, as the gaseous fuel, for example, burns it uses up the oxidant and tends to seek area **72** where there is a higher concentration of oxidant to burn.

[0045] As shown in FIG. **9**, a rich flame is provided from the burner at a distal end of the burner where the fuel pipe is closest to the sidewall of the gas pipe. An oxidized lean flame is provided from the distal end of the burner where the fuel pipe is further away from the side wall of gas pipe. The latter provides an increased or more expanded oxygen zone for combustion, thereby providing a relatively oblong shape, as opposed to a circular shape, in the burn area **62** or footprint of the flame impacting the melt of the furnace. See also FIG. **4**

[0046] The non-circular footprints shown in FIG. **4** may also be provided by any one or combinations of the embodiments of the burners of the Figures.

[0047] The burners of the present invention may be used for glass melting, refining, and distribution. The discharge point of the fuel pipes are not concentric to the oxygen pipes, but staggered or off-set. This off-set and/or rotation of the burners enables the direction of the flame to be changed as well as the resulting flame footprint. The degree or amount of staggering or off-set will increase the amount of flame direction that can be achieved. The off-set can be further accentuated by angling the fuel conduit relative to the oxygen conduit. By way of example, the gas and fuel pipes have a circular cross-section, however the burner design may include gas and fuel pipes having different cross-sectional shapes, including but not limited to, elliptical, square, triangular, hex, etc. The fuel pipe can have a different cross-sectional shape than the gas pipe. Multiple or staged pipes can be utilized as well.

[0048] The arrows **66**, **68** are with respect to all burner **10**, etc. embodiments of the invention as such can be rotated in the block **58**. Such rotation can occur by the individual components of the gas pipes and fuel pipes, or by the integral units formed of a gas pipe or pipes and fuel pipe or pipes.

[0049] In the combustion process, the fuel reacts with the oxidant. By off-setting the pipes **12**, **18**, there is created a fuel-rich flame at the point where the pipes are closest, and a fuel-lean area at the point where the pipes are furthest apart. The fuel-rich portion of the flame will react with the oxidant at the fuel-lean side. This staging will also provide the benefit of lower oxides of nitrogen (NOx) and increase heat transfer. The staging lowers the amount of pre-combustion in the burner block **58** and reduces the momentum of the flame emerging from the burner block. Whilst the flame is turbulent the lower momentum flame will reduce the velocity on the batch surface and reduce volatilization of batch components including but not limited to boron and lead.

[0050] The lower momentum of the flame with respect to a furnace increases the residence time of the carbon in fuel and increases luminosity and heat transfer by radiation through sooting. The primary benefit of this invention is that the off-set of the gas and fuel pipes **12**, **18**, respectively, and hence the gas and fuel flows, delays the mixing of the gaseous fuel and gaseous oxidant until the flame hits the raw batch surface **64**. The excess oxygen from the lean portion of the flame continues in its primary direction away from the remaining fuel components. The resulting flame footprint **62** or burn area is non-circular as shown in FIGS. **4** and **9**. The non-circular flame burn area enables more energy to be directed into the melting area.

[0051] The lower momentum of the flame with respect to a forehearth or distributor for a furnace provides for the flame not to impact a surface of the melt, but rather to "curl" or alter direction to become substantially parallel to a surface of the melt.

[0052] FIGS. **10-16** disclose other embodiments of the non-centric oxy-fuel burner for a furnace or a forehearth of a furnace.

[0053] Referring to FIG. **10**, there is shown a burner generally at **700** for use in a furnace (not shown) or a forehearth (not shown) of the furnace. The burner **700** includes an oxidant delivery pipe **702** and a fuel delivery pipe **704** (also referred to as a fuel pipe **704**). The oxidant delivery pipe **702** is constructed, in this embodiment, as having a "T-shape", wherein an end **706** of the oxidant pipe **702** shown in FIG. **10** is threaded for releasably connecting the pipe **702** to a remote source of oxidant (not shown). The oxidant used may be similar to that used with the embodiments of FIGS. **1-9**. In this embodiment, the oxidant pipe **702** branches at **708** to provide a receptor portion **710** into which the fuel delivery pipe **704** is inserted along an interior **712** of the oxidant pipe **702**. An end **714** of the fuel pipe **704** is also threaded for releasable connection to a remote fuel source (not shown). The fuel used may be similar to that used with the embodiments of FIGS. **1-9**. A portion of the fuel pipe **704** is curved or angled upstream of a flange assembly (discussed below) and prior to insertion into and along the interior **712** of the oxidant pipe **702** as shown in FIG. **10**.

[0054] A central longitudinal axis **716** of the oxidant pipe **702** and a central longitudinal axis **718** of the fuel pipe **704**, while parallel, are offset with respect to each other. That is, as shown in FIG. **10** and by way of example, the fuel pipe **704** is disposed within the oxidant pipe **702** such that there respective longitudinal axis are offset, non-centric, from each other. Spacers **720** are connected, by welding for example, to an exterior surface of the fuel pipe **704** to extend at the interior **712** of the oxidant pipe **702** to provide support for and alignment of the fuel pipe **704** for being disposed offset within the oxidant delivery pipe. Accordingly, the longitudinal axis **716** of the oxidant pipe **702** extends through the center of each of the movable flange **722** and the fixed flange **730**. The longi-

tudinal axis **718** of the fuel pipe **704** is offset or non-centric with respect to the longitudinal axis **716**, due to the spacers **720**.

[0055] Referring also to FIGS. **11**A-**11**C, a flange assembly is shown for use with the oxidant pipe **702** and the fuel pipe **704**. Referring to the fuel pipe **704**, the flange assembly includes a moveable fuel-side flange **722** attached to an exterior **724** of the fuel pipe. The flange **722** has a plurality of holes **726** therethrough and through which mechanical fasteners **728**, such as for example nuts and bolts, may be disposed for releasably securing the flange **722** as will be discussed below. Rotation of the fuel pipe **704** about the longitudinal axis **716** of the oxidant pipe **702** causes the fuel side flange **722** to rotate concurrently with the rotation of the fuel pipe. Since the fuel pipe **704** is off-set or non-centric, i.e. not at a center of the fuel-side flange **722**, when the fuel flange is released and rotated the flange **722** and fuel pipe **704** rotate around the longitudinal axis **716** of the oxidant pipe **702**, which longitudinal axis **716** is at a center of both the fuel-side flange **722** and the oxidant-side flange **730**. This is shown further with respect to FIGS. **11**A-**11**C and **12**A-**12**C.

[0056] Referring as well to FIGS. **13-14**, the oxidant pipe **702** is provided with a fixed oxidant-side flange **730**, part of the flange assembly, mounted to the oxidant pipe. The fixed flange **730** has a plurality of holes **732** therethrough corresponding in number to that of the plurality of holes **726** of the fuel-side moveable flange **722**. The holes **732** of the fixed flange **730** are also constructed and arranged to receive the mechanical fasteners **728** therein. The mechanical fasteners **728** function as a fastener assembly to releasably secure the flanges **722**, **730** to each other.

[0057] A portion of the burner **700** is mounted to a burner block **734** as shown in FIG. **10**. The burner block **734** includes a burner block housing **736**, and has space **738** therein in which the oxidant pipe **702** can be disposed, as shown in FIG. **10**. The housing **736** for the burner block **734** includes at least one mechanical fastener **746**, such as a set screw, to secure the housing **736** to the burner block **734**. A stop collar **740** with a mechanical fastener **742** such as a screw, is secured to the oxidant pipe **702**, thereby preventing the oxidant pipe from slipping downwards out of position into the burner block **734**.

[0058] The burner block **734** itself is mounted to a sleeve **744**, which sleeve is disposed in the crown (not shown) of the furnace or forehearth of the furnace. A bushing **748** or adaptor collar is disposed about an exterior surface **750** of the oxidant pipe **702** between the burner block housing **736** and said surface **750**. The bushing **748** is also provided with a mechanical fastener **752** to releasably secure the burner **700** into place with respect to the burner block housing **736**. A mechanical fastener **754** is provided at the burner block housing **736** to releasably secure the burner block housing to the bushing **748**.

[0059] While the sleeve **744** and burner block **734** are directly exposed to a combustion atmosphere of the furnace, the respective ends of the oxidant pipe **702** and the fuel pipe **704** are recessed within the burner block **734** so as not to be directly in contact with the furnace atmosphere.

[0060] The mechanical fasteners **728**, **742**, **752**, **754** and **746** are releasably engagable in order to permit the burner **700** in its entirety to be rotated within the burner block **734** and the sleeve **744**.

[0061] The fixed oxidant-side flange **730** is affixed, such as by welding, to the burner **700**. The fuel pipe **704** can be rotated with respect to the oxidant pipe **702**, while the oxidant pipe can be rotated with respect to the burner block **734**, as will be discussed below.

[0062] Referring to FIGS. **11**A-**11**C and **12**A-**12**C, such show the orientation of the fuel pipe **704** with respect to the oxidant pipe **702** as provided for by both the movable fuel-side flange **722** and the fixed oxidant-side flange **730**. The mechanical fasteners **728** can be released, thereby permitting the fuel pipe **704** to be rotated about the longitudinal axis **716** of the oxidant pipe **702** with the fuel-side flange **722** moving concurrent with the fuel pipe, and circumscribing the central longitudinal axis **716** of the oxidant pipe **702**, as show in FIGS. **12**A-**12**C. When the fuel pipe **704** has been rotated to a desired position, such as represented by, for example, that of FIG. **11**B or **11**C, the respective holes **726**, **732** at each of the flanges **722**, **730** are moved into registration with each other and the mechanical fasteners **728** engaged or actuated to secure flange **722** of the fuel pipe **704** with respect to the flange **730** of the oxidant pipe **702**. The range of rotation afforded the fuel pipe **704** and different positions said pipe can have with respect to the oxidant pipe **702** is only limited by the number of corresponding holes **726**, **732** provided in the flanges **722**, **730**. That is, the greater number of holes provided in both the movable and fixed flanges **722**, **730** which can be brought into registration with each other, the greater range of positions the fuel pipe **704** can have with respect to the oxidant pipe **702**. The spacers **720** are connected to or may extend from the exterior surface **724** of the fuel pipe **704** and accordingly, FIGS. **12**A-**12**C show the manner by which they retain the fuel pipe in the offset or non-centric position with respect to the oxidant pipe **702**.

[0063] Referring also to FIGS. **13-15**, a sealing arrangement between the moveable fuel-side flange **722** and the fixed oxidant-side flange **730** is shown which includes a seal **756**, such as for example an O-ring, mounted at an indent **758** formed in the fixed oxidant-side flange **730** for coaction with a corresponding portion of the moveable fuel-side flange **722**. The indent **758** "seats" the seal **756** in position for contacting the fuel-side flange **722**. The seal **756** effectively seals off any leaks which could occur in view of the releasable engagement of the flanges **722**, **730** with respect to each other.

[0064] In FIG. **16**, another embodiment of a burner is shown generally at **800**. The only difference between the embodiment of FIG. **16** from that of FIG. **10** is that a fuel delivery pipe **804** has a straight shape upstream of the flange assembly, as opposed to the curved or angled portion of the embodiment shown in FIG. **10**, prior to entry into the oxidant delivery pipe **802**. All other features and functions are similar to that which was described with respect to the embodiment of FIG. **10**.

[0065] Still another embodiment of a burner having features similar to that which are provided shown in FIGS. **10** and **16**, would include the fuel delivery pipe **704**, **804** being angled such as that shown with respect to the embodiment of FIGS. **2**A-**2**B and in FIGS. **3**A-**3**B. That is, the fuel delivery pipe **704**, **804** would be neither parallel to nor concentric with the oxidant delivery pipe **802**, **804**. All other features and functions thereof would otherwise be similar to that which was discussed above with respect to the embodiments of FIGS. **10** and **16**.

[0066] The gaseous fuel and gaseous oxidant used with the embodiments of FIGS. **10-16** is similar to that used with the embodiments of FIGS. **1-9**.

[0067] For all of the embodiments discussed above with respect to FIGS. **1-16**, the ends of the fuel and oxidant pipes can have other than threaded ends for connection to fuel and oxidant sources. For example, such ends may have connecting flanges, clamps or welds to connect the pipes to such fuel and oxidant sources.

[0068] It will be understood that the embodiments described herein are merely exemplary, and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention. All such variations and modifications are intended to be included within the scope of the claims as described herein. It should be understood that embodiments described above are not only in the alternative, but may also be combined.

What is claimed is:

1. A burner for use in a combustion chamber of a furnace or a forehearth, comprising a gas delivery member for delivering a gaseous oxidant, a fuel delivery member for delivering a fuel and having a portion disposed at an interior of the gas delivery member and offset from a longitudinal axis of the gas delivery member, and a flange assembly mechanically associated with the gas and fuel delivery members, the flange assembly adapted for rotational movement to releasably secure the gas and fuel delivery members with respect to each other to provide a flame footprint at a select location in the combustion chamber.

2. The burner of claim **1**, wherein a portion of the gas delivery member and the portion of the fuel delivery member are parallel with each other.

3. The burner of claim **1**, wherein the portion of the fuel delivery member is disposed at an angle at the interior of the gas delivery member.

4. The burner of claim **1**, wherein only the fuel delivery member is rotatable at the flange assembly.

5. The burner of claim **1**, wherein the gas delivery member comprises a gas pipe.

6. The burner of claim **1**, wherein the fuel delivery member comprises a fuel pipe.

7. The burner of claim **1**, wherein the fuel delivery member comprises a plurality of fuel pipes.

8. The burner of claim **7**, wherein the plurality of fuel pipes are an integral unit.

9. The burner of claim **7**, wherein the plurality of fuel pipes are disposed at an angle at the interior of the gas delivery member.

10. The burner of claim **1**, further comprising at least one support member disposed in the gas delivery member to support the fuel delivery member in spaced relation with respect to the gas delivery member and offset from the longitudinal axis of the gas delivery member during the rotational movement to releasably secure the gas and fuel delivery members.

11. The burner of claim **1**, wherein the flange assembly comprises a first flange mounted to the gas delivery member, the first flange having a first plurality of holes therethrough; a second flange mounted to the fuel delivery member, the second flange having a second plurality of holes therethrough; the first plurality of holes in the first flange and the second plurality of holes in the second flange arranged for being in registration with each other upon rotational movement of the first and second flanges to a select position with respect to each other; and a fastener assembly to releasably secure the first and second flanges to each other at the select position.

12. The burner of claim **11**, wherein the second flange is fixed to the fuel delivery member for rotation therewith.

13. The burner of claim **12**, wherein the fuel delivery member is rotatable to circumscribe a path around a central longitudinal axis of the gas delivery member.

14. The burner of claim **11**, further comprising a seal mounted to at least one of the first flange or the second flange for providing sealing engagement of the first and second flanges.

15. The burner of claim **11**, further comprising a collar mounted to an exterior surface of the gas delivery member, the collar having a mechanical fastener associated therewith for releasably securing the collar to the exterior surface of the gas delivery member for preventing the gas delivery member from moving into the furnace or the forehearth.

16. The burner of claim **1**, wherein the fuel delivery member comprises an angled portion upstream of the flange assembly.

17. The burner of claim **1**, wherein the gaseous oxidant is selected from the group consisting of oxygen, oxygen and nitrogen, oxygen and other noble gases, and combinations thereof; and the fuel is selected from the group consisting of natural gas, propane, liquid petroleum gas, synthetic gas, and combinations thereof.

18. The burner of claim **11**, wherein the fastener assembly comprises mechanical fasteners for coacting with the first and second flanges.

* * * * *