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SANTAFÉ DE BOGOTÁ, A.A.

SUPERINDUSTRIA Y COMERCIO

Radicación : 02018003 00000003

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Trámite : 002 PATENTES D 1 REGISTRO/ 444 REPUESTO
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

SEÑORES
DIVISION DE NUEVAS CREACIONES
SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
E. S. D.

REF: EXPEDIENTE No. 02018003 ✓
TITULO: MÉTODO PARA CALENTAR UN HORNO DE FUSIÓN
DE VIDRIO UTILIZANDO UN QUEMADOR DE COMBUSTIÓN
GRADUADA CON OXIGENO-COMBUSTIBLE, MONTADO EN LA
BÓVEDA DEL HORNO.
FECHA DE LA SOLICITUD: FEBRERO 27 DE 2.002
SOLICITANTE: BOC GROUP, INC.
PRIORIDAD: 09/798.826 DE MARZO 2 DE 2.001

ASUNTO: CONTESTACIÓN REQUERIMIENTO

DILIA RODRIGUEZ D'ALEMAN, en mi condición de apoderada de la sociedad solicitante, por el presente escrito doy respuesta a su Auto notificado por estado de 21 de Marzo de 2.002 que vence Mayo 21 de 2.002, solicitando se consideren y tengan en cuenta los siguientes documentos y aclaraciones:

DOCUMENTOS:

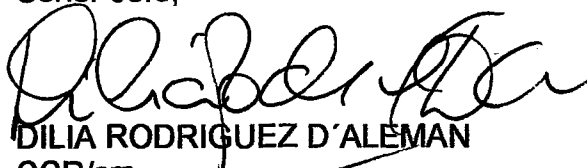
1. Copia auténtica, legalizada y traducida del documento de cesión de los inventores al solicitante.
2. El lugar de constitución de la sociedad solicitante es el estado de Delaware, Estados Unidos de América, como está indicado en el poder.
3. Copia auténtica, legalizada y traducida del poder a mi favor otorgado por la sociedad solicitante.
4. La copia certificada de la prioridad Estadounidense reivindicada Nr. 09/798,826 de Marzo 2 de 2.002 y su traducción al español.

ACLARACIONES:

Como esta invención consiste en un método, no existe una figura representativa de la invención de manera que no se requiere el arte final.

Ruego a Usted aceptar esta respuesta a su primer examen de fondo y continuar con el trámite para el cual mi representada queda en disposición con interés a responder a cualquier inquietud.

Señor Jefe,


DILIA RODRIGUEZ D'ALEMAN
CCR/srr
P-436

CLARK, MOORE & CO.
 1000 BROADWAY
 NEW YORK, N.Y. 10003

SECRET
 DIVISION DE NUEVAS CREACIONES
 SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

REF: EXPEDIENTE NO 025-15008
 TITULO METODO PARA CALENTAR UN HORNO DE VIBRO UTILIZANDO UN QUEMADOR DE COMBUSTION GRASOSA CON OXIGENO COMBUSTIBLE MONTADO EN LA BOVEDA DEL HORNO
 FECHA DE LA SOLICITUD FEBRERO 24 DE 2002
 SOLICITANTE BOG GROUP INC
 PRIORIDAD CARBON DE MARZO 2 DE 2001

ACUENTO: CONTESTACION REQUERIMIENTO

DILIA RODRIGUEZ D. ALFARI, en mi condición de apoderada de la sociedad solicitante por el presente expongo los motivos de la presente para que se declare la nulidad de la resolución de 24 de marzo de 2002 que declara la nulidad de la resolución de 24 de marzo de 2002, solicitando se consideren y tengan en cuenta los siguientes documentos y actuaciones:

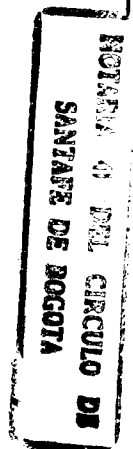
DOCUMENTOS

1. Copia autenticada y legalizada y traducida del documento de cesión de los derechos de la sociedad.
2. El libro de constitución de la sociedad solicitante es el estado de la sociedad.
3. Copia autenticada, legalizada y traducida del poder a mi favor otorgado por la sociedad solicitante.
4. La copia certificada de la presente Resolución emitida por la Superintendencia de Industrias y Comercio.

ACERCA DE

Como esta resolución consiste en un acuerdo no existe una firma legítima, por lo tanto la resolución de 24 de marzo de 2002 que declara la nulidad de la resolución de 24 de marzo de 2002, solicitando se consideren y tengan en cuenta los siguientes documentos y actuaciones:

[Signature]
 DILIA RODRIGUEZ D. ALFARI



TRADUCCIÓN OFICIAL No. 02/141 de un documento escrito en inglés, el cual para su identificación se sella con el sello del traductor al tiempo con la presente. Esta traducción ha sido preparada por Juan Pablo Piedrahita Aguilera, Traductor e Intérprete Oficial debidamente reconocido de conformidad con el Certificado de Idoneidad Profesional No. 0045 expedido por la Universidad Nacional de Colombia.

(Se traducen las reivindicaciones de una solicitud de Patente y el Certificado de la Oficina de Patentes y Marcas No. 09/798,826, escritos en inglés.)

ESTADOS UNIDOS DE AMERICA

A TODOS A QUIENES ESTOS PRESENTES LLEGAREN:

DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS

Oficina de Patentes y Marcas de los Estados Unidos

Febrero 14 de 2002

POR EL PRESENTE CERTIFICO QUE ADJUNTA SE ENCUENTRA UNA COPIA FIEL DE LOS ARCHIVOS DE LA OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS UNIDOS DE AMÉRICA DE LOS DOCUMENTOS DE LA SOLICITUD DE PATENTE IDENTIFICADA ABAJO Y QUE CUMPLIERON CON LOS REQUISITOS PARA QUE SE LES OTORGARA UNA FECHA DE SOLICITUD BAJO EL CÓDIGO DE COMERCIO DE LOS ESTADOS UNIDOS DE AMÉRICA TÍTULO 35 SECCIÓN 111.

NÚMERO DE SOLICITUD: **09/798,826**

FECHA DE SOLICITUD: **Marzo 2, 2001**

02/141

TRADUCCION OFICIAL No.

JUAN PABLO PIEDRAHITA AGUILERA

TRADUCTOR E INTÉRPRETE OFICIAL

C. IDONEIDAD 045

UNIVERSIDAD NACIONAL DE COLOMBIA

Por autoridad del

COMISARIO DE PATENTES Y MARCAS

(Fdo.) H. L. JACKSON

Funcionario que Certifica

(SELLO DE OBLEA DE LA OFICINA DE PATENTES Y MARCAS DE LOS
ESTADOS UNIDOS DE AMÉRICA)

(en todas las hojas: sello: 09798826 030201)

(al pie de todas las páginas: Expediente No. 00A412)

Reivindicamos:

1. Un método para derretir un material para formar vidrio en un horno para derretir vidrio, dicho horno con una pared trasera, con muros de contención encima de las paredes laterales y una pared aguas abajo conectada a un techo,
- 5 donde por lo menos un cargador de lotes para cargar material en lotes para formar vidrio está contenido en por lo menos una de las paredes traseras y en la pared lateral que incluye:

el suministro de por lo menos un quemador de oxi-combustible en el
techo de dicho horno sobre dicho lote de material, donde por lo menos un
10 quemador de oxi-combustible está adaptado para combustión por etapas

el suministro de un flujo de combustible a por lo menos dicho quemador
de oxi-combustible;

el suministro de un flujo de oxidante gaseoso en asociación con por lo

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SANTAFE DE BOGOTA

menos dicho quemador de oxi-combustible;

inyección del combustible y del oxidante dentro del horno y,

la combustión de dicho combustible en por lo menos dicho quemador de oxi-combustible tal que por lo menos una porción de la combustión ocurra en la
5 vecindad de dicho material para formar vidrio para mejorar la transferencia de calor convectiva y de radiación a dicho material para formar vidrio sin perturbar sustancialmente dicho material para formar vidrio.

2. El método de la reivindicación 1 donde la mezcla de dicho combustible y dicho oxidante es demorada para localizar la combustión próximamente a o
10 sobre la superficie de dicho material para formar vidrio.

3. El método de la reivindicación 1 donde el chorro de combustible inyectado y el oxidante inyectado se separan, y opcionalmente se les hace formar un ángulo entre sí, en una medida suficiente para causar que los flujos respectivos converjan en las proximidades de o sobre la superficie de dicho material para
15 formar vidrio.

4. El método de la reivindicación 3 donde el chorro de combustible incluye uno de: un único chorro de combustible sustancialmente o un combustible de mezcla oxidante rica en combustible, y donde el chorro oxidante incluye uno de: sustancialmente un único chorro de oxidante o un combustible pobre de mezcal combustible-mezcal oxidante.

5. El método de la reivindicación 4 donde el chorro de combustible y el

chorro de oxidante se separan se les hace formar un ángulo entre sí de 0° a aproximadamente 90°.

6. El método de la reivindicación 1 donde el oxidante se sopla desde debajo de la superficie del material para formar vidrio.

5 7. El método de la reivindicación 1 que incluye especies reactivas intermedias próximas a o en la superficie del material para formar vidrio.

8. El método de la reivindicación 1 donde el quemador de oxi-combustible está contenido en un bloque de quemador, además donde el mismo proporciona un flujo de oxidante gaseoso que incluye el suministro integral por etapas de
10 dicho oxidante vía inyección desde el mismo bloque del quemador.

9. El método de la reivindicación 1 donde el quemador de oxi-combustible está contenido en un bloque de quemador, además donde el mismo proporciona un flujo de oxidante gaseoso que incluye el suministro externo por etapas de dicho oxidante vía inyección por separado desde el bloque del quemador de oxi-
15 combustible.

10. El método de la reivindicación 9 que además comprende el suministro de por lo menos un inyector de oxidante en el techo de dicho horno para suministrar oxidante adicional para completar la combustión en las proximidades o en la superficie de dicho material para formar vidrio.

11. El método de la reivindicación 9 que incluye la inyección de 0 a 90% de oxidante estequiométrico a través del bloque del quemador de oxi-combustible

vía por lo menos de un inyector secundario de oxidante por separado del bloque del quemador de oxi-combustible.

12. El método de la reivindicación 1 donde el material para formar vidrio entra en el horno a través de por lo menos un cargador, incluyendo el suministro de un quemador de oxi-combustible en el techo del horno en las proximidades de por lo menos un cargador encima del material para formar vidrio.

13. El método de la reivindicación 1 donde el quemador está montado sustancialmente perpendicular a la superficie del material para formar vidrio.

14. El método de la reivindicación 13 donde el quemador está montado hasta 45 grados de la perpendicular y hacia la pared frontal aguas abajo del horno.

15. El método de la reivindicación 13 donde el quemador está montado no más de 10 grados de la perpendicular y aguas abajo hacia la pared frontal del horno.

16. El método de la reivindicación 1 donde el oxidante se selecciona de un grupo consistente de aire enriquecido con oxígeno, oxígeno no puro y oxígeno "industrialmente" puro.

17. El método de la reivindicación 1 incluyendo el flujo por etapas de combustible desde el quemador de oxi-combustible.

18. El método de la reivindicación 1 donde el combustible es un gas seleccionado del grupo consistente en metano, gas natural, gas natural licuado, propano, gas propano licuado, butano, gases de bajo BTU, gas domiciliario, gas

del productor y mezclas de ellos.

19. El método de la reivindicación 1 donde el combustible es un líquido seleccionado de un grupo consistente en combustóleo pesado combustóleo mediano, combustóleo liviano, kerosene, y diesel.

5 20. El método de la reivindicación 1 donde por lo menos un quemador de oxi-combustible se suministra en el techo en las proximidades de la pared frontal de aguas abajo.

21. El método de la reivindicación 1 donde el material para formar vidrio incluye material seleccionado de un grupo consistente en casco de vidrio, sílice, 10 feldespato, nefelina, sienita, caliza, dolomita, cenizas de sosa, potasa, borax, arcilla caolín, alúmina, arsénico, antimonio, sulfatos, sulfuros, carbón, óxido de bario, óxido de estroncio, óxido de zirconio, óxido de plomo, óxidos metálicos para la formación de colores, y mezclas de ellos.

22. El método de la reivindicación 1 incluye el suministro de todos los 15 quemadores del horno como quemadores de oxi-combustible.

23. El método de la reivindicación 1 incluye el suministro de todos los quemadores del horno como quemadores para montaje en el techo.

24. El método de la reivindicación 1 incluye la operación de por lo menos uno de dichos quemadores de oxi-combustible para montaje en el techo en un modo de combustible rico y por lo menos uno de dichos quemadores de oxi-combustible para montaje en el techo en modo de combustible pobre.

25. Un método para derretir material para formar vidrio en un horno para derretir vidrio, dicho horno con una pared trasera, con muros de contención encima de las paredes laterales y una pared aguas abajo conectada a un techo, donde por lo menos un cargador de lotes para cargar material en lotes para
5 formar vidrio está contenido en por lo menos una de las paredes traseras y en la pared lateral que incluye:

el suministro de por lo menos un quemador de oxi-combustible en el techo de dicho horno sobre dicho lote de material

el suministro de un flujo de combustible a por lo menos dicho quemador
10 de oxi-combustible;

el suministro de un flujo de oxidante gaseoso en asociación con por lo menos dicho quemador de oxi-combustible;

inyección del combustible y del oxidante dentro del horno y,
la combustión de dicho combustible

15 26. El método de la reivindicación 25 donde por lo menos un quemador de oxi-combustible se adapta para combustión por etapas, incluyendo:

la combustión de dicho combustible en por lo menos dicho quemador de oxi-combustible tal que por lo menos una porción de la combustión ocurra en la vecindad de dicho material para formar vidrio para mejorar la transferencia de calor convectiva y de radiación a dicho material para formar vidrio sin perturbar sustancialmente dicho material para formar vidrio.

27. El método de la reivindicación 26 donde el quemador de oxi-combustible está contenido en un bloque de quemador, además donde dicha inyección de oxidante gaseoso incluye el suministro integral por etapas de dicho oxidante vía inyección desde el mismo bloque del quemador.

5 28. El método de la reivindicación 26 donde el quemador de oxi-combustible está contenido en un bloque de quemador, además donde dicha inyección de oxidante gaseoso incluye el suministro externo por etapas de dicho oxidante vía inyección por separado desde el bloque del quemador de oxi-combustible.

10 29. El método de la reivindicación 26 además incluyendo la etapa de montar por lo menos un inyector de oxígeno en el techo de dicho horno para proporcionar oxígeno adicional para completar la combustión en o cerca de la superficie de dicho lote de material.

15 30. El método de la reivindicación 26 que incluye la inyección de una mayoría de un conjunto de oxidantes aparte de y sustancialmente rodeando el flujo de combustible líquido hasta un punto más allá de la zona de combustión no visible.

31. El método de la reivindicación 30 que incluye el combustible inyectado y el oxidante inyectado a aproximadamente 45° a 101° de la horizontal.

32. El método de la reivindicación 30 incluyendo la inyección del restante del oxidante adyacente a y concéntricamente al combustible inyectado.

33. El método de la reivindicación 30 incluyendo la inyección del restante del oxidante por inyección terciaria dentro del horno.

34. El método de la reivindicación 26 incluyendo el flujo por etapas del combustible desde el quemador de oxi-combustible.

35. El método de la reivindicación 25 donde el combustible líquido se selecciona de un grupo consistente en combustóleo pesado combustóleo mediano, combustóleo liviano, kerosene, y diesel.

36. El método de la reivindicación 35 donde el combustible líquido inyectado tiene un tamaño de una gota mayor que cerca 100 micrones.

37. El método de la reivindicación 25 donde el quemador está montado sustancialmente perpendicular a la superficie de lote de material.

38. El método de la reivindicación 25 donde el quemador está montado hasta 45 grados de la perpendicular y hacia la pared frontal aguas abajo del horno.

39. El método de la reivindicación 25 donde el quemador está montado no más de 10 grados de la perpendicular y hacia la pared frontal aguas abajo del horno.

40. El método de la reivindicación 25 que incluye la atomización del combustible líquido para producir gotas en el rango de 5 a cerca de 50 micrones.

41. El método de la reivindicación 40 incluyendo el mezclado rápido de las gotas con medio atomizador en la región inicial del quemador para formar una mezcla sustancialmente homogénea.

42. El método de la reivindicación 40 incluyendo la atomización del

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combustible líquido con un medio oxidante atomizante para producir una mezcla parcialmente combustible.

43. El método de la reivindicación 40 incluyendo la atomización del combustible líquido con un medio atomizante seleccionado del grupo consistente en aire, oxígeno, vapor, gas natural e hidrógeno o mezclas de ellos para reducir la proporción C:H en la mezcla del medio combustible/atomizante.

44. Un método para derretir un material para formar vidrio en un horno para derretir vidrio, dicho horno con una pared trasera, con muros de contención encima de las paredes laterales y una pared aguas abajo conectada a un techo, donde por lo menos un cargador de lotes para cargar material en lotes para formar vidrio está contenido en por lo menos una de las paredes traseras y en la pared lateral que incluye:

el suministro de por lo menos un quemador de oxi-combustible en el techo de dicho horno sobre dicho lote de material, donde por lo menos un quemador de oxi-combustible está adaptado para combustión por etapas y contiene por lo menos un inyector externo de oxidante y dos inyectores internos de combustible, el inyector que está más hacia el interior adaptado para inyección a alta velocidad y el otro inyector de combustible, dispuesto entre el inyector que está más al interior y el inyector exterior de oxidante, adaptado para inyección a baja velocidad;

el suministro de un flujo de oxidante gaseoso al inyector exterior de oxidante, con un momento menor al del flujo de combustible a través de

inyector localizado más hacia el interior;

la combustión de dicho combustible desde por lo menos dicho quemador de oxí-combustible tal que por lo menos una porción de la combustión ocurre en la vecindad de dicho material para formar vidrio para mejorar la transferencia de calor convectiva y de radiación a dicho material para formar vidrio sin perturbar sustancialmente dicho material para formar vidrio.

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45. El método de la reivindicación 44 donde cerca del 10% a cerca del 90% del flujo de combustible es utilizado por el inyector de combustible localizado más hacia el interior.

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46. El método de la reivindicación 44 donde la masa del flujo de combustible del inyector de combustible localizado más hacia el interior es menor a la masa de flujo de combustible del otro inyector de combustible.

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47. El método de la reivindicación 44 donde la masa del flujo de combustible del inyector de combustible localizado más hacia el interior es mayor a la masa de flujo de combustible del otro inyector de combustible.

48. El método de la reivindicación 44 donde un combustible líquido se suministra al inyector de combustible localizado más hacia el interior, y se suministra un combustible gaseoso al otro inyector de combustible.

49. El método de la reivindicación 48 donde el combustible líquido se selecciona del grupo consistente en combustóleo pesado combustóleo mediano, combustóleo liviano, kerosene, y diesel; y donde el combustible gaseoso se

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SANTANA DE BOGOTÁ
VICERREY

selecciona del grupo consistente en metano, gas natural, gas natural licuado, propano, gas propano licuado, butano, gases de bajo BTU, gas domiciliario, gas del productor y mezclas de ellos.

50. El método de la reivindicación 44 donde el combustible líquido se
5 selecciona del grupo consistente en metano, gas natural, gas natural licuado, propano, gas propano licuado, butano, gases de bajo BTU, gas domiciliario, gas del productor y mezclas de ellos.

51. El método de la reivindicación 44 donde el oxidante se selecciona de un
grupo consistente en aire enriquecido con oxígeno, oxígeno no puro y oxígeno
10 industrial puro.

52. Un quemador de oxi-combustible que incluye por lo menos un inyector externo de oxidante y dos inyectores internos de combustible, el inyector que está más hacia el interior adaptado para inyección a alta velocidad y el otro inyector de combustible adaptado para inyección a baja velocidad;

15 53. El quemador de oxi-combustible de la reivindicación 52 donde el inyector de combustible que está más hacia el interior está adaptado para suministrar un chorro central de combustible a alta presión; el otro inyector de combustible adaptado para proporcionar una presión sustancialmente anular menor en una cubierta de combustible concéntricamente hacia fuera del chorro central de combustible; y el inyector de oxidante adaptado para proporcionar una corriente sustancialmente anular concéntricamente hacia fuera de una cubierta de combustible; la corriente de oxidante con un momento menor al del chorro

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SECRETARIA DE ECONOMIA
BOGOTA D.C.

central de combustible.

54. El quemador de oxi-combustible de la reivindicación 52 donde los inyectores de combustible están adaptados para proporcionar un combustible gaseoso.

5 55. El quemador de oxi-combustible de la reivindicación 52 donde el inyector que está más hacia el interior está adaptado para proporcionar un combustible líquido y el otro inyector de combustible está adaptado para proporcionar combustible gaseoso.

10 56. Un método para derretir material en lote en un horno para vidrio con regeneradores, recuperadores, y/o elevador eléctrico, dicho horno con paredes laterales, una pared posterior, una pared frontal y un techo, que comprende:

el suministro de por lo menos un quemador en el techo de dicho horno sobre dicho lote de material;

15 el suministro de un flujo de oxidante gaseoso a dicho por lo menos ese quemador;

el suministro de un flujo de combustible gaseoso a dicho por lo menos ese quemador;

generar una llama desde por lo menos ese quemador, dicha llama con velocidad suficiente para maximizar la transferencia de calor de dicha llama a dicho lote de material sin sustancialmente perturbar dicho lote de material, y,

suministrar oxígeno adicional para completar la combustión en o cerca de

NOTARIA 41 DEL CIRCULO 1
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central de combustible

El quemador de ox-combustible de la reivindicación 25 donde los
combustible están adaptados para proporcionar un combustible

El quemador de ox-combustible de la reivindicación 25 donde el inyector
que está más hacia el interior está adaptado para proporcionar un combustible
iludido y el otro inyector de combustible está adaptado para proporcionar

combustible gaseoso

25. Un método para generar material en lote en un horno para vidrio con

10 regeneradores, recuperadores, y/o elevador eléctrico, dicho horno con paredes

laterales, una pared posterior, una pared frontal y un techo, que comprende

el suministro de por lo menos un quemador en el techo de dicho horno

sobre dicho lote de material;

el suministro de un flujo de oxidante gaseoso a dicho por lo menos ese

15 quemador;

el suministro de un flujo de combustible gaseoso a dicho por lo menos

ese quemador;

generar una llama desde por lo menos ese quemador, dicha llama con

velocidad suficiente para maximizar la transferencia de calor de dicha llama a

dicho lote de material sin sustancialmente perturbar dicho lote de material, y

suministrar oxígeno adicional para completar la combustión en o cerca de

la superficie de dicho lote de material de por lo menos un inyector de oxígeno en el techo de dicho horno.

ES TRADUCCIÓN FIEL Y COMPLETA de la cual se deja copia en los archivos de esta oficina para su confrontación y a la cual me remito.

Bogotá, Mayo 17, 2002.

SANITIZADA

AUTENTICACIÓN DE FIRMA REGISTRADA

El suscrito Notario Cuarenta y Uno (41), da testimonio que la firma puesta en el presente documento, corresponde a la registrada en este despacho por Juan Pablo Piedrahita Aguilera

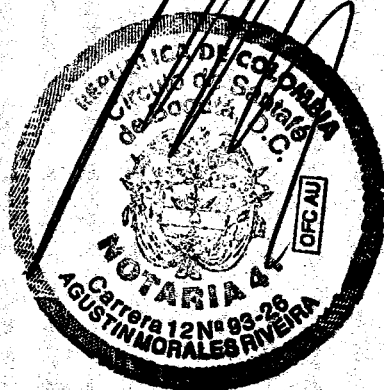
según confrontación de cédula.

Bogotá D.C.

20 MAYO 2002

AUTORIZÓ ESTA DILIGENCIA EL SUSCRITO NOTARIO

Juan Pablo Piedrahita Aguilera
TRADUCCIÓN OFICIAL No. 02-141
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA



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(CONVENTION DE LA HAYE DU 5 OCTOBRE 1961)

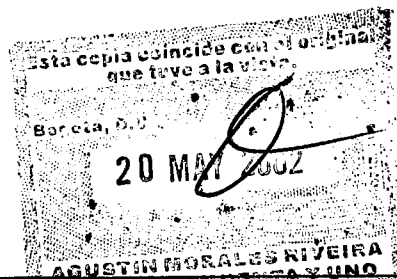
1. COUNTRY: UNITED STATES OF AMERICA
2. THIS PUBLIC DOCUMENT HAS BEEN SIGNED BY:
JOANNE RAJOPPI
3. ACTING IN THE CAPACITY OF:
COUNTY CLERK
4. BEARS THE SEAL/STAMP OF:
COUNTY OF UNION

CERTIFIED

5. AT TRENTON, NEW JERSEY
6. THE 8TH DAY OF MAY 2002
7. BY: John E McCormac, CPA, NEW JERSEY TREASURER
8. NO. A150919
9. SEAL/STAMP:
10. SIGNATURE



John E McCormac



APPROPRIATE

(COMPARISON DE LA PAGE DE 2 OCTOBRE 1961)

UNITED STATES OF AMERICA

THE ABOVE DOCUMENT HAS BEEN SIGNED BY:

THE PRESIDENT

IN THE CAPACITY OF:

THE PRESIDENT

THE SEAL OF THE

UNITED STATES OF AMERICA

CERTIFIED

AT NEW JERSEY

2003

THE DAY OF MAY

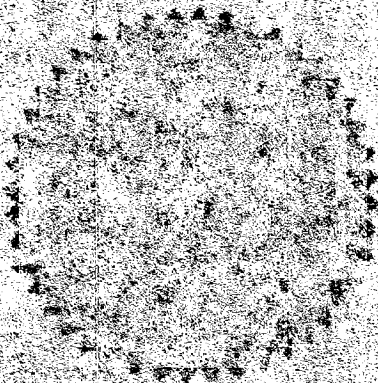
BY JOHN F. MCCORMACK, CPA, NEW JERSEY TREASURER

ALCOBIA

TO: SIGNATURE

SEAL: STAMP

[Handwritten signature]



UNIVERSIDAD NACIONAL DE COLOMBIA
C. IDONEIDAD 045
TRADUCCION E INTERPRETE OFICIAL
JUAN PABLO PIEDRAHITA ACUJERA
TRADUCCION OFICIAL No. 02/142

4
91

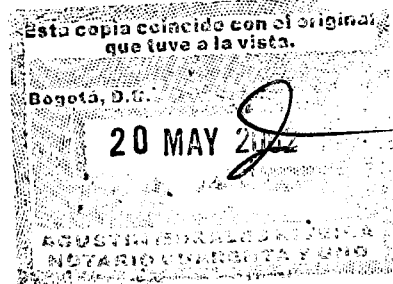
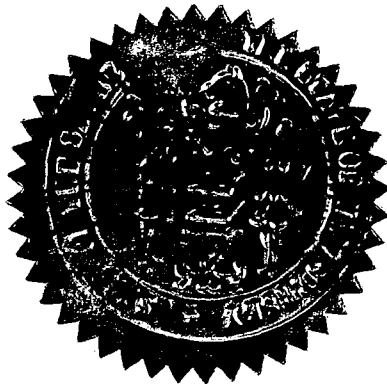
APOSTILLE

(CONVENTION DE LA HAYE DU 5 OCTOBRE 1961)

1. COUNTRY: UNITED STATES OF AMERICA
2. THIS PUBLIC DOCUMENT HAS BEEN SIGNED BY:
JOANNE RAJOPPI
3. ACTING IN THE CAPACITY OF:
COUNTY CLERK
4. BEARS THE SEAL/STAMP OF:
COUNTY OF UNION

CERTIFIED

5. AT TRENTON, NEW JERSEY
6. THE 8TH DAY OF MAY 2002
7. BY: John E McCormac, CPA, NEW JERSEY TREASURER
8. NO. A150918
9. SEAL/STAMP:
10. SIGNATURE



APROBADO

IN WITNESS WHEREOF, I HAVE HEREON SET MY HAND AND SEAL

UNITED STATES OF AMERICA

IN PUBLIC DOCUMENT HAS BEEN SIGNED BY:

IN THE CAPACITY OF:

JOHN F. ROBERTSON

AND THE SEAL OF THE

UNITED STATES OF AMERICA

TESTIFIED

AT WASHINGTON, NEW YORK

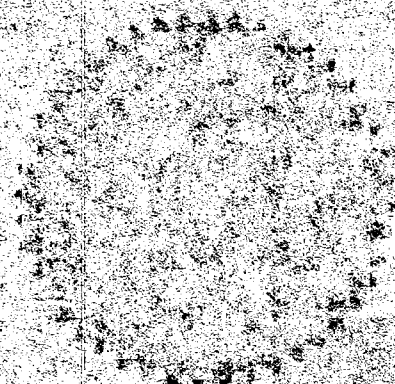
ON THE DAY OF MAY

BY: JOHN F. ROBERTSON, CPA, NEW YORK TREASURER

ALSO:

10. SIGNATURE

[Handwritten signature]



UNIVERSIDAD NACIONAL DE COLOMBIA
C. IDONEIDAD 845
TRADUCTOR E INTERPRETE OFICIAL
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCCION OFICIAL NO. 02/142

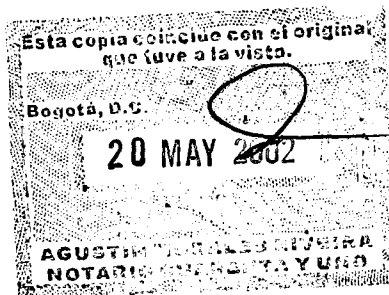
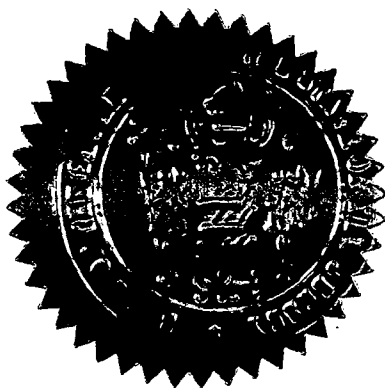
APOSTILLE

(CONVENTION DE LA HAYE DU 5 OCTOBRE 1961)

1. COUNTRY: UNITED STATES OF AMERICA
2. THIS PUBLIC DOCUMENT HAS BEEN SIGNED BY:
JOANNE RAJOPPI
3. ACTING IN THE CAPACITY OF:
COUNTY CLERK
4. BEARS THE SEAL/STAMP OF:
COUNTY OF UNION

CERTIFIED

5. AT TRENTON, NEW JERSEY
6. THE 8TH DAY OF MAY 2002
7. BY: John E McCormac, CPA, NEW JERSEY TREASURER
8. NO. A150917
9. SEAL/STAMP:
10. SIGNATURE



ALOSTILOS

(CONVENTION DE LA HAYA DE 5 OCTUBRE 1954)

CONFEDERATION OF THE UNITED STATES OF AMERICA

THE FOLLOWING DOCUMENT HAS BEEN SIGNED BY

JOHN R. KATONAH

ACTING IN THE CAPACITY OF:

COUNTY CLERK

HAVING THE SEAL/STAMP OF:

COUNTY OF UNION

CERTIFIED

AT NEW JERSEY, NEW JERSEY

THE 25TH DAY OF MAY

BY JOHN F. MCCORMACK, CLERK, NEW JERSEY TREASURER

NOT APOSTOLIC

10. SIGNATURE

[Handwritten signature]

UNIVERSIDAD NACIONAL DE COLOMBIA
C. IDONEIDAD 045
POR E INTERPRETE OFICIAL
JUAN F. PIEDRAHITA AGUILERA

TRADUCCION DEL No. 027470



Clarke, Modet & Co. Colombia Ltda.

PROPIEDAD INDUSTRIAL y DERECHOS DE AUTOR

Apartado Aereo 92397
Santafé de Bogotá, Colombia

93

PODER

Yo (nosotros), abajo firmante(s)

en mi (nuestro) caracter de representante(s) legales de

una sociedad organizada y existente de acuerdo con las leyes de

y en actual cumplimiento de su objeto social, con domicilio en

por el presente instrumento confiero (conferimos) poder especial a favor de DILIA MARIA RODRIGUEZ D'ALEMAN, con Cédula de Ciudadanía No. 41.654.882 de Bogotá, y tp. 20824 y CLAUDIA LUCIA CARO RAMIREZ, con Cédula de Ciudadanía No. 40.017.374 de Tunja, y tp. 36448, con domicilio en Santa Fé de Bogotá, Colombia para que actuando en su orden en nombre del (de la) otorgante le (la) representen ante cualquier entidad, autoridad y/o persona, especialmente ante las del orden Administrativo. Contencioso Administrativo, Judicial, Tribunales de Arbitramento y/o cualquier otro en lo referente a las siguientes asuntos:

- 1) Solicitar, tramitar, obtener y/o registrar cualquiera de las modalidades de Propiedad Industrial, tales como: patentes de invención, modelos de utilidad; diseños industriales, variedades vegetales; marcas, lemas, nombres y enseñas comerciales y denominaciones de origen; así como sus renovaciones, prórrogas, transferencias, cambios de nombre y/o domicilio, contratos y licencias.
- 2) Solicitar, tramitar, obtener y/o registrar derechos de autor, en cualquiera de sus presentaciones así como la protección de secretos industriales y know-how.
- 3) Solicitar, tramitar, obtener y/o registrar registros sanitarios, permisos y/o licencias de funcionamiento; así como sus renovaciones o prórrogas, transferencias, cambios de nombre y/o domicilio, contratos y licencias.
- 4) Ejercer acciones de oposición, observación, reclamas, reconsideración, reposición, apelación, cancelación, administrativa o judicial, nulidad, protección al consumidor, concesión de licencias, protección de secretos industriales y demás acciones y recursos relacionadas con derechos derivados de los asuntos arriba indicados y en contra de la competencia desleal, acciones derivadas de la obtención o explotación de licencias, acciones de indemnización de perjuicios. También podrá(n) intervenir en juicios civiles, comerciales, penales, contencioso-administrativos, tutelas y de policía; en acciones o juicios promovidos por el (la) mandante o en contra el (ella).
- 5) En el ejercicio de este mandato los mandatarios arriba mencionados quedan facultados para: conciliar, concelar, transigir, comprometer en árbitros, desistir, recibir y tomar posesión de la cosa objeto de litigio y renunciar o desistir a derechos concedidos o en curso de concesión, admitir los hechos del proceso.
- 6) Ratificar o no la agencia oficiosa.
- 7) Así mismo faculto (facultamos) a los mencionados apoderados para recibir notificaciones y designar apoderados judiciales o extrajudiciales, sustituir el presente poder y revocar las sustituciones que hicieren.

Dado y firmado en

a los

días de

de

POWER OF ATTORNEY

I (we), the undersigned

Salvatore P. Pace

legal representative(s) of

The BOC Group, Inc.

an organization existing under the laws of

the state of Delaware, United States of America

and in present execution of its business activity, domiciled at

575 Mountain Avenue, Murray Hill
New Providence, New Jersey 07974, U.S.A.

do hereby grant POWER OF ATTORNEY to DILIA MARIA RODRIGUEZ D'ALEMAN, identification card No. 41.654.882 of Bogotá, and tp. 20824 and CLAUDIA LUCIA CARO RAMIREZ, tp. 36448, identification card No. 40.017.374 of Tunja, residing in Santa Fé de Bogotá, Colombia, to act in the order of their appointment in behalf of grantor before any entity, authority and/or natural or juridical person, specially before those Administrative, Administrative-Contentious, Judicial, arbitration courts, and/or any other, in all matters concerning the following:

- 1) To apply, process, obtain and/or register any of the modalities of Industrial Property such as: Patents of invention, Utility Models; Designs, vegetal varieties; Marks Slogans, Trade Names and emblems and appellations of Origin; as well as their renewals, extensions, assignments, changes of name and/or domicile, agreements and licenses.
- 2) To apply, process, obtain and/or register copyrights of any kind as well as protection of industrial secrets or know-how.
- 3) To apply, process, obtain and/or register sanitary registrations, operating authorizations and/or licenses; as well as their renewals or extensions, assignments, changes of name and/or domicile, agreements and licenses.
- 4) To bring actions of opposition, observations, claims, reconsideration, appeal or legal remedies, cancellations, nullity, protection to the consumer, granting of licenses, protection of trade secrets and other actions related with rights derived from the above-mentioned matters and against the unfair competition, actions resulting from the obtention or exploitation of licenses, recovering damages actions. They can also intervene or participate in Civil, Commercial, Criminal or Contentious-Administrative Trials; the actions for writ mandamus, police actions; in actions, lawsuits or litigations instituted by the grantor or against him.
- 5) To the effect of this mandate the above-named proxy are empowered to: conciliate, cancel, settle, submit to arbitration, withdraw and to receive and take possession of the litigation related object and waive or renounce the rights granted or in process of granting, admit the facts of the case.
- 6) To ratify or not the officious agency.
- 7) I (we) hereby appoint the afore mentioned attorneys with powers to receive notifications and to designate judicial and extrajudicial attorneys, substitute this Power of Attorney and to revoke such substitutions.

Granted and signed

on this 14th

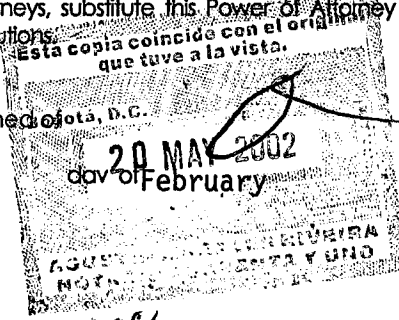
20 MAY 2002
day of February

of 2002

Salvatore P. Pace

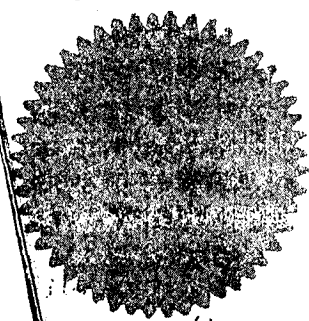
Firma / signature

Salvatore P. Pace, Vice President
and Group Counsel, Intellectual Property



Esta copia concuerda con el original
que tuve a la vista.
20 MAY 2002
Bogotá, D.C.
AGUSTIN MORALES RIVERA
NOTARIO PUBLICO Y UNO

State of New Jersey } ss.
County of Union



I, Joanne Rajoppi, Clerk of the County of Union, having by law a seal

DO HEREBY CERTIFY, That ANNABELLE L. SHORT
whose name is subscribed to the attached certificate of acknowledgment, proof or affidavit, was at the time
of taking said acknowledgment proof or affidavit, a **NOTARY PUBLIC** duly commissioned and sworn and
residing in said State, and was as such **NOTARY PUBLIC**, an officer of said State duly authorized by the
laws thereof to take and certify the same, as well as to take and certify the proof and acknowledgment of
deeds for the conveyance of land, tenements or hereditament, and other instruments in writing to be recorded
in said State, and that the said acknowledgment is duly executed and taken according to the laws of said
State, and that full faith and credit are and ought to be given to his/her official acts; and I further certify that
I am well acquainted with his/her handwriting and verify that the signature to the attached certificate is his/her
genuine signature.

And I do further certify that the impression of the seal of such **NOTARY PUBLIC** is not required by the laws
of this State to be filed in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal this

JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL

1ST day of MARCH

A. D. 20 02

Joanne Rajoppi Clerk

UNIVERSIDAD DE LA COLOMBIA

95

MAESTRO PEDRAHITA AGUILERA
INTERPRETE OFICIAL
DOMICILIO 045
BOGOTÁ, COLOMBIA

CERTIFICADO NOTARIAL (Cuando el solicitante es SOCIEDAD)
(Poderes otorgados en: El Salvador, Estados Unidos, Mexico y Venezuela)

A los _____ días del mes de _____, el Notario que suscribe DA FE de que:

1. _____
(nombre de la persona que firma el poder)

mayor de edad y domiciliado _____

_____ firmó de su puño y letra el documento que antecede.

2. Conoce al (a la) otorgante y que este (a) está legalmente capacitado para el otorgamiento.

3. El otorgante ha firmado el referido documento en su carácter de _____ de la persona jurídica _____

4. La citada persona jurídica con sede en _____ está Legalmente constituida, que tiene actualmente Existencia legal y que el acto para el cual se ha otorgado este poder está comprendido entre los que constituyen su objeto social.

5. El otorgante tiene efectivamente la representación que ostenta, que esta es legítima y que está facultado para otorgar este poder.

6. las anteriores certificaciones de los puntos 3, 4 y 5, me constan porque he tenido a la vista los documentos auténticos.

Notario Público

NOTA: A continuación de lo anterior, el Consul de Colombia debe autenticar la firma del Notario Público.

CERTIFICADO NOTARIAL (Cuando el solicitante es INDIVIDUO)

A los _____ días del mes de _____, el Notario que suscribe DA FE de que
1. _____

(nombre de la persona qu firma el poder)

Mayor de edad y domiciliado en _____
_____ firmó en su presencia

el documento que antecede, conoce al otorgante y que este está legalmente capacitado para el otorgamiento.

Notario Público

NOTA: A continuación de la anterior, el Consul de Colombia debe autenticar la firma del Notario Publico.

Para todos los demás países el Señor Consul de Colombia o ante quien se otorgue, debe expedir una certificación dejando constancia 1) de la existencia legal de la sociedad, 2) de que esta ejerce actualmente su objeto social, y 3) de que la persona o personas que otorgan el poder están facultadas para hacerlo, dejando constancia así mismo de que tuvo a la vista las pruebas que acrediten tales circunstancias.

NOTARIAL CERTIFICATE (When the applicant is a CORPORATION)
(Powers of attorney granted In: El Salvador, Mexico, U.S.A. and Venezuela)

This 14th day of February 2002
the undersigned Notary CERTIFIES that:

1. Sálvatore P. Pace
(name of the person who signs the power of attorney)

_____ of legal age and domiciled in Chester, New Jersey, U.S.A.

set his hand on the foregoing document.

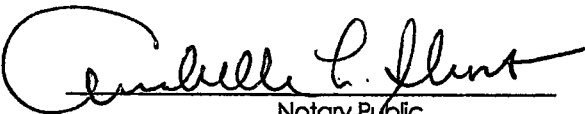
2. The grantor is to him personally known and that he/she has legal capacity to execute the document.

3. The grantor has executed the foregoing document in his capacity of Vice President and Group Counsel, of the juridical person Intellectual Property, The BOC Group, Inc.

4. The mentioned juridical person with place of business in Murray Hill, New Providence, NJ, USA is duly organized, has actual legal existence and that the purposes for which the power of attorney is granted are within the scope of its corporate purposes.

5. The grantor has in fact the referred quality and that his/her representation is legal and that he/she is empowered to grant this power of attorney.

6. I have based the above certifications 3, 4 and 5, on the authentic documents which for such purpose were exhibited to me.


Notary Public

NOTA: Then the Colombian Consul must legalize the signature of the Notary Public.

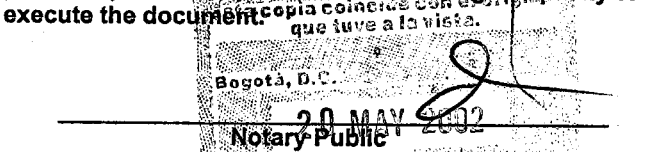
NOTARIAL CERTIFICATE (When the applicant is an INDIVIDUALS)

On this _____ day of _____
the undersigned Notary CERTIFIES that:

1. _____
(name of the peson who signs the Power of Attorney)

of legal age and domiciled at _____

_____ signed in his presence the foregoing document, the grantor is to him personally known, and that he/she has legal capacity to execute the document.


Bogotá, D.C.
20 MAY 2002
Notary Public

NOTA: Then the Colombian Consul must legalize the signature of the Notary Public.

For all other countries the Colombian Consul or before who it is granted must issue a certification stating 1) the legal existence of the corporation, 2) that the corporate purposes are actually being accomplished, 3) that the person or persons who this Power of Attorney are empowered to do it. The Consul will certify also that the documents evidencing those circumstances were exhibited to him.

TRADUCCIÓN OFICIAL No. 02/140 de un documento escrito en inglés, el cual para su identificación se sella con el sello del traductor al tiempo con la presente. Esta traducción ha sido preparada por Juan Pablo Piedrahita Aguilera, Traductor e Intérprete Oficial debidamente reconocido de conformidad con el Certificado de Idoneidad Profesional No. 0045 expedido por la Universidad Nacional de Colombia.

(Se traduce un Documento de Cesión, Certificaciones Notariales y Apostilla No. A150917 escritos en inglés adjuntos a un Poder otorgado por The BOC Group Inc., con fecha Febrero 14, 2002, escrito en inglés y español.)

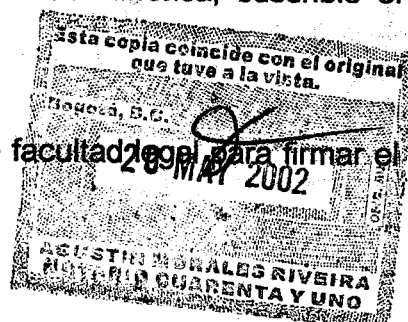
(En español e inglés, Poder otorgado por The BOC Group Inc con fecha Febrero 14, 2002)

CERTIFICADO NOTARIAL (Cuando el Solicitante es una Sociedad)

(Poderes otorgados en El Salvador, México, Estados Unidos de América y Venezuela)

Expedido hoy Febrero 14, 2002, el suscrito Notario CERTIFICA que:

- 1) Salvatore P.Pace (nombre de la persona que firma el poder), mayor de edad y domiciliado en Chester, New Jersey, Estados Unidos de América, suscribió el anterior documento.
- 2) El otorgante le es conocido personalmente y tiene facultad legal para firmar el



documento.

3) El otorgante ha suscrito el anterior documento en su facultad de Vicepresidente y Asesor Legal del Grupo, Propiedad Intelectual de la persona jurídica The BOC Group Inc.

4) La mencionada persona jurídica con domicilio comercial en Murray Hill, New Providence, New Jersey, Estados Unidos de América, está debidamente constituida, tiene actualmente existencia legal y el fin para el cual se otorga este poder se encuentra dentro de su objeto social.

5) El otorgante tiene en efecto la idoneidad referida y su representación es legal y está autorizado para otorgar este poder.

6) Fundamento las certificaciones 3), 4) y 5) en los documentos auténticos que para tal fin me fueron exhibidos.

(Firmado) Anabelle L-Short

Notario Público

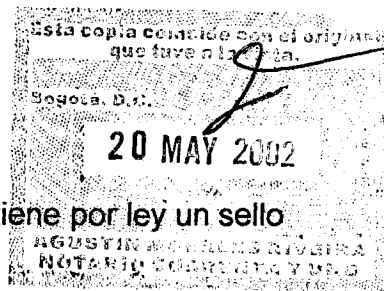
(Sello Notarial en Relieve)

(Nota: a continuación el Consulado Colombiano debe legalizar la firma del Notario Público)

ESTADO DE NEW JERSEY,

CONDADO DE UNION, } ss.:

Yo, Joanne Rajoppi, Escribano del Condado de Unión, que tiene por ley un sello



02 / 140

TRADUCCION OFICIAL No. 140
JUAN PABLO PIEDRAHITA ACERERA
TRADUCTOR E INTERPRETE OFICIAL

C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

POR EL PRESENTE CERTIFICO, que ANABELLE L. SHORT, cuyo nombre está suscrito en el certificado de reconocimiento, de prueba, o declaración juramentada adjunto, era en el momento de recibir dicho reconocimiento, prueba o declaración juramentada, un NOTARIO PUBLICO, debidamente, comisionado, juramentado y residente en dicho Estado, y era en tal calidad de NOTARIO PUBLICO un funcionario de dicho Estado debidamente autorizado por las leyes del mismo para recibir y certificar los anteriores, así como para tomar y certificar los reconocimientos o pruebas de escrituras para traspasos de tierra, tenencias o herencias, y otros instrumentos escritos para registro en dicho Estado, y que dicho reconocimiento está debidamente firmado y tomado de acuerdo con las leyes de dicho Estado, y que a sus actos oficiales deben dársele plena fe y crédito y además certifico que estoy bien familiarizado con su caligrafía y verdaderamente creo que la firma en el certificado adjunto es auténtica.

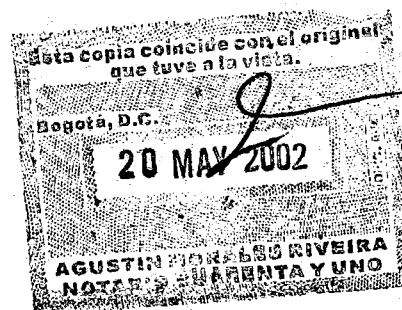
Además certifico que no se requiere, de acuerdo con la ley de dicho Estado, el registro de la impresión del Sello de dicho NOTARIO PUBLICO en mi oficina.

EN TESTIMONIO DE LO CUAL, estampo aquí mi firma y el Sello Oficial, hoy día 1 de Marzo de 2002.

(Firmado) Joanne Rajoppi

Escribano

(Sello Preimpreso de Oblea en Relieve) 2993



TRADUCCION OFICIAL No. 32-1-1-3
JUAN PABLO PIEDRAHITA AGUIRRA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

APOSTILLA

(Convenio de la Haya de Octubre 5 de 1961)

1. País: ESTADOS UNIDOS DE AMÉRICA

Este documento público

2. Ha sido firmado por JOANNE RAJOPPI
3. Actuando en calidad de Escribano del Condado
4. Lleva el sello/estampilla del Condado Union

CERTIFICADO

5. En Trenton, New Jersey
6. Hoy 8 de Mayo, 2002
7. Por el John E. McCormac, CPA, TESORERO de NEW JERSEY
8. No. A150917
9. Sello (Sello de Oblea)
10. Firma (Firmado)

ES TRADUCCIÓN FIEL Y COMPLETA de la cual se deja copia en los archivos de esta oficina para su confrontación y a la cual me remito.

Bogotá, Mayo 17 de 2002



MINISTERIO DE RELACIONES
 EXTERIORES
 456975
 Juan P. Rodríguez
 COPIA PARA APOYAR EN EL
 DOCUMENTO DESENTADO
 LAS FUNCIONES DE LA
 JEFATURA DE BOGOTÁ D.C.
 2002 MAY 20 A 9:44
 NO SE ASUME
 RESPONSABILIDAD DEL TEXTO



100

TRADUCCIÓN OFICIAL No. 02/142 de un documento escrito en inglés, el cual para su identificación se sella con el sello del traductor al tiempo con la presente. Esta traducción ha sido preparada por Juan Pablo Piedrahita Aguilera, Traductor e Intérprete Oficial debidamente reconocido de conformidad con el Certificado de Idoneidad Profesional No. 0045 expedido por la Universidad Nacional de Colombia.

Se traduce un documento de Cesión a favor de The BOC Group Inc., Certificados Notariales y Apostillas, escritos en inglés.

Colombia

CESIÓN

El suscrito, (en adelante el CEDENTE) Neil George SIMPSON, Greg Floyd PRUSIA, Thomas G. CLAYTON, Andrew Peter RICHARDSON, y John R. LEBLANC, inventor(es) / diseñador(es) de UN MÉTODO PARA CALENTAR UN HORNO PARA DERRETIR VIDRIO USANDO UN QUEMADOR DE COMBUSTIÓN POR ETAPAS MONTADO EN EL TECHO, CON QUEMADOR DE OXIGENO-COMBUSTIBLE, por el presente declara que cede todos y cada uno de los derechos y privilegios sobre la siguiente invención, diseño industrial o modelo de utilidad a

The BOC Group Inc., con domicilio en 575 Mountain Avenue, Murray Hill, New Providence, New Jersey 07974 Estados Unidos de América.

El Cedente y el Cesionario firman este documento como prueba de aceptación



101

de la cesión.

Dada y firmada en (en blanco), a los 19 días del mes de Febrero, 2002.

(Firmado) Ilegible	(Firmado) Ilegible	(Firmado) Ilegible
El Cedente	El Cedente	El Cedente
(Firmado) Ilegible	(Firmado) Ilegible	
El Cedente	El Cedente	

Por The BOC Group, Inc.

(Firmado) Ilegible

El Cesionario/ Salvatore P.Pace, Vicepresidente y Asesor Legal del Grupo,
Propiedad Intelectual

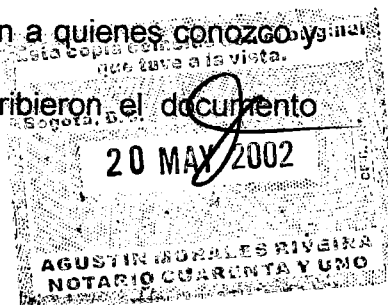
Nota: Este documento debe ser otorgado ante Notario Público y legalizado por
el Cónsul Colombia o mediante Apostilla).

99A408-1

CERTIFICADO NOTARIAL

Estados Unidos de América)
Estado de Ohio)SS 289-56-9406
Condado de Lucas)

Hoy día 19 de Febrero 2002, compareció personalmente ante mí, Lori Hamilton
(Lori Torok), Notario Público en y para el Estado y Condado mencionados, Neil
George Simpson, Greg Floyd Prusia y Thomas G. Clayton a quienes conozco y
sé que son las personas descritas en y quienes suscribieron el documento



102

anterior, y debidamente reconocieron que suscribieron el mismo para los fines y propósitos allí expresados.

Notario Público Lori A. Hamilton (Lori Torok)

(Sello Notarial a Tinta: LORI A. TOROK, Notario Público Estado de Ohio, Comisión Vence 3-8-04)

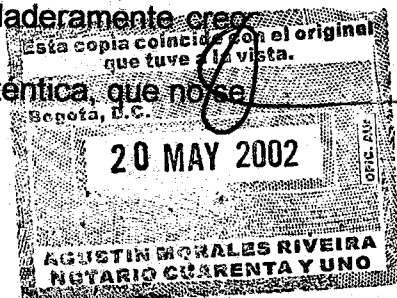
(Sello Notarial Redondo en Relieve)

CERTIFICADO NOTARIAL

ESTADO DE OHIO,

CONDADO DE LUCAS }SS

J. Bernie Quilter, Escribano de la Corte de Causas Comunes y Corte de Apelaciones del Condado de Lucas y estado de Ohio, la misma siendo una corte de registro, que tiene por ley un sello, por el presente certifico, que LORI A TOROK, cuyo nombre está suscrito en el certificado de reconocimiento, del instrumento adjunto y sobre él escrito, era en el momento de tomar dicha prueba o reconocimiento, un Notario Público, debidamente nombrado y juramentado, debidamente facultado por las leyes de dicho Estado, para tomar reconocimientos y pruebas de escrituras o traspasos de tierras, tenencias o herencias en dicho Estado, para ser registrados en él. Además, que estoy bien familiarizado con la caligrafía de dicho Notario Público, y verdaderamente creo que la firma en el certificado o prueba de reconocimiento es auténtica, que no se



TRADUCCION OFICIAL No. 102
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

743
103

requiere por ley que la impresión del sello de dicho funcionario esté registrado en mi oficina y que su comisión vence el 8 de Marzo, 2004.

EN TESTIMONIO DE LO CUAL, estampo aquí mi firma y el sello de dicha Corte y Condado en Toledo, Ohio , hoy día 12 de Marzo, 2002. (Fecha)

J. Bernie Quilter, Escribano de las Cortes

(Firmado) J. Bernie Quilter, Escribano

(Sello de Oblea y en Relieve de las Cortes de Causas Comunes)

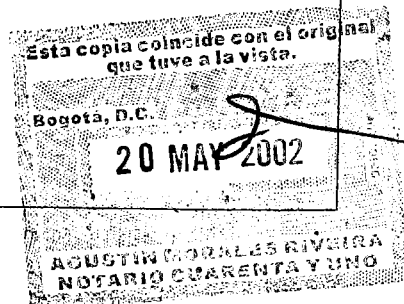
APOSTILLA

(Convención de la Haya de Octubre 5 de 1961)

1. País: Estados Unidos de América
Este documento público
2. Ha sido firmado por J. BERNIE QUILTER
3. Obrando en calidad de Escribano de la Corte de Causas Comunes
4. Lleva el sello/estampilla de la Corte de Causas Comunes, Condado de Lorain

CERTIFICADO

5. En Columbus, Ohio
6. Hoy 14 de Mayo, 2002
7. Por el Secretario de Estado de Ohio
8. No. 93411
9. Sello/Estampilla (Sello Pre-impreso)



TRADUCCIÓN OFICIAL No. 045
JUAN PABLO PIEDRAHITA AGUIRRE
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

10. Firma (Firmado)

J. Kenneth Blackwell

Secretario de Estado de Ohio

CERTIFICADO NOTARIAL

Estados Unidos de América)

Estado de New Jersey)SS

Condado de (en blanco))

Hoy día 9 de Marzo 2002, compareció personalmente ante mí, Annabelle L. Short, Notario Público en y para el Estado y Condado mencionados, Andrew Peter Richardson a quien conozco y sé que es la persona descrita en y quien suscribió el documento anterior, y debidamente reconoció que suscribió el mismo para los fines y propósitos allí expresados.

Notario Público Annabelle L. Short

(Sello Notarial a Tinta: Annabelle L. Short, Notario Público de New Jersey, Estados Unidos de América, Mi Comisión Vence Enero 31, 2005)

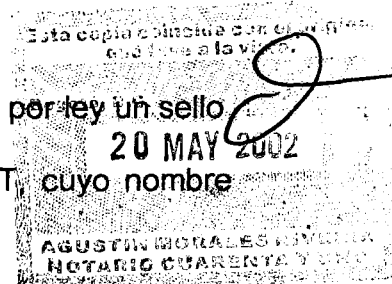
(Sello Notarial Redondo en Relieve)

ESTADO DE NEW JERSEY,

CONDADO DE UNION,) ss.:

Yo, Joanne Rajoppi, Escribano del Condado de Unión, que tiene por ley un sello

POR EL PRESENTE CERTIFICO, que ANABELLE L. SHORT, cuyo nombre



45
105

está suscrito en el certificado de reconocimiento, de prueba, o declaración juramentada adjunto, era en el momento de recibir dicho reconocimiento, prueba o declaración juramentada, un NOTARIO PUBLICO, debidamente, comisionado, juramentado y residente en dicho Estado, y era en tal calidad de NOTARIO PUBLICO un funcionario de dicho Estado debidamente autorizado por las leyes del mismo para recibir y certificar los anteriores, así como para tomar y certificar los reconocimientos o pruebas de escrituras para traspasos de tierra, tenencias o herencias, y otros instrumentos escritos para registro en dicho Estado, y que dicho reconocimiento está debidamente firmado y tomado de acuerdo con las leyes de dicho Estado, y que a sus actos oficiales deben dársele plena fe y crédito y además certifico que estoy bien familiarizado con su caligrafía y verdaderamente creo que la firma en el certificado adjunto es auténtica.

Además certifico que no se requiere, de acuerdo con la ley de dicho Estado, el registro de la impresión del Sello de dicho NOTARIO PUBLICO en mi oficina.

EN TESTIMONIO DE LO CUAL, estampo aquí mi firma y el Sello Oficial, hoy día 25 de Marzo de 2002.

(Firmado) Joanne Rajoppi

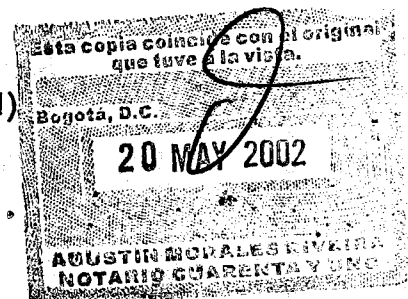
Escribano

(Sello Preimpreso de Oblea en Relieve) 2971

APOSTILLA

(Convenio de la Haya de Octubre 5 de 1961)

1. País: ESTADOS UNIDOS DE AMÉRICA



196
106

Este documento público

2. Ha sido firmado por JOANNE RAJOPPI
3. Actuando en calidad de Escribano del Condado
4. Lleva el sello/estampilla del Condado Union

CERTIFICADO

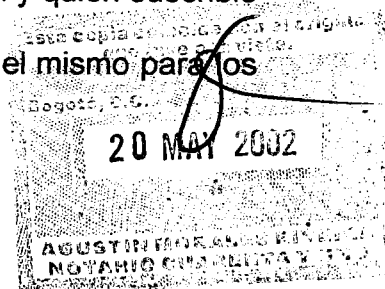
5. En Trenton, New Jersey
6. Hoy 8 de Mayo, 2002
9. Por el John E. McCormac, CPA, TESORERO de NEW JERSEY
10. No. A150918
11. Sello (Sello de Oblea)
12. Firma (Firmado)

99A408-1

CERTIFICADO NOTARIAL

Estados Unidos de América)
Estado de Ohio)SS 289-56-9406
Condado de Lucas)

Hoy día 28 de Febrero 2002, compareció personalmente ante mí, Lori Hamilton (Lori Torok), Notario Público en y para el Estado y Condado mencionados, John R. LeBlanc a quien conozco y sé que es la persona descrita en y quien suscribió el documento anterior, y debidamente reconoció que suscribió el mismo para los fines y propósitos allí expresados.



TRANSLACION OFICIAL No. _____
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDORIDAD Q45
C. IDORIDAD Q45
C. IDORIDAD Q45

Notario Público Lori A. Hamilton (Lori Torok)

(Sello Notarial a Tinta: LORI A. TOROK, Notario Público Estado de Ohio,
Comisión Vence 3-8-04)

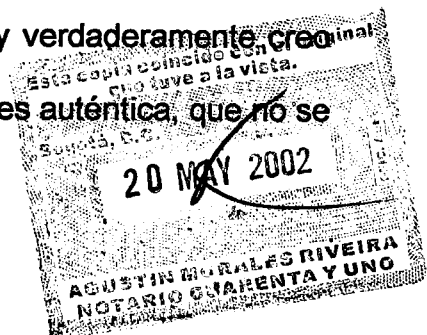
(Sello Notarial Redondo en Relieve)

CERTIFICADO NOTARIAL

ESTADO DE OHIO,

CONDADO DE LUCAS }SS

J. Bernie Quilter, Escribano de la Corte de Causas Comunes y Corte de Apelaciones del Condado de Lucas y estado de Ohio, la misma siendo una corte de registro, que tiene por ley un sello, por el presente certifico, que LORI A TOROK, cuyo nombre está suscrito en el certificado de reconocimiento, del instrumento adjunto y sobre él escrito, era en el momento de tomar dicha prueba o reconocimiento, un Notario Público, debidamente nombrado y juramentado, debidamente facultado por las leyes de dicho Estado, para tomar reconocimientos y pruebas de escrituras o traspasos de tierras, tenencias o herencias en dicho Estado, para ser registrados en él. Además, que estoy bien familiarizado con la caligrafía de dicho Notario Público, y verdaderamente, creo que la firma en el certificado o prueba de reconocimiento es auténtica, que no se



requiere por ley que la impresión del sello de dicho funcionario esté registrado en mi oficina y que su comisión vence el 8 de Marzo, 2004.

EN TESTIMONIO DE LO CUAL, estampo aquí mi firma y el sello de dicha Corte y Condado en Toledo, Ohio , hoy día 12 de Marzo, 2002. (Fecha)

J.Bernie Quilter, Escribano de las Cortes

(Firmado) J.Bernie Quilter, Escribano

(Sello de Oblea y en Relieve de las Cortes de Causas Comunes)

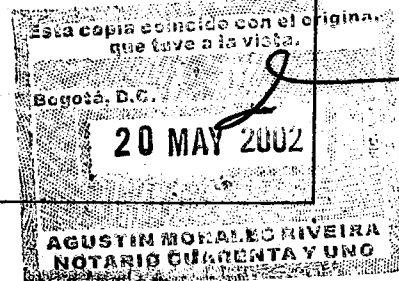
APOSTILLA

(Convención de la Haya de Octubre 5 de 1961)

1. País: Estados Unidos de América
Este documento público
2. Ha sido firmado por J. BERNIE QUILTER
3. Obrando en calidad de Escribano de la Corte de Causas Comunes
4. Lleva el sello/estampilla de la Corte de Causas Comunes, Condado de Lorain

CERTIFICADO

5. En Columbus, Ohio
6. Hoy 14 de Mayo, 2002
11. Por el Secretario de Estado de Ohio
12. No. 93410



TRANSDUCCION OFICIAL No. 045
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

13. Sello/Estampilla (Sello Pre-impreso)

14. Firma (Firmado)

J. Kenneth Blackwell

Secretario de Estado de Ohio

CERTIFICADO NOTARIAL

Estados Unidos de América)

Estado de New Jersey)SS

Condado de Union)

Hoy día 14 de Febrero 2002, compareció personalmente ante mí, Annabelle L. Short, Notario Público en y para el Estado y Condado mencionados, Salvatore P. Pace a quien conozco y sé que es la persona descrita en y quien suscribió el documento anterior, y debidamente reconoció que suscribió el mismo para los fines y propósitos allí expresados.

Notario Público Annabelle L. Short

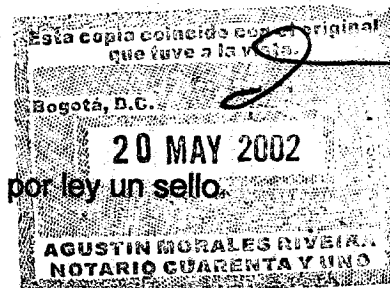
(Sello Notarial a Tinta: Annabelle L. Short, Notario Público de New Jersey, Estados Unidos de América, Mi Comisión Vence Enero 31, 2005)

(Sello Notarial Redondo en Relieve)

ESTADO DE NEW JERSEY,

CONDADO DE UNION, } ss.:

Yo, Joanne Rajoppi, Escribano del Condado de Unión, que tiene por ley un sello.



TRADUCCION OFICIAL No.
JUAN PABLO PIEDRAHITA AGUILES
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

POR EL PRESENTE CERTIFICO, que ANABELLE L. SHORT, cuyo nombre está suscrito en el certificado de reconocimiento, de prueba, o declaración juramentada adjunto, era en el momento de recibir dicho reconocimiento, prueba o declaración juramentada, un NOTARIO PUBLICO, debidamente, comisionado, juramentado y residente en dicho Estado, y era en tal calidad de NOTARIO PUBLICO un funcionario de dicho Estado debidamente autorizado por las leyes del mismo para recibir y certificar los anteriores, así como para tomar y certificar los reconocimientos o pruebas de escrituras para traspasos de tierra, tenencias o herencias, y otros instrumentos escritos para registro en dicho Estado, y que dicho reconocimiento está debidamente firmado y tomado de acuerdo con las leyes de dicho Estado, y que a sus actos oficiales deben dársele plena fe y crédito y además certifico que* estoy bien familiarizado con su caligrafía y verdaderamente creo que la firma en el certificado adjunto es auténtica.

Además certifico que no se requiere, de acuerdo con la ley de dicho Estado, el registro de la impresión del Sello de dicho NOTARIO PUBLICO en mi oficina.

EN TESTIMONIO DE LO CUAL, estampo aquí mi firma y el Sello Oficial, hoy día 25 de Marzo de 2002.

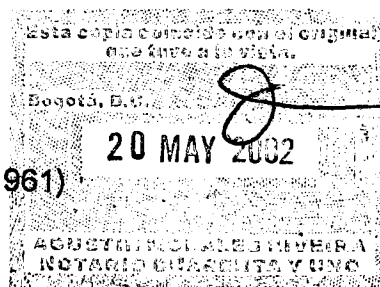
(Firmado) Joanne Rajoppi

Escribano

(Sello Preimpreso de Oblea en Relieve) 2973

APOSTILLA

(Convenio de la Haya de Octubre 5 de 1961)



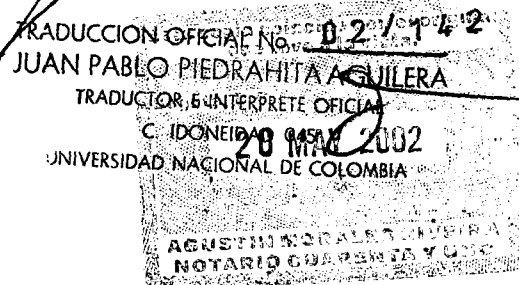
- 111
1. País: ESTADOS UNIDOS DE AMÉRICA
Este documento público
 2. Ha sido firmado por JOANNE RAJOPPI
 3. Actuando en calidad de Escribano del Condado
 4. Lleva el sello/estampilla del Condado Union

CERTIFICADO

5. En Trenton, New Jersey
6. Hoy 8 de Mayo, 2002
13. Por el John E. McCormac, CPA, TESORERO de NEW JERSEY
14. No. A150919
15. Sello (Sello de Oblea)
16. Firma (Firmado)

ES TRADUCCIÓN FIEL Y COMPLETA de la cual se deja copia en los archivos
de esta oficina para su confrontación y a la cual me remito.

Bogotá, Mayo 25 de 2001.



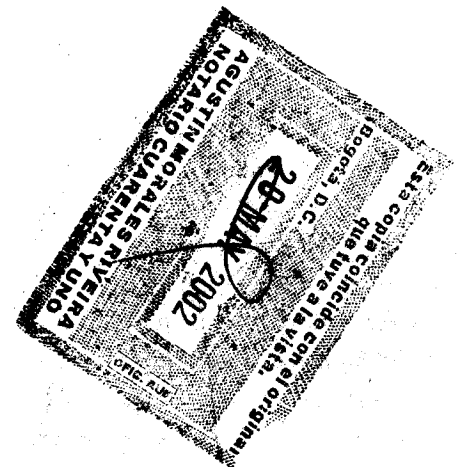
MINISTERIO DE RELACIONES
EXTERIORES

456974
Juan P. Prochinda
CUYA FIRMA APARECE EN EL
DOCUMENTO DESEMPEÑA
LAS FUNCIONES INDICADAS

NO SE ASUME
RESPONSABILIDAD DEL TEXTO

2002 MAY 20 A 9:46

1286
JEFE DE LEGALIZACIONES
SANTAFE DE BOGOTA D.C.



APOSTILLE

(Convention de la Haye du 5 octobre 1961)

1. Country: United States of America

This public document

2. has been signed by J. BERNIE QUILTER

3. acting in the capacity of Clerk of Court of Common Pleas

4. bears the seal/stamp of Court of Common Pleas, Lucas County

CERTIFIED

5. at Columbus, Ohio

6. May 14, 2002

7. by the Secretary of State of Ohio.

8. **Nº 93410**

9. Seal/Stamp:

10. Signature:



On this 28th day of February 2002,
personally appeared before me Lori Hamilton (Lori Torok)
a Notary Public in and for the above-mentioned state and county,

113

John R. LeBlanc to me known and known to me
to be the persons described in and who executed the foregoing
document, and duly acknowledged to me that they executed
same for the uses and purposes therein expressed.

Notary Public Lori A. Hamilton (Lori Torok)
LORI A. TOROK
Notary Public, State of Ohio

NOTARY CERTIFICATE

THE STATE OF OHIO
COUNTY OF LUCAS

ss.

JUAN PABLO PIEDRAHITA AGUILERA
TRADUCCION Y ALFABETIZACION
C. IDONEIDAD 045

DE COLOMBIA

INTERPRETE OFICIAL

whose name is subscribed to the certificate of the proof of acknowledgment of the annexed instrument and thereon written, was, at the time of taking such proof and acknowledgment, a

Notary Public, duly commissioned and sworn, and authorized by the laws of said State to take the acknowledgments and proofs of deeds or conveyances for lands, tenements or hereditaments in said State, to be recorded therein. And further, that I am well acquainted with the handwriting of such Notary Public, and verily believe that the signature to said certificate of proof or acknowledgment is genuine, that impression of seal of such officer is not required by law to be filed in my office, and the commission expires on the 8th day of March 2004.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seal of the said Court and County, at Toledo, Ohio, March 12, 2002

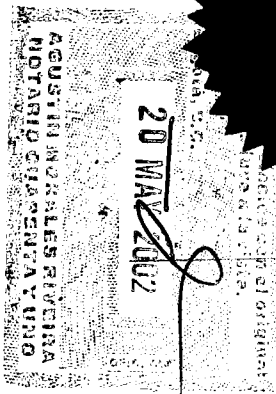
(Date)

J. Bernie Quilter, Clerk of Courts

, Clerk

J. Bernie Quilter

20 MAR 2002



021142

NOTARIAL CERTIFICATE

United States of America)
 State of ~~Virginia~~ Ohio J.H.) ss.: 289-56-9406
 County of Lucas)

TRADUCCION OFICIAL No. _____
 JUAN PABLO PIEDRAHITA AGUILERA
 TRADUCTOR E INTERPRETE OFICIAL
 C. IDONEIDAD 045
 UNIVERSIDAD NACIONAL DE COLOMBIA

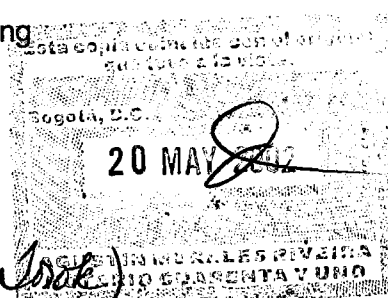
On this 28th day of February 2002,
 personally appeared before me Lori Hamilton (Lori Torok)
 a Notary Public in and for the above-mentioned state and county,

John R. LeBlanc to me known and known to me
 to be the persons described in and who executed the foregoing
 document, and duly acknowledged to me that they executed
 same for the uses and purposes therein expressed.

Notary Public

Lori A. Hamilton (Lori Torok)

LORI A. TOROK
 Notary Public, State of Ohio



NOTARY CERTIFICATE

THE STATE OF OHIO
 COUNTY OF LUCAS

ss.

TRADUCCION OFICIAL
 JUAN PABLO PIEDRAHITA AGUILERA
 TRADUCTOR E INTERPRETE OFICIAL
 C. IDONEIDAD 045
 UNIVERSIDAD NACIONAL DE COLOMBIA

J. Bernie Quilter, Clerk of the Common Pleas Court and Court of Appeals for the County
 Lucas and State of Ohio, the same being a court of record, and having by LAW a Seal, do hereby
 certify that

Lori A. Torok

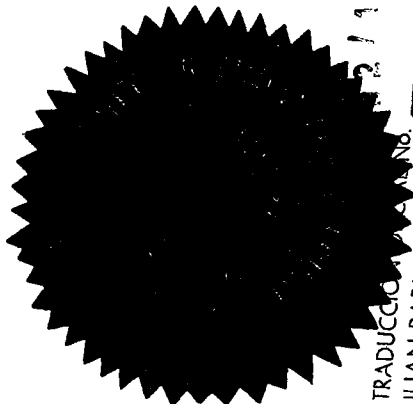
whose name is subscribed to the certificate of the proof of acknowledgment of the annex
 instrument and thereon written, was, at the time of taking such proof and acknowledgment
 Notary Public, duly commissioned and sworn, and authorized by the laws of said State to take
 acknowledgments and proofs of deeds or conveyances for lands, tenements or hereditaments
 said State, to be recorded therein. And further, that I am well acquainted with the handwriting
 such Notary Public, and verily believe that the signature to said certificate of proof
 acknowledgment is genuine, that impression of seal of such officer is not required by law to be fil
 in my office, and the commission expires on the 8th day
March 2004

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seal of the s.
 Court and County, at Toledo, Ohio, March 12, 2002

(Date)

J. Bernie Quilter, Clerk of Courts

J. Bernie Quilter, Clerk



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115

of New Jersey
y of Union



2973

TRADUCCION OFICIAL No. 2973
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD JAACOBINO

I, Joanne Rajoppi, Clerk of the County of Union, having by law a seal

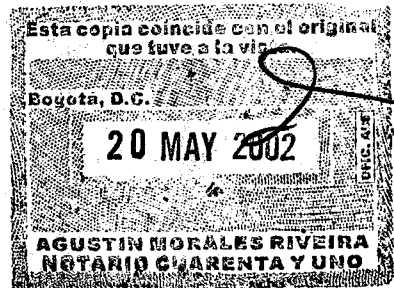
DO HEREBY CERTIFY, That ANNABELLE L. SHORT
whose name is subscribed to the attached certificate of acknowledgment, proof or affidavit, was at the time
of taking said acknowledgment proof or affidavit, a **NOTARY PUBLIC** duly commissioned and sworn and
residing in said State, and was as such **NOTARY PUBLIC**, an officer of said State duly authorized by the
laws thereof to take and certify the same, as well as to take and certify the proof and acknowledgment of
deeds for the conveyance of land, tenements or hereditament, and other instruments in writing to be recorded
in said State, and that the said acknowledgment is duly executed and taken according to the laws of said
State, and that full faith and credit are and ought to be given to his/her official acts; and I further certify that
am well acquainted with his/her handwriting and verify that the signature to the attached certificate is his/her
genuine signature.

And I do further certify that the impression of the seal of such **NOTARY PUBLIC** is not required by the laws
of this State to be filed in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal this
25TH day of MARCH

A. D. 2002

Joanne Rajoppi Clerk



NOTARIAL CERTIFICATE

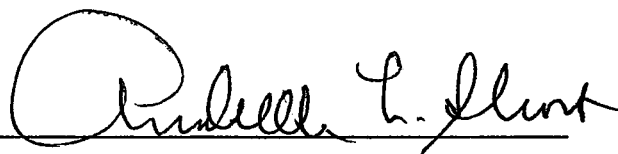
United States of America)
State of New Jersey) ss.:
County of Union)

TRADUCCION OFICIAL No. _____
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

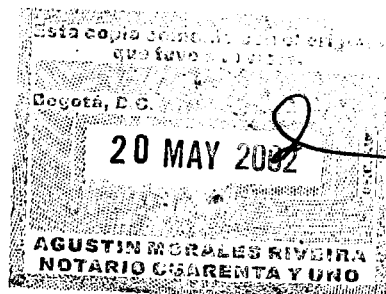
On this 14th day of February 2002, I, Annabelle L. Short
personally appeared before me a Notary Public in and for the above-mentioned state and county,

Salvatore P. Pace to me known and known to me
to be the persons described in and who executed the foregoing
document, and duly acknowledged to me that they executed
same for the uses and purposes therein expressed.

Notary Public



ANNABELLE L. SHORT
NOTARY PUBLIC OF NEW JERSEY USA
My Commission Expires Jan. 31, 2005



TRADUCCION OFICIAL No. 42
 JUAN PABLO PIEDRAHITA AGUILERA
 TRADUCTOR E INTERPRETE OFICIAL
 C. IDONEIDAD 045
 UNIVERSIDAD NACIONAL DE COLOMBIA

NOTARIAL CERTIFICATE

United States of America)
 State of Ohio) ss.: 289-56-9406
 County of Lucas)

On this 19th day of February, 2002,
 personally appeared before me Lori Hamilton (Lori Torok)
 a Notary Public in and for the above-mentioned state and county,

Neil George Simpson, Greg Floyd Prusia,
 and Thomas G. Clayton to me known and known to me
 to be the persons described in and who executed the
 foregoing document, and duly acknowledged to me that
 they executed same for the uses and purposes therein
 expressed.

Notary Public

Lori A. Hamilton (Lori Torok)

LORI A. TOROK
 Notary Public, State of Ohio
 Commission Expires 3-8-04

NOTARIAL CERTIFICATE

United States of America)
 State of New Jersey) ss.:
 County of)

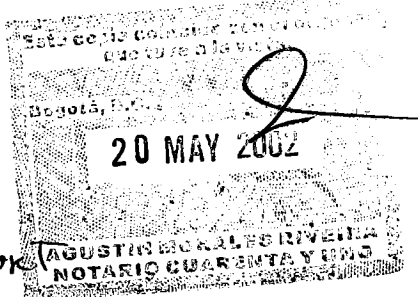
On this 7th day of March, 2002,
 personally appeared before me Annabelle L. Short
 a Notary Public in and for the above-mentioned state and county,

Andrew Peter Richardson to me known and known to me
 to be the persons described in and who executed the foregoing
 document, and duly acknowledged to me that they executed
 same for the uses and purposes therein expressed.

Notary Public

Annabelle L. Short

ANNABELLE L. SHORT
 NOTARY PUBLIC OF NEW JERSEY USA
 My Commission Expires Jan. 31, 2005



Colombia

CESION

El (la) abajo firmanto (En adelante EL CEDENTE)

En su caracter de inventor/disenador

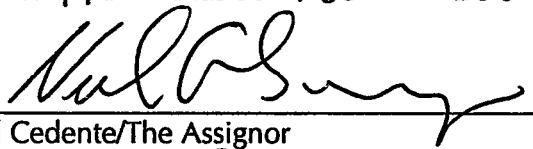
Por el presente documento declara que todos y cada uno de los derechos que le corresponden o puedan corresponderle sobre la siguiente invencion, modelo de utilidad, deseno industrial
a:

con domicilio en

En prueba de la mutua aceptacion de esta cesion ambas partes CEDENTE y CESIONARIO firman el presente documento.

Dado y firmado en

A los 19th Dias de Feb De 2002


El Cedente/The Assignor


El Cedente/The Assignor


El Cedente/The Assignor

For: The BOC Group, Inc.

(Este documento debe ser otorgado ante Notario publico y legalizado por el Consul de Columbia) a por Apostilla.)

ASSIGNMENT

The undersigned (Hereinafter THE ASSIGNOR(s))
Neil George SIMPSON, Greg Floyd PRUSIA, Thomas G. CLAYTON, Andrew Peter RICHARDSON, and John R. LEBLANC
inventor(s)/designer(s) of
METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED, STAGED COMBUSTION OXYGEN-FUEL BURNER

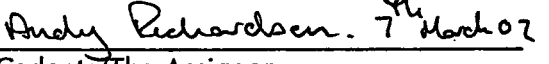
do hereby declare(s) that it assigns all and each of his/their rights and privileges on the following invention, industrial design, utility model

to: The BOC Group, Inc. ✓

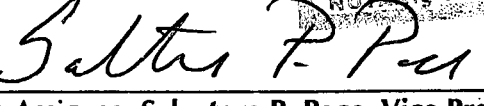
with domicile in
575 Mountain Avenue, Murray Hill,
New Providence, New Jersey 07974 U.S.A.
As proof of the mutual acceptance of this assignment, both parties ASSIGNOR(s) and ASSIGNEE sign the present document.

Granted and signed at

on this day of 2002


El Cedente/The Assignor


El Cedente/The Assignor


El Cedente/The Assignor

El Cesionario/The Assignee Salvatore P. Pace, Vice President and Group Counsel, Intellectual Property

(This document must be signed before Notary Public and legalized before the Columbian Consul) or by Apostille.)

02114
TRANSECCION OFICIAL No. 02114
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

20 MAY 2002

JOSE ANTONIO GONZALEZ RIVERA
NOTARIO GUARENTAY UNO

APOSTILLE

(Convention de la Haye du 5 octobre 1961)

1. Country: United States of America

This public document

2. has been signed by J. BERNIE QUILTER

3. acting in the capacity of Clerk of Court of Common Pleas

4. bears the seal/stamp of Court of Common Pleas, Lucas County

CERTIFIED

5. at Columbus, Ohio

6. May 14, 2002

7. by the Secretary of State of Ohio.

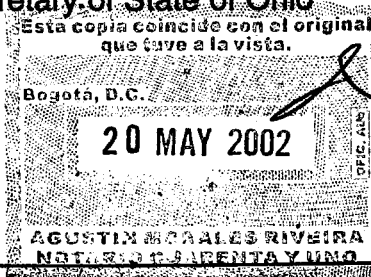
8. **Nº 93411**

9. Seal/Stamp:

10. Signature:

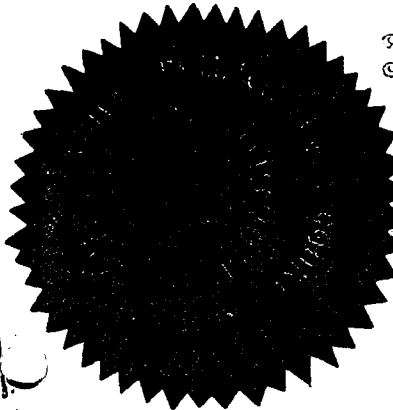


J. Kenneth Blackwell
J. Kenneth Blackwell
 Secretary of State of Ohio



NOTARY CERTIFICATE

THE STATE OF OHIO
COUNTY OF LUCAS



TRADUCCION OFICIAL No. 2971
JUAN PABLO PIEDRAHITA AGUILERAS
TRADUCTOR E INTERPRETE OFICIAL

C. IDONEIDAD 045

J. Bernie Quilter, Clerk of the Common Pleas Court and Court of Appeals for the County of Lucas and State of Ohio, the same being a court of record, and having by LAW a Seal, do hereby certify that

Lori A. Torok

whose name is subscribed to the certificate of the proof of acknowledgment of the annexed instrument and thereon written, was, at the time of taking such proof and acknowledgment, a Notary Public, duly commissioned and sworn, and authorized by the laws of said State to take the acknowledgments and proofs of deeds or conveyances for lands, tenements or hereditaments in said State, to be recorded therein. And further, that I am well acquainted with the handwriting of such Notary Public, and verily believe that the signature to said certificate of proof or acknowledgment is genuine, that impression of seal of such officer is not required by law to be filed

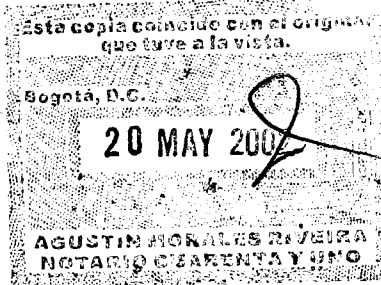
in my office, and the commission expires on the 8th day of March 2004

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seal of the said Court and County, at Toledo, Ohio, March 12, 2002

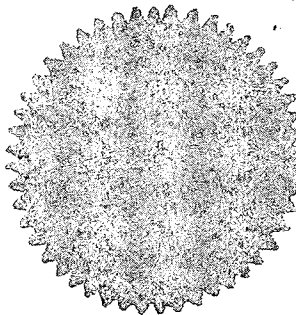
(Date)

J. Bernie Quilter, Clerk of Courts

, Clerk



State of New Jersey
County of Union



2971

TRADUCCION OFICIAL No. 2971
JUAN PABLO PIEDRAHITA AGUILERAS
TRADUCTOR E INTERPRETE OFICIAL

C. IDONEIDAD 045

I, Joanne Rajoppi, Clerk of the County of Union, having by law a seal

DO HEREBY CERTIFY, That ANNABELLE L. SHORT

whose name is subscribed to the attached certificate of acknowledgment, proof or affidavit, was at the time of taking said acknowledgment proof or affidavit, a NOTARY PUBLIC duly commissioned and sworn and residing in said State, and was as such NOTARY PUBLIC, an officer of said State duly authorized by the laws thereof to take and certify the same, as well as to take and certify the proof and acknowledgment of deeds for the conveyance of land, tenements or hereditament, and other instruments in writing to be recorded in said State, and that the said acknowledgment is duly executed and taken according to the laws of said State, and that full faith and credit are and ought to be given to his/her official acts; and I further certify that I am well acquainted with his/her handwriting and verify that the signature to the attached certificate is his/her genuine signature.

And I do further certify that the impression of the seal of such NOTARY PUBLIC is not required by the laws of this State to be filed in my office.

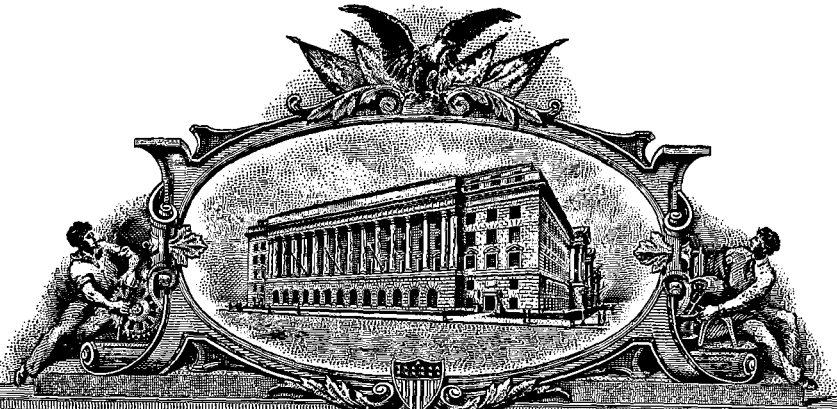
IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal this

25TH day of MARCH

A. D. 2002

Joanne Rajoppi, Clerk

PA 524159



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

February 14, 2002

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM
THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK
OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT
APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A
FILING DATE UNDER 35 USC 111.

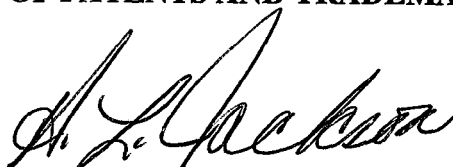
APPLICATION NUMBER: 09/798,826

FILING DATE: March 02, 2001

TRADUCCION OFICIAL No. _____
JUAN PABLO PIEDRAHITA AGUILERA
TRADUCTOR E INTERPRETE OFICIAL
C. IDONEIDAD 045
UNIVERSIDAD NACIONAL DE COLOMBIA

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS




H. L. JACKSON
Certifying Officer

03/02/01

31052 U.S. P.

05-05-01

122

122

Please type a plus sign (+) inside this box → ☐Approved for use through 09/30/2000. OMB 0851-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. 00A412

First Inventor or Application Identifier Neil George SIMPSON et al.

Title See 1 in Addendum

Express Mail Label No. EL722631569US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages 45]
(preferred arrangement set forth below)
- Descriptive title of the invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the invention
 - Brief Summary of the invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 14]
4. Oath or Declaration [Total Pages 4]
- a. ☒ Executed (original or copy)
- b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 18 completed)
- i. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting
inventor(s) named in the prior application,
see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

5. ☐ Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
- a. ☐ Computer Readable Copy
- b. ☐ Paper Copy (identical to computer copy)
- c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☐ 37 C.F.R. § 3.73(b) Statement of Power of Attorney
(when there is an assignee)
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
11. ☐ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
13. ☐ * Small Entity Statement(s) ☐ Statement filed in prior application
(PTO/SB/09-12) Status still proper and desired
14. ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
15. ☐ Other: _____

* NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.37), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.38).

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No: 09/374,921

Prior application information: Examiner J. Derrington Group / Art Unit: 1731

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☐ Customer Number or Bar Code Label (Insert Customer No. or Attach bar code label here) or ☒ Correspondence address below

Name Salvatore P. Pace, Esq.
The Boc Group Inc.; Patent, Trademark & Licensing Department
Address 100 Mountain Avenue
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City New Providence State NJ Zip Code 07974
Country USA Telephone 908-771-6242 Fax 908-771-6159

Name (Print/Type) Joseph G. Curatolo Registration No. (Attorney/Agent) 28,837
Signature [Signature] Date 3-2-2001

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision.

Complete if Known

Application Number	New Application
Filing Date	March 2, 2001
First Named Inventor	Neil George SIMPSON et al
Examiner Name	
Group Art Unit	
Attorney Docket No.	00A412

TOTAL AMOUNT OF PAYMENT (\$1518.00)

METHOD OF PAYMENT

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 18-0987
Deposit Account Name: Renner Kenner

- ☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17
Applicant claims small entity status. See 37 CFR 1.27

2. ☒ Payment Enclosed:
☒ Check ☐ Credit Card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee (\$)	Small Entity Fee Code	Small Entity Fee (\$)	Fee Description	Fee Paid
101	710	201	355	Utility filing fee	710.00
106	320	206	160	Design filing fee	
107	480	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) (\$710.00)

2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from Below	Fee Paid
56	-20**= 36	18.00	648.00
5	-3**= 2	80	160.00

Multiple Dependent

Large Entity Fee Code	Large Entity Fee (\$)	Small Entity Fee Code	Small Entity Fee (\$)	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$808.00)

** or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Fee Code	Large Entity Fee (\$)	Fee Code	Small Entity Fee (\$)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for ex parte reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	195	Extension for reply within second month	
117	880	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1.17(q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR § 1.128(a))	
149	710	249	355	For each additional invention to be examined (37 CFR § 1.128(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)

SUBMITTED BY

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Signature: *Joseph G. Curatolo*

Registration No. (Attorney/Agent): 28,837

Complete (if applicable)

Telephone: 440-808-0011
Date: 3-2-01

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EL722631569US

RENNER KENNER GREIVE
BOBAK TAYLOR & WEBER

A LEGAL PROFESSIONAL ASSOCIATION

Intellectual Property Law

Established 1917

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CHRISTOPHER J. KORFF

*ADMITTED TO PENNSYLVANIA BAR

March 2, 2001
Docket No. 00A412

BOX PATENT APPLICATION
COMMISSIONER FOR PATENTS
WASHINGTON, DC 20231

Sir:

Transmitted herewith for filing under 35 U.S.C. §111(a) is the following written application for a patent.

Express Mail No.: EL722631569US

Inventor(s): Neil George SIMPSON, Gregory Floyd PRUSIA, Thomas G. CLAYTON,
Andrew Peter RICHARDSON and John R. LeBLANC

Title: METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF
MOUNTED, STAGED COMBUSTION OXYGEN-FUEL BURNER

Certificate of Express Mailing

I hereby certify that this correspondence is being deposited on the date shown below with the United States Postal Service as Express Mail - Label No. EL722631569US - "Express Mail Post Office to Addressee" in an envelope with sufficient postage addressed to: Box Patent Application, Commissioner for Patents, Washington, D.C. 20231.

Heidi R. Carroll
(type or print name of person signing paper)

Neil Blauvelt
(signature of person mailing paper)

3-2-01
(date)

Offices in

AKRON

CLEVELAND/WESTLAKE

WOOSTER

Enclosed:

Transmittal Letter with Certificate of Mailing and Authorization to Charge Deposit Account
(2 pages-in duplicate)

Utility Patent Application Transmittal (2 pages)

Fee Transmittal (1 page - in duplicate)

Print EFS Application Data Sheet

Combined Declaration and Power of Attorney document (unexecuted - 4 pages)

Specification

34 Pages of Description

10 Pages of Claims

1 Page of Abstract

14 Drawing Sheets

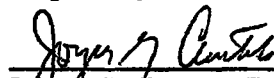
Check in the Amount of \$1518.00

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Authorization to Charge Deposit Account

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Respectfully submitted,



Joseph G. Curatolo (Reg. No. 28,837)

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Date

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126

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Country of Residence:: USA
Citizenship Country:: United States

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CORRESPONDENCE INFORMATION

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State or Province:: NJ
Country:: USA
Postal or Zip Code:: 07974
Telephone One:: 908/771-6242

APPLICATION INFORMATION

Title Line One:: Method of Heating a Glass Melting Furnac
Title Line Two:: e Using a Roof Mounted, Staged Combustio
Title Line Three:: n Oxygen-Fuel Burner
Total Drawing Sheets:: 14
Formal Drawings?:: Yes
Application Type:: Utility
Docket Number:: 00A412
Secrecy Order in Parent Appl.?:: No

REPRESENTATIVE INFORMATION

Registration Number One:: 30206
Registration Number Two:: 34307
Registration Number Three:: 34942
Registration Number Four:: 28837
Registration Number Five:: 24726
Registration Number Six:: 37400
Registration Number Seven:: 42859
Registration Number Eight:: 42906
Registration Number Nine:: 43921
Registration Number Ten:: 42451
Registration Number Eleven:: 46069

CONTINUITY INFORMATION

This application is a:: CONTINUATION IN PART OF
> Application One:: 09/374,921
Filing Date:: 08-16-1999

129 120

METHOD OF HEATING A GLASS MELTING FURNACE USING A
ROOF MOUNTED, STAGED COMBUSTION OXYGEN-FUEL BURNER

CROSS REFERENCE TO RELATED APPLICATIONS

5 The present application is a continuation-in-part of U.S. Serial No.
09/374,921, filed August 16, 1999.

FIELD OF THE INVENTION

10 The invention relates to the use of roof mounted oxy-fuel burners for
glass melting. This invention further relates to the use of at least one oxygen-
fuel burner that utilizes internal or external combustion staging in the roof of a
glass melting furnace. The invention applies both to 100% oxygen-fuel fired
furnaces and to furnaces heated by electric or non oxygen-fuel means, such as
15 air-fuel burner(s) or their combinations.

BACKGROUND OF THE INVENTION

 In one embodiment, this invention relates to the use of at least one
oxygen-fuel burner in the roof of a glass melting furnace to boost production
20 capacity or maintain current production capacity with either reduction of
electro-boost or as a result of deterioration of existing heat recovery equipment
such as recuperators or regenerators. The process involves the replacement of
a portion of existing or previously existing air-fuel or electrical energy
capacity with oxy-fuel energy. With the exception of end-fired regenerative
25 furnaces and electric furnaces, the process involves the blocking of
regenerative ports or isolation of recuperative burners. In particular the design
selection, angling and positioning of the burners over the raw batch materials
entering the furnace improves the rate of melting, increases product yield,
provides better energy efficiency and improves glass quality. Accurate control
30 of the stoichiometric ratio of combustion in the burner, rich-lean interaction of

burners, and furnace zonal fuel/oxygen staging are used to optimise heat transfer while minimizing oxides of nitrogen and sulfur dioxide emissions.

Regenerative, recuperative, electric and direct fired furnaces have been commonly involved in the manufacture of glass and related frit products.

5 Air-fuel regenerative furnaces fall into two categories: cross-fired and end-fired. Cross-fired regenerative furnaces have multiple ports, typically three to eight on each side of the furnace that connect to either a common or compartmentalized regenerator to preheat the combustion air. The regenerators, which come in various shapes and sizes, reverse every 15-30
10 minutes dependent on furnace operation. During each reversal cycle combustion air from a fan passing through one passage in a reversal valve enters the base of the regenerator on one side of the furnace and is preheated prior to entering the ports which connect to the furnace. Fuel in the form of oil and/or gas is injected either under, over, through or side of port to produce a
15 flame which is combusted in the glass melting furnace. The hot products of combustion exit the furnace through the opposing side port, down through the regenerator checker bricks, releasing heat and then exiting to the exhaust stack through a second passageway in the reversal valve. As the incoming combustion air-side regenerator cools, the exhaust regenerator heats until the
20 reversal valve reverses and combustion air enters the previously hot exhaust regenerator.

 The glass is melted partly due to the radiation of the air-fuel flame but mainly by re-radiation from the roof and walls which are heated by the products of combustion. To obtain higher furnace glass production capacity,
25 many furnaces use electric boost by means of electrodes immersed in the glass. This is costly and can cause damage to the glass contact tank walls. Through time, regenerators can become blocked due to thermal/structural damage and/or carry-over of raw glass forming materials, also known as batch materials or batch, or condensation of volatile species released from the glass
30 batch. As the regenerators start to block or fail, the preheat temperature of the air in the furnace will decrease, and the atmospheric pressure within the

5 furnace will increase, reducing the thermal efficiency of the furnace. More fuel and combustion air would be required to maintain the same glass production rate. More importantly, because of the increase in furnace pressure, the rate of glass production must be decreased so as not to damage the refractory materials that make up the superstructure of the furnace.

10 To recover production capacity lost to preceding regenerator issues or to increase production in a non-encumbered furnace, oxygen has been used by four means: general air enrichment with oxygen, specific oxygen lancing under the port flames, installation of an oxy-fuel burner between first port and charging end wall, and water-cooled oxy-fuel burners installed through the port. The capacity increases from these technologies are limited by access, process requirements or refractory temperature limits.

15 The End-Fired Regenerative furnace is similar in operation to a cross-fired furnace; however, it has only two ports in the end wall which connect to individual regenerators. Regenerator deterioration can occur by the same mechanism as in cross-fired furnaces and similarly, electric and oxygen boost is utilized.

20 To recover production capacity lost to the aforementioned regenerator issues or to increase production, oxygen has been used by three means: general air enrichment with oxygen, specific oxygen lancing under the port and installation of oxy-fuel burners through the furnace. These technologies are typically capacity limited due to temperature limitations within the furnace, because of location and concerns for overheating of the furnace.

25 The recuperative furnace utilizes at least one recuperator type heat exchanger. Unlike the regenerator, the recuperator is continuous with a hot concurrent flow heat exchanger where exhaust gases preheat combustion air, which is ducted to individual air fuel burners along the sides of the furnace. Recuperative furnaces can also use electric boost. As with regenerative furnaces, recuperators can start to lose their efficiency and ability to preheat the air. They can become blocked or develop leaks between the walls separating the combustion air and exhaust gases.

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To recover production capacity lost from the aforementioned recuperator issues or to increase production, oxygen has been used by three means: general air enrichment with oxygen, specific oxygen lancing under the air fuel burners and installation of oxy-fuel burners either through the furnace breast walls. These technologies are typically limited on capacity because of burner location limitations and concerns for overheating of the furnace.

Direct fired furnaces do not utilize preheated air and are therefore less efficient than the preceding examples of furnace design. To improve thermal efficiency or increase production capacity, side wall oxy-fuel burners have replaced air fuel burners.

Electric furnaces or furnaces which utilize electricity for the majority of melting are typically costly to operate and are subject to a shorter campaign life than the typical fossil fuel fired furnaces. Once designed, it is difficult to increase the production capacity. This invention relates to what are commonly referred to in the industry as hot top and warm top electric furnaces and does not apply to cold top furnaces.

United States Patent No. 5,139,558 to Lauwers discloses the use of a water cooled, high-momentum roof-mounted auxiliary oxygen fired burner in a glass melting furnace, which is directed to the interface of the melted and solid glass forming ingredients at an angle directed upstream relative to the glass flow, whereby the solid glass forming ingredients are mechanically held back, thus being prevented from escaping the melting zone.

United States Patent No. 3,337,324 to Cable discloses a process for melting batch material in a glass furnace using a burner positioned to fire substantially down over the feed end of a water-cooled furnace.

In the past, roof-mounted burners were considered in the glass industry, but were disregarded. It was perceived that the heat release from roof mounted burners was too great, resulting in the melting of the furnace crown (roof). In addition, high momentum flames from the burners would blow the batch materials around, harming the furnace walls, and generating a

layer of gaseous bubbles, commonly referred to as foam, on the glass melt surface.

Recently, it has been proposed to install roof-mounted oxy-fuel burners in refractory lined glass melters. These burners are directed downwards at an angle greater than 45° with respect to the surface of the glass forming material at a controlled velocity so as not to transport loose batch material into the furnace atmosphere, and are further controlled such that a generally columnar fuel and oxygen flow combusts proximate to the top surface of the glass forming material, to produce a flame that impinges the surface of the raw glass forming material. This permits a significant increase in heat transfer into the glass, while maintaining refractory temperatures within safe operating limits, and avoiding the overheating of the roof and walls of the furnace. This technology approach, of using roof-mounted burners (non-staged) as the primary source of heat in a glass melting furnace having no regenerators or recuperators, is described in United States Patent Application No 08/992,136 to LeBlanc, which is incorporated herein by reference as if fully written out below.

The design of an oxygen fuel burner with integral staging is disclosed in U.S. Patent No. 5,458,483 to Taylor. Its use in a roof mounted configuration was not contemplated, however.

It is desirable to provide processes for the staging of combustion in embodiments that improve heat transfer and/or lower emissions of oxides of nitrogen, in the operation of at least one oxy-fuel burner mounted in the roof of a glass melting furnace.

SUMMARY OF THE INVENTION

The present invention relates to both 100% oxy-fuel glass furnaces and oxy-fuel boosting of air-fuel furnaces with or without the use of regenerators or recuperator heat recovery devices and/or oxygen enrichment. Consequently, the present invention relates to both the modification of existing glass furnaces and newly designed, dedicated purpose glass furnaces.

According to the present invention, glass melting furnaces of all designs can be boosted using at least one roof-mounted oxygen fuel burner(s) positioned over the raw batch materials as the materials enter the furnace to improve the rate of melting and improve glass quality and/or glass product yield. Because of the increased rate and yield of the glass melting generated by the design and positioning of these burners, depending on furnace condition and type, at least one or more of the following can be achieved: increased glass production, improved glass quality, reduction in electric boost, recovery of production lost due to inefficient heat recovery (i.e., blocked regenerators), reduction of oxygen use by replacing oxygen enrichment of the furnace atmosphere, reduction of oxygen use by replacing oxygen lancing, reduction of oxygen use by replacing conventional oxy-fuel burners positioned through the walls of a glass furnace, reduction in furnace superstructure temperature, increased furnace campaign life, improved energy efficiency, reduction in emissions of oxides of nitrogen and oxides of sulfur, reduction in fossil fuel usage, reduction in recycled glass cullet, control of exit glass temperature, and increased product glass yield.

This invention may be applied to the following types of furnaces. In hot top electric furnace applications of this invention, at least one oxygen-fuel burner will be mounted in the roof of the furnace. In cross-fired regenerative furnaces applications of this invention may sometimes necessitate at least one pair of the opposing ports to be fully or partially blocked or isolated. In end-fired regenerative furnace applications of this invention, at least one oxygen-fuel burner will be mounted in the roof of the furnace and the combustion air flow will be reduced by a portion of the original design maximum flow. In all recuperative furnace applications of this invention, at least one oxygen-fuel burner will be mounted in the roof of the furnace. In multi-burner furnaces, wall mounted burners adjacent to the roof mounted burners should be removed and the air supply isolated. In single burner or single port applications, the combustion air flow will be reduced by a portion of the original design maximum flow.

In all direct fired furnace applications of this invention, at least one oxygen-fuel burner will be mounted in the roof of the furnace. In multi-burner furnaces, wall mounted burners adjacent to the roof mounted burners should be removed and the air supply discontinued. In single burner or single port applications, the combustion air flow will be reduced by a portion of the original design maximum flow.

In all the above cases the scope of the invention is effectively the same: glass melting which was previously performed by air-fuel or oxy-fuel including but not exclusive of furnaces that utilize electric boost or conventional oxygen boosting methods, is replaced by roof-mounted oxy-fuel burners positioned over the raw batch materials entering the furnace to improve the rate of melting and/or improve glass quality and/or glass product yield. Because of the ability to position these burners at specific locations, increased heat transfer to the unmelted raw batch materials is achieved.

In all cases, at least one roof-mounted oxy-fuel burner is positioned over the raw batch materials entering the furnace to improve the rate of melting and improve glass quality, and in all multi-port and multi-burner air fuel applications at least one pair of ports or pair of burners are isolated. In all single port and single burner applications, the combustion air and fuel are reduced to a portion below the maximum design. The more efficient roof mounted burners provide energy to replace the conventional energy removed from the process and the additional energy required to achieve the desired process requirements. The positioning of the burners over the raw batch entering the furnace improves the rate of melting. The stoichiometric oxygen and fuel ratios and flow characteristics of the roof-mounted burners and remaining air-fuel burners can be controlled so as to minimize the emission of nitrous oxide and sulfur dioxide from the glass furnace.

A further embodiment of this invention relates to the use of at least one oxygen-fuel burner that utilizes internal or external combustion staging, positioned in the roof of a glass-melting furnace. This embodiment applies both to 100% oxygen-fuel fired furnaces and to furnaces heated by electric or

non-oxygen-fuel (such as air-fuel burner) means. The application to oxygen-fuel fired furnaces provides an increased rate of melting, resulting in at least one of an improvement in glass quality, glass production capacity and energy efficiency (by reduction in either fossil fuel- or electro-boost) per unit output of glass. The application of the present invention to non-oxygen fuel furnaces permits one to improve glass quality, and to boost production capacity or maintain current production capacity with either reduction of electro-boost or despite the deterioration of existing heat recovery equipment. In retrofit installations, the process involves the supplement or replacement of a portion of existing or previously existing oxygen-fuel, air-fuel or electric energy capacity with oxy-fuel energy through at least one oxygen fuel burner with integral or external combustion staging located in the roof of the furnace.

In new glass furnace installations, the present invention permits the use of 100% oxy-fuel burners, including at least one roof mounted oxy-fuel burner for which combustion is integrally or externally staged. Optionally, all burners are roof mounted.

The present invention therefore provides a method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:

- providing at least one oxy-fuel burner in the roof of said furnace over said batch material, wherein said at least one oxy-fuel burner is adapted for staged combustion;
- providing a flow of fuel to said at least one oxy-fuel burner;
- providing a flow of gaseous oxidant in association with said at least one oxy-fuel burner;
- injecting the fuel and the oxidant into the furnace; and,
- combusting said fuel from at least said one oxy-fuel burner such that at least a portion of combustion is effected in the vicinity of said glass forming

material to enhance convective and radiative transfer of heat to said glass forming material without substantially disturbing said glass forming material.

5 In one embodiment the invention provides a method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:

providing at least one oxy-fuel burner in the roof of said furnace over said batch material;

10 providing a flow of liquid fuel to said at least one oxy-fuel burner;

providing a flow of gaseous oxidant in association with said at least one oxy-fuel burner;

injecting the fuel and the gaseous oxidant into the furnace; and, combusting said fuel.

15 In this embodiment the one oxy-fuel burner may be adapted for staged combustion, including

combusting said fuel from at least said one oxy-fuel burner such that at least a portion of combustion is effected in the vicinity of said glass forming material to enhance convective and radiative transfer of heat to said glass forming material without substantially disturbing said glass forming material.

20 In another embodiment, the invention provides a method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream end front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:

25 providing at least one oxy-fuel burner in the roof of said furnace over said batch material, wherein said at least one oxy-fuel burner is adapted for fuel staged combustion and contains at least one outer oxidant injector and two inner fuel injectors, the innermost fuel injector being adapted for high velocity fuel injection and the other fuel injector, disposed between the

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innermost fuel injector and the outer oxidant injector, being adapted for lower velocity fuel injection;

5 providing a flow of fuel to said at least one oxy-fuel burner, wherein the flow of fuel through the innermost fuel injector has a higher momentum than the flow of fuel through the other fuel injector;

providing a flow of gaseous oxidant to the outer oxidant injector, having a lower momentum than the flow of fuel through the innermost fuel injector;

10 combusting said fuel from at least said one oxy-fuel burner such that at least a portion of combustion is effected in the vicinity of said glass forming material to enhance convective and radiative transfer of heat to said glass forming material without substantially disturbing said glass forming material.

15 In another embodiment, the present invention provides an oxy-fuel burner comprising at least one outer oxidant injector and two inner fuel injectors, the innermost fuel injector being adapted for high velocity fuel injection and the other fuel injector being adapted for lower velocity fuel injection.

20 In a further embodiment, the present invention provides a method of melting batch material in a glass furnace having regenerators, recuperators and/or electric boost, said furnace having sidewalls, a back wall, a front wall and a roof comprising:

providing at least one burner in the roof of said furnace over said batch material;

25 providing a flow of gaseous oxidant to said at least one burner;

providing a flow of gaseous fuel to said at least one burner;

generating a flame from at least said one burner said flame having a velocity sufficient to maximize transfer of heat from said flame to said batch material without substantially disturbing said batch material, and,

30 providing additional oxygen to complete combustion at or near the surface of said batch material from at least one oxygen injector in the roof of said furnace.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Further features and other objects and advantages of this invention will become clear from the following detailed description made with reference to the drawings in which:

Fig. 1 is a cross sectional longitudinal view of a glass melting furnace in accordance with the present invention.

10 Fig. 2A is a cross-sectional plan view of a cross-fired regenerative embodiment of the glass melting furnace of Fig. 1 along line 2-2.

Fig. 2B is a cross-sectional plan view of an end-fired regenerative embodiment of the glass melting furnace of Fig. 1 along line 2-2.

Fig. 2C is a cross-sectional plan view of a cross-fired recuperative embodiment of the glass melting furnace of Fig. 1 along line 2-2.

15 Fig. 2D is a cross-sectional plan view of an end-fired recuperative embodiment of the glass melting furnace of Fig. 1 along lines 2-2.

Fig. 2E is a cross-sectional plan view of a unit melter embodiment of the glass melting furnace of Fig. 1 along lines 2-2.

20 Fig. 3 is a cross sectional view of the glass melting furnace of Fig. 1 along line 3-3 illustrating two oxygen-fuel burners adjacent the upstream end wall of the furnace.

Fig. 4 is an alternate cross sectional view of the glass melting furnace of Fig. 1 along line 3-3 illustrating one oxygen-fuel burner adjacent the upstream end wall of the furnace.

25 Fig. 5 is a cross sectional view of an oxygen fuel burner and a schematic representation of a burner flame from the oxygen burner.

Fig. 6 is a cross sectional elevation view of a glass melting furnace having an integrally staged combustion, roof mounted oxy-fuel burner.

30 Fig. 7 is a cross sectional elevation view of a roof mounted oxy-fuel burner with associated external combustion staging means.

Fig. 8 is a schematic, plan view of a glass melting furnace having a roof mounted grouping of oxy-fuel burners operating at different stoichiometric ratios to achieve inter-burner staging.

5 Fig. 9 is a cross sectional elevation view of a glass melting furnace having a roof mounted oxy-fuel burner and an associated oxygen bubbler for providing staged oxygen to the surface of the glass batch, through the melt.

Fig. 10 is a cross-sectional elevation view of a roof-mounted oxy-oil burner with staged oxygen injectors according to the present invention.

10 Fig. 11 is a schematic, cutaway view of a fuel staged oxy-fuel burner.

DETAILED DESCRIPTION OF THE INVENTION

15 In the glass furnaces for which the present invention is intended, a typical burner discharges a mixture of fuel and either air or oxygen in a particular ratio of fuel to oxidant, to produce a combustible mixture. Once ignited, this combustible mixture burns to produce a flame that is used to heat and melt the glass batch materials. The process of the present invention differs from that utilized in conventional fossil fuel fired air fuel and oxy-fuel furnaces, where heat transfer is effected principally by radiation directly from the walls and roof of the furnace and direct radiation from the flames. The process utilizing at least one roof mounted oxy-fuel burner(s), in addition to a radiation heat transfer component, provides significant convective heat transfer due to the impingement and final reaction of reactive intermediate species such as carbon monoxide, hydrogen, and hydroxyl radicals, to stable combustion products such as carbon dioxide and water vapor at the glass batch surface. This type of heat transfer is enhanced when the oxy-fuel burner is either integrally (within the burner block) or externally staged, so as to delay a portion of the combustion, thereby lowering flame temperature and radiant heat losses until the glass surface is reached. As a result, heat transfer to the furnace superstructure is reduced.

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Suitable fuels for combustion include, but are not limited to, methane, natural gas, liquefied natural gas, propane, liquefied propane gas, butane, low BTU gases such as town gas, producer gas or the like, vaporized or atomized

oil, kerosene or diesel, or mixtures thereof, at either ambient temperature or in preheated form. Preferred oxidants include oxygen-enriched air, containing greater than 20.9 volume percent oxygen to about 80 volume percent, preferably greater than 50 volume percent, such as produced by filtration, absorption, membrane separation, or the like; non-pure oxygen such as that produced by, for example, a vacuum swing adsorption process and containing about 80 volume percent to about 95 volume percent oxygen; and "industrially" pure oxygen containing about 90 volume percent to about 100 volume percent oxygen, such as is produced by a cryogenic air separation plant. The oxidant may be introduced at either ambient temperature or in preheated form. The fuel and the oxidant are generally introduced in the furnace through a burner assembly.

The burner assembly generally includes a burner block formed to include a flame chamber having inlet and outlet openings, burner means for discharging fuel into a flame chamber formed in the burner block and means for discharging oxygen into the flame chamber. In operation, discharged oxygen mixes with fuel provided by the discharging burner means inside the flame chamber. This combustible fuel and oxygen mixture can be ignited to define a flame having a root portion in the flame chamber and a tip portion outside the flame chamber. If the burner assembly to be used comprises an "internally staged" burner for secondary combustion purposes, the burner block may further include bypass means for conducting oxygen outside of the flame chamber, such as to oxygen-discharge ports around the outlet opening of the flame chamber. In operation, oxygen may pass through the bypass means formed in the burner block to the oxygen-discharge ports, and be ejected from the burner block into a downstream "second-stage" region containing a portion of the flame and lying outside the flame chamber in the furnace, to heat the glass batch materials or melt.

In certain preferred embodiments, the integrally staged burner block is made of a refractory material and includes an outside wall formed to include the flame chamber inlet opening and a plurality of oxygen-admission ports around the inlet opening. The burner block also includes a furnace wall configured to lie in a furnace and formed to include the flame chamber outlet

opening and the plurality of oxygen-discharge ports around the outlet opening. In alternative embodiments, one or more oxidant entry means can be provided externally to the burner block, as described below, to enable staged combustion to be effected in the furnace.

5 Suitable materials for the refractory burner block include but are not limited to silica, mullite, zirconia (ZrO_2), fused cast alumina-zirconia-silica (AZS), rebonded AZS, or bonded alumina (Al_2O_3). The particular material chosen is determined, in part, by the type of glass to be melted in the glass furnace.

10 Staged combustion has been proposed for glass furnace burners, such as those in which a fuel rich oxy-fuel mixture is injected into the furnace from a burner, and additional oxygen is injected by means external to the burner block in order to provide complete combustion displaced from the burner exit. In the instance of roof-mounted burners, preferably complete combustion
15 would occur in the proximity of the surface of the raw batch materials. Preferably, additional oxygen injectors would be positioned to delay complete combustion until after the flame has impinged on the surface of the raw batch. The location of the additional injectors is dependant upon the desired operating conditions of the burner(s), as well as burner location and number.
20 According to the present invention, externally staged combustion is preferably provided by installing at least one oxygen injector means in the roof or crown of the furnace, although oxygen injectors may be positioned elsewhere in order to obtain the desired delayed combustion effects.

 According to the present invention, the at least one oxy-fuel burner(s)
25 are preferably positioned in the roof (or crown) of the furnace above the raw batch (and optionally, cullet) materials, and directed to the batch surface. The burners may be positioned as close as possible to the batch chargers where the coolest batch materials are, proximate to the furnace back wall where the glass forming material is charged, to obtain rapid melting due to the higher thermal
30 difference. Conventional air fuel or oxygen fuel burners may be positioned through the walls of the furnace downstream from the roof-mounted burners to provide a refining zone and insure complete combustion of reactants. Alternatively, oxy-fuel roof mounted burners may provide heat transfer

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downstream of the batch chargers proximate to the furnace downstream end wall, that is, the front wall of the furnace.

5 The roof mounted oxy-fuel burner is successful according to the present invention, because a portion of the combustion occurs on the batch surface of the glass melter, which adds convective heat transfer to the traditional radiative heat transfer. Further in accordance with the preferred embodiment of this invention, use of roof mounted oxy-fuel burners provided with integrally or externally staged combustion, delays mixing the oxygen and fuel to project the combustion zone farther away from the roof. This results in
10 localizing more of the combustion on or at the surface of the glass raw batch or melt materials to increase the convective heat and radiative heat transfer. The high temperature flame is moved away from the roof to avoid damaging the structure, and nearer to the glass to promote heat transfer. One additional advantage is that the inventive roof mounted staged combustion embodiment
15 allows the process to operate in furnace constructions that have higher roofs. The delay is created by separating the two gas flows (either oxygen only/fuel only, or a fuel-lean/fuel-rich mix) by a sufficient amount, and in one embodiment, angling them toward each other to have their flow center lines converge on the batch or melt surface.

20 Oxygen/natural gas burners operate at a stoichiometric ratio of 2:1 when the natural gas is pure methane and the oxidant is pure oxygen. The conventional conical flame oxygen/gas burner uses a concentric tube in tube construction with the inner tube supplying the gas and the outer tube supplying the oxygen. The flame length then becomes a function of the velocity of the
25 two flows and the relative velocity differences between the two flows, which will affect the mixing rate at the interface between the two streams and therefore the rate of combustion. Because both streams will expand as they exit the tubes, they will begin to mix immediately and combustion will start very close to the burner discharge point.

30 The present invention separates the two flows (fuel and oxidant) into two or more separate streams. In one embodiment, a fuel gas stream can be operated as a gaseous fuel only or as a concentric tube burner with a less than the stoichiometric ratio of oxygen. The remaining oxygen required for

complete combustion, optionally up to 100% of the required oxygen, is introduced through one or more additional tubes that are located away from the gas tube far enough that the two streams do not mix until they have traveled a substantial distance to the target, glass materials surface. The angle that separates the two streams can be as low as 0° (parallel), or as high as 90° if projected through the walls of the furnace, and up to 180° if bubbled from beneath the surface of the melt, as long as the mixing occurs beyond the burner discharge point.

As stated above, one advantage of the process of the present invention is the ability to operate the roof mounted burner farther away from the target, i.e. have a greater distance from the roof to the glass material surface. This allows the roof mounted oxy-fuel burner(s) to operate in existing furnace designs, where the roof is currently too far from the batch for a non-staged roof mounted burner to achieve any significant rate of convective transfer.

Referring to the figures, there is shown a glass melting furnace 10 for providing molten glass to a glass forehearth or refiner 12 wherein the molten glass is further refined and subsequently fed to one or more glass-forming machines such as containers, fiberizers, float baths and the like (not shown). In considering the figures, it will be appreciated that for purposes of clarity certain details of construction are not provided in view of such details being conventional and well known by someone skilled in the art once the invention is disclosed and explained. Specific items excluded are the regenerator ports, air-fuel burners and exhausts since these are different for each type of furnace.

The glass melting furnace 10 typically includes an elongated channel having an upstream end wall 14 and a downstream end wall 16, side walls 18 a floor 20 and a roof 22 all made from appropriate refractory materials such as alumina, silica, alumina-silica, zircon, zirconia-alumina-silica, chrome oxide and the like. The roof 22 is shown generally as having an arcuate shape transverse to the longitudinal axis of the channel, however, the roof may be of most any suitable design. The roof 22 of the typical glass melting furnace 10 is positioned between about 3 - 15 feet above the surface of the raw glass-forming material. As well known in the art, the glass melting furnace 10 may optionally include one or more bubblers 24 and/or pairs of electrical boost

electrodes (not shown). The bubblers and/or electrical boost electrodes increase the temperature of the bulk glass and increase the molten glass circulation under the batch cover.

5 The glass melting furnace 10 includes two successive zones, a melting zone 27 and a downstream fining zone 28. The melting zone 27 is considered the upstream zone of the glass melting furnace 10 wherein raw glass-forming material is charged into the furnace using a charging device 32 of a type well known in the art. The raw glass-forming material 30 may be a mixture of raw materials typically used in the manufacture of glass. It will be appreciated that 10 the composition of the raw glass-forming material (or batch) 30 is dependent on the type of glass being produced. Normally, the material comprises, inter alia, silica containing materials including scrap glass commonly referred to as cullet. Other glass-forming materials including but not limited to feldspar, nepheline syenite, limestone, dolomite, soda ash, potash, borax, kaolin clay 15 and alumina may also be used. To alter the properties of the glass, a minor amount of arsenic, antimony, sulfates, sulfides, carbon, fluorides and/or other components may also be added. Moreover, oxides of barium, strontium, zirconium and lead may be added for special purpose glass, and other color forming metal oxides may be added to obtain the desired color.

20 The raw glass-forming material 30 forms a batch layer of solid particles on the surface of the molten glass in the melting zone 27 of the glass melting furnace 10. The floating solid batch particles of raw glass-forming material 30 are melted principally by at least one oxygen-fuel burner 34 having a controlled impinging flame shape and length mounted within the roof 22 of the glass melting furnace 10. It will be appreciated that it has been 25 found that the installation and proper control of at least one oxygen-fuel burner 34 in the roof 22 of the glass melting furnace 10 over the raw glass-forming material 30 in accordance with the present invention increases the melting rate of the solid raw glass-forming material and, at the same time, maintains the operating temperature of the surrounding refractory material within acceptable 30 operating limits.

As used herein, the phrase "at least one oxygen-fuel burner" means one or more oxygen fuel burners. Also as used herein, by 100% oxy-fuel is meant

that all burners are adapted to utilize oxygen or oxygen enriched air, as contrasted to air alone, as the oxidant. Furthermore, as used herein the phrase "principally by at least one oxygen-fuel burner" refers in retrofit installations, to the condition wherein the additional or recovered glass production capacity and replaced air fuel and or electric/oxygen boost energy for melting of the raw glass-forming material is from at least one oxygen-fuel burner. In one particular embodiment, as shown in FIGS. 1 and 2A the glass melting furnace 10 includes three oxygen-fuel burners 34. A single oxygen-fuel burner 34 is positioned upstream of two adjacently positioned downstream oxygen fuel burners. However, it will be appreciated that any number of oxygen-fuel burners 34 may be positioned at almost any suitable location in the roof 22 of the furnace 10 over the batch to melt the raw glass-forming material 30. For example, two oxygen-fuel burners 34 may be positioned in a side-by-side relation as depicted in FIG. 3 or a single oxygen-fuel burner may be used as depicted in FIG. 4. Nonetheless, in accordance with the present invention, the angular orientation of each oxygen-fuel burner 34 in the roof 22 of the glass melting furnace may be such that the flame 36 produced is directed substantially perpendicular to the glass batch surface to produce a flame which impinges on the glass surface to form an impingement area 26. In a preferred embodiment, the oxygen-fuel burners 34 are positioned substantially perpendicular to the batch material at an angle of about 90 degrees relative to the raw glass-forming material 30. The angle may deviate from the perpendicular in the direction of the downstream end-wall (*i.e.*, the front wall) in some embodiments by as much as 45 degrees, but preferably less than 10 degrees. It has been found that the glass production rate and the quality of glass produced may be improved by melting the raw glass-forming material 30 with at least one downwardly firing oxygen-fuel burner 34 having a controlled impinging flame shape and length in accordance with the present invention.

The at least one oxygen-fuel burner requires fuel and an oxidant. The fuel can be either gaseous or liquid or combinations of both. Gaseous fuels include those listed above, as well as blends of the aforementioned gases. Liquid fuels include heavy, medium and light fuel oils, kerosene and diesel. Liquid fuels are required to be atomized and/or vaporized. The atomization

can be either by mechanical means or secondary atomizing mediums which include air, steam, oxygen, any of the aforementioned gaseous fuels and in some cases an inert gas. Vaporization relies on the heat of the surrounding products of combustion gases to evaporate the oil. The oxidant can be either
5 100% pure oxygen or a blend of oxygen and inert gas with an oxygen concentration of preferably 50-100%, as described above.

Referring to FIG. 5, the at least one oxygen-fuel burner 34 within the roof 22 of the glass melting furnace 10 has at least one fuel conduit 40 for providing fuel and at least one oxygen conduit 42 for providing oxygen flow.
10 The oxygen-fuel burner 34 may have a capacity ranging from about 0.5 to about 15 MM Btu/hr depending upon the glass melting furnace 10 size and desired pull rate. The oxygen-fuel burner 34 is designed to use a higher percentage of oxygen than is present in air and thus the temperature above the area of impingement of the flame 36 from the oxygen-fuel burner 34 is
15 substantially higher than in a conventional glass melting furnace utilizing air-fuel burners. Notwithstanding, as well known to one skilled in the art, the temperature of the flame 36 imparted by an oxygen-fuel burner 34 is dependent on the quality of the fuel and the oxygen/fuel ratio. In a preferred embodiment, the oxygen concentration of the oxygen-fuel burner 34 is
20 typically at a level of about 95 - 125 percent of the stoichiometric amount of oxygen required to combust the fuel. The fuel to oxygen ratio can be varied, however, to produce a range of operating conditions in the glass melting furnace 10 to effect one or more desired properties, including, for example, redox level, glass color, the level of gaseous bubbles known as seeds and
25 blisters in the trade and other glass properties.

The oxygen-fuel burner 34 extends downwardly from a burner block 38 located in the roof 22 of the glass melting furnace 10. Each primary burner block 38 includes an opening having an inside diameter (id) which is at least as great as the external diameter of the largest conduit 42 or 40 dependent on
30 configuration. The inside diameter (id) of the opening of the burner block 38 may range between about 2 - 8 inches. The end of the oxygen-fuel burner 34 primary combustion zone is located from the end of the burner block 38 a distance (LBb) between about 0 - 18 inches. The secondary and in some cases

5 tertiary combustion zone is external to the burner block 38. It will be appreciated that the opening of the burner block 38 between the end of the oxygen-fuel burner 34 and the end of the burner block in some instances acts to focus the burner flame and prevent the burner flame from spreading outwardly but moreover protects the conduits of the burner. The burner block 38 is made of a refractory material as well known in the art and may be of most any suitable outside shape such as rectangular and the like.

10 The bottom surface of the burner block 38 may be flush with the inside surface of the roof 22 or the bottom surface may project below the inside surface of the roof to a distance of about 2 inches to protect the burner block 38 and adjacent crown refractories from wear. Furthermore, as shown in FIG. 5, the fuel conduits 40 and oxygen conduits 42 of the oxygen-fuel burner 34 extend downwards within the burner block 38 and terminate at either substantially the same vertical height or totally different vertical heights from the exit of burner block 38.

15 Dependent on height of burner block 38 from raw batch and desired operating conditions of the burner, the greater the fraction of fuel staging and oxygen staging internal and external to the burner block 38 will vary. Additional oxygen injectors 60 are positioned to delay complete combustion until after the flame has impinged on the raw batch. The location of these additional injectors 60 is dependent on number and position of roof mounted burners, however they can be located in practically any point in the roof and walls.

25 In accordance with the present invention, the downwardly directed impinging flame 36 produced by the at least one oxygen-fuel burner 34 is precisely controlled to give a flame length greater than or equal to the distance from the exit of burner block 38 to the surface of the raw glass-forming ingredients 30 or the surface of the molten glass, and away from the surrounding refractory, thereby reducing the risk of overheating the roof 22 and side walls 18 of the glass melting furnace 10. The impinging flame 36 may be controlled by such control devices as are conventional and standard in chemical processing. For example, valves, thermocouples, thermistors coupled with suitable servo circuits, heater controllers and the like are readily available

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and conventionally used for controlling the quantity and velocity of the fuel and oxygen from the oxygen-fuel burner 34.

5 The impinging flame 36 is precisely controlled by controlling both the relative velocity and the maximum and minimum velocities of the fuel and of the oxygen streams and the internal and external staging from the at least one oxygen-fuel burner 34.

10 The maximum and minimum velocity of the fuel and oxygen flow impinging on the surface of the raw glass-forming material 30 must be controlled to prevent the disturbance of the batch material and entrainment of or the displacement of glass batch material against the side walls 18 and roof 22 of the furnace while maintaining optimum convective heat transfer to the surface of the raw glass-forming material. It will be appreciated that the displacement of glass batch material against the side walls 18 and roof 22 will adversely effect the refractory material and possibly shorten the operating life of the glass melting furnace 10.

15 In order to determine the proper maximum velocity for the fuel and oxygen flow a burner was vertically mounted and fired downwards into a bed of glass sand across which grooves had been made. While the burner was adjusted to different heights from the sand and burner retractions into the block (LBb) the firing rates at which sand movement was discerned was noted. 20 The data from these experiments was compared against simulations run on a commercially available computational fluid dynamics code thus yielding a maximum velocity across the surface above which sand would be disturbed in the aforementioned experiments.

25

170
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Table 1 - Maximum Burner Firing Rates (MMBtu/Hour)

(LBb)	Height (feet)			
	5 ft	6 ft	7 ft	8 ft
13	3.9	4.4	5.4	6.2
11.5	4.9	5.0	6.2	6.8
9	5.5	6.1	6.4	7.1
6.5	6.4	7.2	7.4	8.1
4	6.9	8.8	8.3	9.1

5 From these experiments the maximum surface velocity was ascertained
by comparison with the CFD models to be approximately 21 m/s. Due to
variations in batch material, batch glazing and batch particle cohesion the
exact maximum may differ from the above calculated maximum, therefore, it
should be possible for one skilled in the art to vary the maximum velocity up
10 to approximately 25 m/sec. To minimize disturbance and entrainment of the
batch material, however, the maximum velocity should be kept below 30
m/sec.

The maximum and minimum velocities of the fuel and of the oxygen
of the oxygen-fuel burner 34 are also controlled to harness the maximum
15 energy from the impinging flame 36 without damaging the surrounding
refractory material. The maximum energy from the impinging flame 36 is
achieved by minimizing the amount of heat released to the glass melting
furnace 10 combustion space and maximizing the heat transfer to the raw-glass
forming material 30. The operational maximum and minimum velocity range
20 for the oxygen-fuel burner 34 to generate an acceptable heat transfer rate to the
raw glass-forming material 30 without damaging the refractory material
furnace walls and superstructure is a function of the design and location of the
oxygen-fuel burner, burner block opening geometry, the velocities of the fuel
and oxygen from the oxygen-fuel burner 34, burner staging, interaction of
25 adjacent oxygen-fuel burners, fuel burners and furnace exhaust.

The stagnation region 56, is the region where the flame 36 penetrates
the thermal boundary layer and impinges upon the surface of the raw glass-
forming material 30. Within this region 56, the flame 36 penetrates the thermal
boundary layer and impinges on the surface of the raw glass-forming material

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building a sharp pressure gradient at the surface that accelerates the horizontal flow of the deflected flame causing the flame to spread outwardly radially along the impinged surface. The end of the stagnation region 56 is defined as the location on the surface of the raw glass-forming material where the pressure gradient generated by the impinging flame 36 drops to zero. Within the stagnation region 56, by carefully controlling the momentum of flame 36, the thermal boundary layer that naturally exists at the surface of the raw glass-forming material 30 is penetrated and eliminated and thus its strong heat resistive features are attenuated. Accordingly, the heat generated by the impinging flame 36 penetrates more easily into the partially melted raw glass-forming material 30. Furthermore, within the stagnation region 56 the flame 36 luminosity significantly increases which enhances the radiation heat transfer into the relatively colder raw glass-forming material 30.

At the radial limits of the stagnation region 56 the wall jet region 58 begins. In this region, the flame 36 flows essentially parallel to the impinged surface and the thermal boundary layer grows along the impingement surface and outward from the stagnation region 56, thus the thermal boundary layer starts to build up restoring the surface resistance to the heat flow into the raw glass-forming material surface.

The controlled flame heat generation in the free-jet region 54 is the result of the design of the oxygen-fuel burner 34, inside diameter of the opening (id) of the burner block 38 and both the relative velocities and maximum and minimum velocities of the oxygen and fuel streams. By selectively controlling the design of the oxygen-fuel burner 34, the burner block 38 geometrical design and the velocities of the oxygen and fuel streams a reduced shear stress between the oxygen and gas streams is produced providing controlled partial combustion and reduced thermal radiation emissions. It will be appreciated that by optimizing burner design and operation of the oxygen-fuel burner 34, the flame heat generated in the free jet region 54 and the heat transfer resistance at the raw glass surface in the stagnation region 56 are minimized thereby maximizing the heat generated in the stagnation region.

The heat generated in the free-jet region 54 is the result of the following processes. First, the controlled partial combustion in the free-jet region 54 permits controlled combustion at the surface of the raw glass-forming material 30 thereby bringing the combustion process proximate to the surface of the raw glass-forming material. Bringing the combustion process proximate the surface of the raw glass-forming material 30 generates an elevated temperature gradient at the surface of the raw glass-forming material thereby improving the convection heat transfer. Second, the controlled partial combustion in the free-jet region 54 generates an acceptable temperature for the chemical dissociation of the combustion gases and the products of combustion. These dissociated species, once impinged on the relatively colder surface of the raw glass-forming material 30, partially recombine, exothermically, generating significant heat at the surface of the raw glass-forming material. The heat from the exothermic reactions further augments the convective heat transfer process. The minimization of the heat resistance at the stagnation region 56 of the surface of the raw glass-forming material 30 is the result of the following factors.

First, the thermal boundary layer is eliminated through the controlled flame 36 momentum and the turbulence generated by the carefully controlled combustion characteristics at the surface of the raw glass-forming material 30. Second, the localized surface heat generation allows for the conversion of the low thermal conductive raw glass-forming material 30 into a significantly better conductive molten glass material. This conversion allows for the heat generated at the surface to penetrate more efficiently into the raw glass-forming material depth.

In the cross-fired regenerative furnace Figure 2A with regenerators 81 the preferred embodiment of the present invention utilizes at least one crown mounted burner 34 positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. Crown-mounted burner 34 impinges the surface of the batch material 30 in impingement area 26. In all cross-fired regenerative furnace applications of this invention at least one pair of the opposing ports 71 will be fully or

partially blocked or isolated. This will typically be the first port and perhaps the second port dependent on the amount of boost required. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the unmelted batch materials. The energy delivered from the crown mounted burners replaces energy removed from the previously firing ports, the removed conventional electric or oxy-boost.

In the end-fired regenerative furnace of Figure 2B with regenerators 81 the preferred embodiment of the present invention utilizes at least one crown mounted burners 34 positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. In all end-fired regenerative furnace applications of this invention the combustion air and conventional fuel requirements will be reduced from the previous design and replaced with energy from the at least one crown mounted burners 34 positioned over the raw batch materials and impinging the batch materials in impingement area 26. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the unmelted batch materials. The energy delivered from the crown mounted burners replaces energy reduced from the firing port, the removed conventional electric or oxy-boost.

In the cross-fired recuperative furnace of Figure 2C with recuperator 82 the preferred embodiment of the present invention utilizes at least one roof mounted burner 34 positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. In all cross-fired recuperative furnace applications of this invention at least one pair of the opposing burners 73 will be fully or partially blocked or isolated using a block 74. This will typically be the first zone of burners and perhaps the second zone dependent on the amount of boost required. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the unmelted batch materials. The energy delivered from the crown mounted burners replaces energy removed from the previously firing ports, the removed conventional electric or oxy-boost.

In the end-fired recuperative furnace of Figure 2D with recuperator 82 the preferred embodiment of the present invention utilizes at least one crown mounted burner 34 positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. In all end-fired recuperative furnace applications of this invention the combustion air and conventional fuel requirements will be reduced from the previous design and replaced with energy from the at least one crown mounted burner 34 positioned over the raw batch materials. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the unmelted batch materials. The energy delivered from the crown mounted burners replaces energy reduced from the firing port, the removed conventional electric or oxy-boost.

In the direct-fired furnace of Figure 2E, the preferred embodiment of the present invention utilizes at least one crown mounted burners positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. In all direct fired furnace applications of this invention the combustion air and conventional fuel requirements will be reduced from the previous design and replaced with energy from the at least one crown mounted burners positioned over the raw batch materials. In multi-air-fuel-burner 73 applications at least one burner 74 will be isolated. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the unmelted batch materials. The energy delivered from the crown mounted burners replaces energy reduced from the firing port, the removed conventional electric or oxy-boost.

In an electric hot top furnace the preferred embodiment of the present invention utilizes at least one crown mounted burners positioned over the raw batch materials entering the furnace to improve the rate of melting and improvement in quality to recover or boost production capacity or reduce electric boost capacity. Additional roof-mounted burners can be located down the glass tank provided there are crown mounted burners positioned over the

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unmelted batch materials. The energy delivered from the crown mounted burners replaces energy reduced from the firing port, the removed conventional electric or oxy-boost.

5 In all cases nitrogen oxides and sulfur dioxide can be reduced by the careful selection of stoichiometric ratio of the different roof-mounted burners and remaining air fuel burners. Referring to Figure 2A as an example in the cross-fired furnace application, the burners 34 mounted in the AL or AR positions are operated with excess stoichiometric oxygen to create a fuel lean (oxidizing) zone in the furnace. By operating either burner 34 at position BC
10 and or burners at the second port 71 with less than stoichiometric oxygen or air creates a fuel rich (reducing) zone in the furnace. The remaining ports are operated with excess stoichiometric oxygen to create a fuel lean (oxidizing) zone in the furnace. This rich-lean-rich configuration effectively stages the combustion zones of the furnace to optimize heat transfer and minimize nitrogen oxide formation by creating a carbon monoxide screen.
15

The at least one roof mounted oxygen-fuel burner 34 may be either placed in a new air-fuel glass melter furnace 10 or retrofitted into an existing air-fuel glass melter furnace to increase the glass quality relative to an air-fuel only fired furnace. It will be appreciated that the present invention facilitates a
20 substantial pull rate increase, reduction in glass melting furnace 10 wall temperature and improved glass quality as compared to the same air-fuel furnace that is not retrofitted with at least one roof mounted oxygen-fuel burner as described herein. Furthermore, as will be readily appreciated by one skilled in the art, the use of at least one oxygen-fuel burner as opposed to an
25 all air-fuel system can appreciably reduce NO_x emissions, dependent upon the stoichiometry of the oxy-fuel flames and the air-fuel flames.

Example 1. Retrofit with roof mounted oxy-fuel burners.

One demonstration of this invention was the oxygen boosting, 100% oxygen conversion, re-conversion to oxygen boost and finally conventional air fuel firing of an existing hot 3-port cross-fired regenerative furnace. The furnace was initially firing all air fuel. Port #1 firing was replaced with at least one roof mounted oxygen fuel burner. The furnace fired conventionally air fuel regenerative on the remaining two ports. In the second phase, Port #2 firing was then replaced with at least one roof mounted oxy-fuel burner and the furnace fired conventionally air fuel regenerative on the third port. In the third phase, Port #3 firing was replaced with energy in the already installed roof-mounted oxy-fuel burners. The furnace capacity was increased from 55 to 85 tons per day with reduced energy input from 23.5 mm BTU/hr to 18 mm BTU/hr. The furnace was re-converted to air fuel firing in incremental stages. This example demonstrates the ability to selectively boost an existing air fuel furnace as well as to provide total heat input for a glass furnace from roof-mounted oxy-fuel burners. The process does not require water-cooled burners.

Example 2. Burner and burner block with integral oxygen staging.

An oxy-fuel burner provided with integral staging of oxygen, by means of the burner configuration or the burner in combination with the burner block, has been shown to provide increased heat transfer and reduced NOx. According to the present invention, at least one of this type of integrally staged burner 103 is provided in the roof 111 of a glass melting furnace 110. The burner 103 is ideally positioned over the raw batch materials 130 and is preferably angled such that the angle alpha (α in FIG. 6) equals about 91° to about 135° in the direction of the glass flow 104 in the furnace.

Example 3. A burner and burner block with external oxygen staging.

Referring to FIG. 7, it has been shown that a burner 122 with burner block 121 mounted in the roof of a glass melting furnace 111 with 2-8 oxygen injectors 112 external to the burner 122 and block 121 can produce higher heat transfer than a non-staged burner. The burner 122 is preferably angled from about 91° to about 135° relative to the surface of the glass and in the direction of the glass flow in the furnace. According to this example, 0% to about 90% of the stoichiometric combustion oxygen is injected through the primary oxygen burner 133, and the remaining 100% to about 10% secondary combustion oxygen 134 is injected through the oxygen injectors 112, which are angled from about 0° to about 90° relative to the surface of the glass. As it can be appreciated by one skilled in the art, the number, angle and amount of staging ports is designed specifically for each furnace, in order to delay the combustion of the fuel 145 until it impinges on or near the surface of the raw glass batch materials.

Example 4. Inter-burner staging between at least two roof mounted burners.

The staging of combustion utilizing oxy-fuel burners can be accomplished according to the invention by inter-burner staging, between at least two roof mounted burners. One of the burners is operated at sub-stoichiometric levels, that is, in a fuel-rich mode, and the second or additional burner(s) is run with the balance of the oxygen required for complete combustion, that is, in a fuel-lean mode. Experimentation was conducted on the boosting of a conventional air fuel regenerative glass furnace 110, where two of the rear burners 162 were operated in a fuel lean mode, while the upstream, roof mounted oxy-fuel burner 161 was operated in a fuel rich mode. (FIG. 8). This mode of operation produced an oxy-fuel lean zone, adjacent to an oxy-fuel rich zone, followed by an air-fuel lean zone. The result of operating the glass furnace according to this method was to increase furnace capacity while reducing the emissions of oxides of nitrogen on a per ton basis.

This method of inter-burner staging can also be applied in conjunction with the two previously detailed staged combustion embodiments.

Example 5. Staging combustion in a glass melting furnace with oxygen bubblers.

One method of staging combustion according to the invention involves the use of oxygen bubblers in conjunction with at least one roof mounted burner (FIG. 9). Oxygen bubbling has been used for several glass manufacturing applications, such as to mechanically promote the convection currents within the molten glass. Oxygen is soluble in glass, and under normal operating conditions only a small amount (less than 5% of stoichiometric) of oxygen is injected into the glass. By positioning at least one roof mounted oxy-fuel burner 105 above a single oxygen bubbler 108, or a row or bundle of bubblers, it is possible to operate the roof mounted oxy-fuel burner(s) 105 under stoichiometric or sub-stoichiometric conditions, and supply the remainder of combustion oxygen 134 via bubblers 108 located in the floor 107 of the glass melter 110. This enhances the availability of oxygen at the glass 131 surface for secondary combustion of fuel or partially oxidized combustion products or reactive intermediates.

Example 6. Oxy-Oil Burners.

Conventional oil and oxygen oil burners for glass melting furnaces rely on the combustion of oil drops which have been atomized by either twin fluid atomizers (using steam or compressed gas) or mechanical atomizers (using either pressure or rotational energy). The flame shape is governed by the thrust of the spray and the size of the droplets. Conventional oxy-oil burners would release a high proportion of the heat in the near roof position.

As shown in FIG. 10, in this oxy-oil burner design, the majority of the combustion oxygen (greater than about 60%) is injected by at least 2 nozzles 136, or a plurality of nozzles up to a concentric ring set apart from, yet substantially surrounding the oil stream 137, to a point beyond the initial non

and the results are shown in Table 1. The results show that the model is able to predict the results of the experiment with a high degree of accuracy. The model is able to predict the results of the experiment with a high degree of accuracy.

There is a small amount of water in the air, and it is not very much.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
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One finding of this study is that the majority of the respondents are male, which is consistent with the literature.

...the fact that it is the continuation of a tradition...

[illegible]

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

1. The first part of the document is a list of names and titles, including "The Hon. Mr. Justice" and "The Hon. Mr. Justice".

1. 1922-1923 2. 1924-1925 3. 1926-1927 4. 1928-1929 5. 1930-1931 6. 1932-1933 7. 1934-1935 8. 1936-1937 9. 1938-1939 10. 1940-1941 11. 1942-1943 12. 1944-1945 13. 1946-1947 14. 1948-1949 15. 1950-1951 16. 1952-1953 17. 1954-1955 18. 1956-1957 19. 1958-1959 20. 1960-1961 21. 1962-1963 22. 1964-1965 23. 1966-1967 24. 1968-1969 25. 1970-1971 26. 1972-1973 27. 1974-1975 28. 1976-1977 29. 1978-1979 30. 1980-1981 31. 1982-1983 32. 1984-1985 33. 1986-1987 34. 1988-1989 35. 1990-1991 36. 1992-1993 37. 1994-1995 38. 1996-1997 39. 1998-1999 40. 2000-2001 41. 2002-2003 42. 2004-2005 43. 2006-2007 44. 2008-2009 45. 2010-2011 46. 2012-2013 47. 2014-2015 48. 2016-2017 49. 2018-2019 50. 2020-2021 51. 2022-2023 52. 2024-2025 53. 2026-2027 54. 2028-2029 55. 2030-2031 56. 2032-2033 57. 2034-2035 58. 2036-2037 59. 2038-2039 60. 2040-2041 61. 2042-2043 62. 2044-2045 63. 2046-2047 64. 2048-2049 65. 2050-2051 66. 2052-2053 67. 2054-2055 68. 2056-2057 69. 2058-2059 70. 2060-2061 71. 2062-2063 72. 2064-2065 73. 2066-2067 74. 2068-2069 75. 2070-2071 76. 2072-2073 77. 2074-2075 78. 2076-2077 79. 2078-2079 80. 2080-2081 81. 2082-2083 82. 2084-2085 83. 2086-2087 84. 2088-2089 85. 2090-2091 86. 2092-2093 87. 2094-2095 88. 2096-2097 89. 2098-2099 90. 2100-2101 91. 2102-2103 92. 2104-2105 93. 2106-2107 94. 2108-2109 95. 2110-2111 96. 2112-2113 97. 2114-2115 98. 2116-2117 99. 2118-2119 100. 2120-2121 101. 2122-2123 102. 2124-2125 103. 2126-2127 104. 2128-2129 105. 2130-2131 106. 2132-2133 107. 2134-2135 108. 2136-2137 109. 2138-2139 110. 2140-2141 111. 2142-2143 112. 2144-2145 113. 2146-2147 114. 2148-2149 115. 2150-2151 116. 2152-2153 117. 2154-2155 118. 2156-2157 119. 2158-2159 120. 2160-2161 121. 2162-2163 122. 2164-2165 123. 2166-2167 124. 2168-2169 125. 2170-2171 126. 2172-2173 127. 2174-2175 128. 2176-2177 129. 2178-2179 130. 2180-2181 131. 2182-2183 132. 2184-2185 133. 2186-2187 134. 2188-2189 135. 2190-2191 136. 2192-2193 137. 2194-2195 138. 2196-2197 139. 2198-2199 140. 2200-2201 141. 2202-2203 142. 2204-2205 143. 2206-2207 144. 2208-2209 145. 2210-2211 146. 2212-2213 147. 2214-2215 148. 2216-2217 149. 2218-2219 150. 2220-2221 151. 2222-2223 152. 2224-2225 153. 2226-2227 154. 2228-2229 155. 2230-2231 156. 2232-2233 157. 2234-2235 158. 2236-2237 159. 2238-2239 160. 2240-2241 161. 2242-2243 162. 2244-2245 163. 2246-2247 164. 2248-2249 165. 2250-2251 166. 2252-2253 167. 2254-2255 168. 2256-2257 169. 2258-2259 170. 2260-2261 171. 2262-2263 172. 2264-2265 173. 2266-2267 174. 2268-2269 175. 2270-2271 176. 2272-2273 177. 2274-2275 178. 2276-2277 179. 2278-2279 180. 2280-2281 181. 2282-2283 182. 2284-2285 183. 2286-2287 184. 2288-2289 185. 2290-2291 186. 2292-2293 187. 2294-2295 188. 2296-2297 189. 2298-2299 190. 2300-2301 191. 2302-2303 192. 2304-2305 193. 2306-2307 194. 2308-2309 195. 2310-2311 196. 2312-2313 197. 2314-2315 198. 2316-2317 199. 2318-2319 200. 2320-2321 201. 2322-2323 202. 2324-2325 203. 2326-2327 204. 2328-2329 205. 2330-2331 206. 2332-2333 207. 2334-2335 208. 2336-2337 209. 2338-2339 210. 2340-2341 211. 2342-2343 212. 2344-2345 213. 2346-2347 214. 2348-2349 215. 2350-2351 216. 2352-2353 217. 2354-2355 218. 2356-2357 219. 2358-2359 220. 2360-2361 221. 2362-2363 222. 2364-2365 223. 2366-2367 224. 2368-2369 225. 2370-2371 226. 2372-2373 227. 2374-2375 228. 2376-2377 229. 2378-2379 230. 2380-2381 231. 2382-2383 232. 2384-2385 233. 2386-2387 234. 2388-2389 235. 2390-2391 236. 2392-2393 237. 2394-2395 238. 2396-2397 239. 2398-2399 240. 2400-2401 241. 2402-2403 242. 2404-2405 243. 2406-2407 244. 2408-2409 245. 2410-2411 246. 2412-2413 247. 2414-2415 248. 2416-2417 249. 2418-2419 250. 2420-2421 251. 2422-2423 252. 2424-2425 253. 2426-2427 254. 2428-2429 255. 2430-2431 256. 2432-2433 257. 2434-2435 258. 2436-2437 259. 2438-2439 260. 2440-2441 261. 2442-2443 262. 2444-2445 263. 2446-2447 264. 2448-2449 265. 2450-2451 266. 2452-2453 267. 2454-2455 268. 2456-2457 269. 2458-2459 270. 2460-2461 271. 2462-2463 272. 2464-2465 273. 2466-2467 274. 2468-2469 275. 2470-2471 276. 2472-2473 277. 2474-2475 278. 2476-2477 279. 2478-2479 280. 2480-2481 28

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1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

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1. The first step in the process is to identify the problem or issue that needs to be addressed. This involves gathering information and understanding the context of the problem.

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and the Bureau is advised of the results of the investigation.

method to give the impression of a solid and reliable source of information.

...the foot was not out of the air to the ground, but it was a matter of time.

12-10-1964

...dalam rangka meningkatkan kualitas pelayanan kesehatan masyarakat...

... et tous les autres ont été mis à la disposition de la Commission.

... ..

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[illegible]

Age Group	1970	1980	1990	2000	2010	2020
0-14	20	18	15	12	10	10
15-24	15	14	13	12	11	10
25-34	12	11	10	9	8	7
35-44	10	9	8	7	6	5
45-54	8	7	6	5	4	3
55-64	6	5	4	3	2	1
65-74	4	3	2	1	1	2
75+	5	6	7	8	10	20

[illegible]

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visible combustion zone of the oil spray. The centerline of these nozzles is preferably angled about 45° to about 101° from the horizontal. This staging of the oxygen produces reactive intermediate species, such as described hereinabove, and delays complete combustion until it impinges on or near the raw batch materials. The remaining oxygen can be injected immediately adjacent and concentric to the oil stream 137, such as via the atomizing medium 138, via an additional concentric oxygen tube (not shown), or by tertiary injection in the furnace such as by an oxygen lance (not shown), to achieve complete combustion. This oxy-oil, staged, roof mounted burner minimizes heat release to the roof while maximizing heat transfer to the raw batch, due to the additional convective heat transfer on the surface. The burner may be cooled by a water jacket having an inlet 139 and an outlet 140.

An oil atomizer commonly used in the glass industry for conventional melting has been shown, by measurements made of the oil droplet particle size from this atomizer using Laser Doppler Annemometry, to produce a mean particle diameter of about 50 microns ($50 \times 10E-06m$) when atomized with compressed air.

We have found that in this and in other series of burners, the combustion of the oil spray is delayed until the oil meets the oxygen stream. A visible "no flame" can be witnessed at up to 18 inches from the atomizer tip. During this non-visible combustion phase in the hot glass melting furnace, the oil particle size is reduced due to endothermic evaporation. When utilized in a roof mounted burner, this endothermic reaction absorbs radiative heat energy from the surrounding environment, and advantageously reduces the net radiative heat transfer to the furnace roof.

The present invention includes the use of an atomizer that produces a significantly higher particle size, of greater than about 100 microns ($100 \times 10E-06m$). Less energy is required to produce this larger particle, and as a result, the thrust of the flame is reduced. The partially atomized large oil droplets free-fall from the roof-mounted burner, and at least partially evaporate in the endothermic, non visible combustion zone adjacent to the roof.

140
160

The maximum velocity of combustion reactants and products at the surface of the raw batch, however, should be less than 30 m/s to avoid air borne movement of raw batch materials.

5 Because a gas (such as oxygen) free jet expands about 11°, an oxygen outlet positioned close to a fuel outlet will cause oxygen to impinge on the fuel jet close to the outlet point. It is therefore preferred that staging of oxygen, and hence combustion, be accomplished by angling the oxygen outlets from about 45° convergent to the axis of the fuel stream to about 11° divergent from the axis of the fuel stream. This can be accomplished with externally staged
10 burners, as well as with integrally staged burners where the oxygen outlets are provided in the burner block.

It is possible to further reduce the radiative losses from oxy-oil flames by altering the mechanisms that can lead to extremely radiative carbonaceous species in the flame. Two common processes leading to the formation of these
15 species are liquid phase cracking and reformation of the less volatile components in the oil droplets and gaseous phase condensation reactions leading to soot formation. The former mechanism is exacerbated by large droplet sizes and the presence of aromatic compounds e.g. asphaltenes. The second mechanism is promoted in high temperatures and fuel rich regions
20 where partially saturated gaseous phase reactants, e.g. acetylene, can react via a multitude of reaction paths to eventually form aromatic networks and eventually solid soot.

In one embodiment, the present invention preferably utilizes a high degree of atomization to produce small oil droplets, on the order of about 5 to
25 about 50 microns, preferably about 10 to about 50 microns, so that the time spent in the liquid phase is short. Thus, liquid phase cracking is minimized and any resultant solid carbonaceous residue is finely divided and will thus be oxidized more readily by its increased surface area. Rapid mixing with an atomizing medium in the initial burner region, such as by inducing a relative
30 velocity difference between the fuel atomizing and oxidant streams to increase the rate of shear in the gaseous phase, rapidly dilutes the fuel rich regions surrounding each oil droplet, thus creating a more substantially homogeneous mixture overall of vaporized fuel droplets, oxidant, atomizing medium and

partial combustion products. Reactions of the fuel vapor with an oxidizing atomizing medium creates a partially precombusted mixture which is less prone to sooting. The amount of atomizing medium introduced in the initial region of the flame is very much dependent on the sooting nature of the fuel itself, which is a strong function of its chemical make up.

It is known that as a broad rule the degree of sooting that occurs is related to the C:H ratio of the oil, with a much reduced tendency to soot at greater H concentrations. However the trend becomes extremely erratic as the aromaticity of the fuel increases e.g. naphthas are extremely prone to sooting. Thus the atomizing medium itself can be advantageously chosen to reduce the sooting tendency via alteration of the C:H ratio. Atomizing mediums useful in countering the sooting tendency include air, oxygen, steam, natural gas and hydrogen or a mixture thereof. The first two have a purely oxidizing effect, the last two have the effect of altering the C:H ratio in the fuel vapor/atomization medium mixture in the near burner region so that sooting conditions are avoided. Steam has a combined effect, and coupled with radiative heating from the main flame and/or furnace, causes gasification reactions to occur, yielding CO and H₂ for further reaction.

Following the initial near burner region, the original liquid fuel stream becomes essentially a gaseous fuel stream, and interacts with surrounding secondary oxygen streams in the same manner as experienced with use of the staged gas burners discussed above.

Example 7. Fuel Staged Oxy Fuel Burner.

An oxy-fuel burner 150 shown schematically in FIG. 11 was designed for use in roof mounted glass melting furnace applications, using fuel staged principles, from one outer oxidant (oxygen) injector and two inner fuel injectors; one central fuel injector being adapted for high velocity injection and one annular fuel injector being adapted for low velocity injection. The injectors preferably comprise at least three concentric tubes. Burner flame length and oxidant-fuel mixing is controlled by a central high pressure fuel jet 142, which is supplied through tube walls 152 from the first fuel feed 147,

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utilizing about 10-90% of the fuel stream. This high velocity, high momentum flow governs the flame shape and the mixing, rather than the lower momentum fuel gas shroud 143. This gas flow is also higher than that of the oxygen flow, in order to control the mixing. The remaining fuel 143 (about 90-10%) is supplied from the second fuel feed 148 concentrically through at least one annular fuel injector formed by tube walls 152 and tube walls 153, with the combustion oxygen 141 being supplied from the oxygen feed 146 via an outer annular injector formed by tube walls 151 and tube walls 153. Sizing of the central high pressure injector governs the rate of mixing due to the high momentum of the jet. The central jet is staged due to the shrouding of the secondary gas streams. This arrangement provides a means of propelling the fuel gas, such as natural gas, and allowing the fuel gas to interact with raw batch and oxygen in a staged manner near the batch surface in a glass furnace application. Optionally, the central high velocity jet may have a lower mass than the low velocity fuel jet, as long as the momentum of the central jet is higher.

In one embodiment, the high velocity central jet may comprise a liquid fuel supplied by a liquid fuel burner, such as an oil burner, rather than a gaseous fuel, and the lower velocity fuel shroud may comprise a gaseous fuel.

The patents and documents described herein are hereby incorporated by reference.

Although the invention has been described in detail with reference to certain specific embodiments, those skilled in the art will recognize that there are other embodiments within the spirit and scope of the claims. It should therefore be appreciated that the present invention is not limited to the specific embodiments described above, but includes variations, modifications and equivalent embodiments defined by the following claims.

We claim:

1. A method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:
- 5
- providing at least one oxy-fuel burner in the roof of said furnace over said batch material, wherein said at least one oxy-fuel burner is adapted for staged combustion;
- 10
- providing a flow of fuel to said at least one oxy-fuel burner,
- providing a flow of gaseous oxidant in association with said at least one oxy-fuel burner;
- injecting the fuel and the oxidant into the furnace; and,
- 15
- combusting said fuel from at least said one oxy-fuel burner such that at least a portion of combustion is effected in the vicinity of said glass forming material to enhance convective and radiative transfer of heat to said glass forming material without substantially disturbing said glass forming material.
- 20
2. The method of claim 1 wherein the mixing of said fuel and said oxidant is delayed to localize combustion proximate to or at the surface of said glass forming material.
3. The method of claim 1 wherein the injected fuel jet and the injected oxidant jet are separated, and are optionally angled with respect to the other, by an amount sufficient to cause the respective flows to converge proximate to or at the surface of the glass forming material.
- 25
4. The method of claim 3 wherein the fuel jet comprises one of a substantially fuel only jet and a fuel rich fuel-oxidant mixture, and wherein the
- 30

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oxidant jet comprises one of a substantially oxidant only jet and a fuel lean fuel-oxidant mixture.

5 5. The method of claim 4 wherein the fuel jet and oxidant jet are separated and angled with respect to each other from 0° to about 90°.

6. The method of claim 1 wherein oxidant is bubbled from beneath the glass forming material surface.

10 7. The method of claim 1 including fully combusting reactive intermediate species proximate to or at the glass forming material surface.

15 8. The method of claim 1 wherein the oxy-fuel burner is contained in a burner block, further wherein said providing a flow of gaseous oxidant comprises providing integral staging of said oxidant via injection from the same oxy-fuel burner block.

20 9. The method of claim 1 wherein the oxy-fuel burner is contained in a burner block, further wherein said providing a flow of gaseous oxidant comprises providing external staging of said oxidant via injection separate from the oxy-fuel burner block.

25 10. The method of claim 9 further comprising providing at least one secondary oxidant injector in the roof of said furnace to provide additional oxidant for completing combustion proximate to or at the surface of said glass forming material.

30 11. The method of claim 9 including injecting from 0 to 90% of stoichiometric oxidant through the oxy-fuel burner block and injecting from 100% to about 10% stoichiometric oxidant via at least one secondary oxidant injector separate from the oxy-fuel burner block.

5 12. The method of claim 1 wherein the glass forming material enters the furnace through at least one charger, including providing the at least one oxy-fuel burner in the roof of the furnace proximate to the at least one charger above the glass forming material.

13. The method of claim 1 wherein the burner is mounted substantially perpendicular to the surface of the glass forming material.

10 14. The method of claim 13 wherein the burner is mounted up to 45 degrees away from the perpendicular and toward the downstream front wall of the furnace.

15 15. The method of claim 13 wherein the burner is mounted not more than 10 degrees from the perpendicular and toward the downstream front wall of the furnace.

20 16. The method of claim 1 wherein the oxidant is selected from the group consisting of oxygen-enriched air, non-pure oxygen and "industrially" pure oxygen.

17 The method of claim 1, including staging the flow of fuel from the oxy-fuel burner.

25 18. The method of claim 1 wherein the fuel is a gas selected from the group consisting of methane, natural gas, liquefied natural gas, propane, liquefied propane gas, butane, low BTU gases, town gas, producer gas and mixtures thereof.

19. The method of claim 1 wherein the fuel is a liquid selected from the group consisting of heavy fuel oil, medium fuel oil, light fuel oil, kerosene and diesel.

5 20. The method of claim 1 wherein at least one oxy-fuel burner is provided in the roof proximate the downstream front wall.

10 21. The method of claim 1 wherein the glass forming material comprises material selected from the group consisting of cullet, silica, feldspar, nepheline syenite, limestone, dolomite, soda ash, potash, borax, kaolin clay, alumina, arsenic, antimony, sulfates, sulfides, carbon, barium oxide, strontium oxide, zirconium oxide, lead oxide, color forming metal oxides, and mixtures thereof.

15 22. The method of claim 1 including providing all furnace burners as oxy-fuel burners.

20 23. The method of claim 1 including providing all furnace burners as roof mounted burners.

24. The method of claim 1 including operating at least one said roof mounted oxy-fuel burner in a fuel rich mode and at least one said roof mounted oxy-fuel burner in a fuel lean mode.

25 25. A method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:

30 providing at least one oxy-fuel burner in the roof of said furnace over said batch material;

providing a flow of liquid fuel to said at least one oxy-fuel burner;
 providing a flow of gaseous oxidant in association with said at least
 one oxy-fuel burner;
 injecting the fuel and the gaseous oxidant into the furnace; and,
 combusting said fuel.

5

26. The method of claim 25 wherein said at least one oxy-fuel burner is
 adapted for staged combustion, including:

10

combusting said fuel from at least said one oxy-fuel burner such that
 at least a portion of combustion is effected in the vicinity of said glass forming
 material to enhance convective and radiative transfer of heat to said glass
 forming material without substantially disturbing said glass forming material.

15

27. The method of claim 26 wherein the oxy-fuel burner is contained in
 a burner block, further wherein said injecting the gaseous oxidant comprises
 providing integral staging of said oxidant via injection from the same oxy-fuel
 burner block.

20

28. The method of claim 26 wherein the oxy-fuel burner is contained in
 a burner block, further wherein said injecting the gaseous oxidant comprises
 providing external staging of said oxidant via injection separate from the oxy-
 fuel burner block.

25

29. The method of claim 26 further comprising the step of mounting at
 least one oxygen injector in the roof of said furnace to provide additional
 oxygen to complete combustion at or near the surface of said batch material.

30

30. The method of claim 26 comprising injecting a majority of oxidant
 set apart from and substantially surrounding the liquid fuel flow to a point
 beyond the initial non visible combustion zone.

31. The method of claim 30 including angling the injected fuel and the injected oxidant about 45° to about 101° from the horizontal.

5 32. The method of claim 30 including injecting the remainder of the oxidant adjacent to and concentric to the injected fuel.

33. The method of claim 30 including injecting the remainder of the oxidant by tertiary injection into the furnace.

10 34. The method of claim 26 including staging the flow of the fuel from the oxy-fuel burner.

15 35. The method of claim 25 wherein the liquid fuel is selected from the group consisting of heavy fuel oil, medium fuel oil, light fuel oil, kerosene and diesel.

36. The method of claim 35 wherein the injected liquid fuel has a droplet size of greater than about 100 microns.

20 37. The method of claim 25 wherein the burner is mounted substantially perpendicular to the surface of the batch material.

25 38. The method of claim 25 wherein the burner is mounted up to 45 degrees away from the perpendicular and toward the downstream front wall of the furnace.

30 39. The method of claim 25 wherein the burner is mounted not more than 10 degrees from the perpendicular and toward the downstream front wall of the furnace.

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40. The method of claim 25 including atomizing the liquid fuel to produce droplets in the range of about 5 microns to about 50 microns.

41. The method of claim 40 including rapidly mixing the droplets with an atomizing medium in the initial burner region to form a substantially homogeneous mixture.

42. The method of claim 40 including atomizing the liquid fuel with an oxidizing atomizing medium to produce a partially pre-combusted mixture.

43. The method of claim 40 including atomizing the liquid fuel with an atomizing medium selected from the group consisting of air, oxygen, steam, natural gas and hydrogen or mixtures thereof to reduce the C:H ratio in the fuel/atomizing medium mixture.

44. A method of melting glass forming material in a glass melting furnace, said furnace having a back wall, breastwalls above sidewalls, and a downstream end front wall connected to a roof, wherein at least one batch charger for charging glass forming batch material is contained in at least one of the back wall and the sidewall, comprising:

providing at least one oxy-fuel burner in the roof of said furnace over said batch material, wherein said at least one oxy-fuel burner is adapted for fuel staged combustion and contains at least one outer oxidant injector and two inner fuel injectors, the innermost fuel injector being adapted for high velocity fuel injection and the other fuel injector, disposed between the innermost fuel injector and the outer oxidant injector, being adapted for lower velocity fuel injection;

providing a flow of fuel to said at least one oxy-fuel burner, wherein the flow of fuel through the innermost fuel injector has a higher momentum than the flow of fuel through the other fuel injector;

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providing a flow of gaseous oxidant to the outer oxidant injector, having a lower momentum than the flow of fuel through the innermost fuel injector;

combusting said fuel from at least said one oxy-fuel burner such that at least a portion of combustion is effected in the vicinity of said glass forming material to enhance convective and radiative transfer of heat to said glass forming material without substantially disturbing said glass forming material.

45. The method of claim 44 wherein about 10% to about 90% of the fuel flow is utilized by the innermost fuel injector.

46. The method of claim 44 wherein the mass of the fuel flow of the innermost fuel injector is lower than the mass of the fuel flow of the other fuel injector.

47. The method of claim 44 wherein the mass of the fuel flow of the innermost fuel injector is greater than the mass of the fuel flow of the other fuel injector.

48. The method of claim 44 wherein a liquid fuel is provided to the innermost fuel injector, and a gaseous fuel is provided to the other fuel injector.

49. The method of claim 48 wherein the liquid fuel is selected from the group consisting of heavy fuel oil, medium fuel oil, light fuel oil, kerosene and diesel; and the gaseous fuel is selected from the group consisting of methane, natural gas, liquefied natural gas, propane, liquefied propane gas, butane, low BTU gases, town gas, producer gas and mixtures thereof.

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50. The method of claim 44 wherein the fuel is a gas selected from the group consisting of methane, natural gas, liquefied natural gas, propane, liquefied propane gas, butane, low BTU gases, town gas, producer gas and mixtures thereof.

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51. The method of claim 44 wherein the oxidant is selected from the group consisting of oxygen-enriched air, non-pure oxygen and industrially pure oxygen.

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52. An oxy-fuel burner comprising at least one outer oxidant injector and two inner fuel injectors, the innermost fuel injector being adapted for high velocity fuel injection and the other fuel injector being adapted for lower velocity fuel injection.

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53. The oxy-fuel burner of claim 52 wherein the innermost fuel injector is adapted to provide a central high pressure fuel jet; the other fuel injector is adapted to provide a substantially annular lower pressure fuel shroud outwardly concentric to the central fuel jet; and the oxidant injector is adapted to provide a substantially annular oxidant stream outwardly concentric to the fuel shroud; the oxidant stream being provided with a lower momentum than the central fuel jet.

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54. The oxy-fuel burner of claim 52 wherein the fuel injectors are adapted to provide a gaseous fuel.

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55. The oxy-fuel burner of claim 52 wherein the innermost fuel injector is adapted to provide a liquid fuel and the other fuel injector is adapted to provide a gaseous fuel.

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56. A method of melting batch material in a glass furnace having regenerators, recuperators and/or electric boost, said furnace having sidewalls, a back wall, a front wall and a roof comprising:

providing at least one burner in the roof of said furnace over said batch material;

providing a flow of gaseous oxidant to said at least one burner;

providing a flow of gaseous fuel to said at least one burner;

generating a flame from at least said one burner said flame having a velocity sufficient to maximize transfer of heat from said flame to said batch material without substantially disturbing said batch material, and,

providing additional oxygen to complete combustion at or near the surface of said batch material from at least one oxygen injector in the roof of said furnace.

ABSTRACT OF THE DISCLOSURE

5 In an industrial glass furnace, which optionally contains
recuperators, regenerators, electric boost or other devices for providing heat to
glass batch material, at least one staged combustion oxy-fuel burner is
mounted in the roof of the furnace to provide heat to melt the glass batch
material by providing a flow of fuel to the oxy-fuel burner; providing a flow of
gaseous oxidant in association with said the oxy-fuel burner; injecting the fuel
10 and the oxidant into the furnace; and, combusting the fuel such that at least a
portion of combustion is effected in the vicinity of said glass forming material
to enhance convective and radiative transfer of heat to said glass forming
material without substantially disturbing the glass forming material. In one
embodiment, the oxy-fuel burner is adapted for injecting liquid fuels. In
15 another embodiment, the oxy-fuel burner is adapted for fuel staged
combustion and contains at least one outer oxidant injector and two inner fuel
injectors, the innermost fuel injector being adapted for high velocity fuel
injection and the other fuel injector, disposed between the innermost fuel
injector and the outer oxidant injector, being adapted for lower velocity fuel
20 injection.

DECLARATION AND POWER OF ATTORNEY

As below named inventors, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names.

We believe we are the original, first and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER**

including any amendments referred to below,
the specification of which

_____ is attached hereto.

_____ was filed on _____ as Application Serial No. _____ and

was amended on _____.

We hereby state that we have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

			<u>Priority Claimed</u>	
<u>None</u>			<u>Yes</u>	<u>No</u>
Number	Country	Date Filed		

We hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

<u>None</u>	
Provisional Application Number	Filing Date

We hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

09/374,921 August 16, 1999 Pending

Application Ser. No.	Filing Date	Status
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We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As named inventors, we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

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00A412

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178

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00705555-030201

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER

Applicants: Neil George SIMPSON et al
Docket No. 00A412

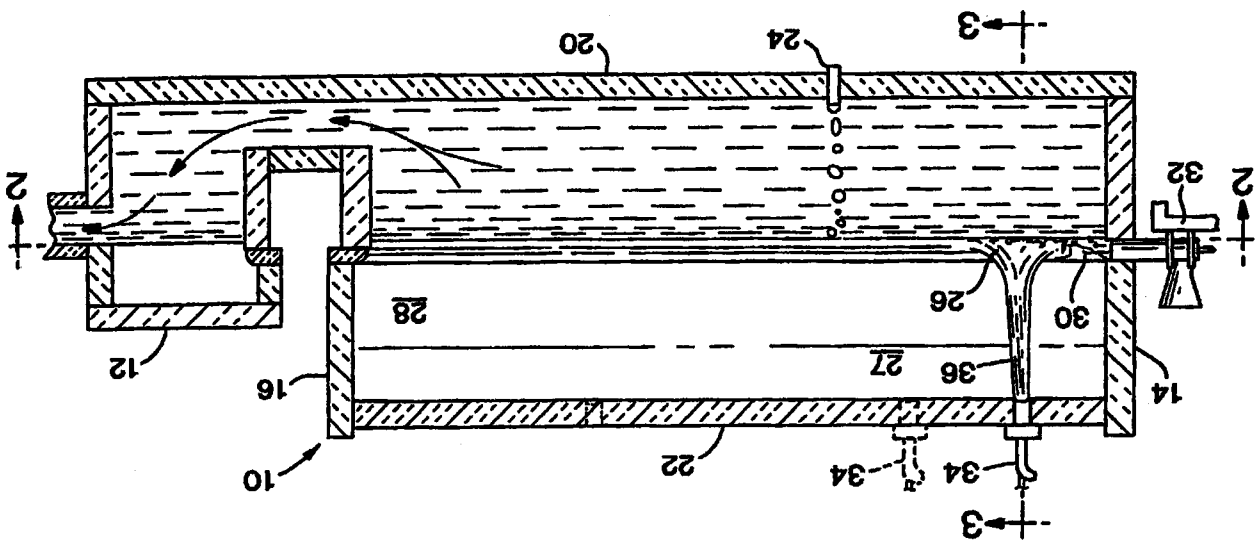


FIG. 1

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER
Applicants: Neil George SIMPSON et al
Docket No. 00A412

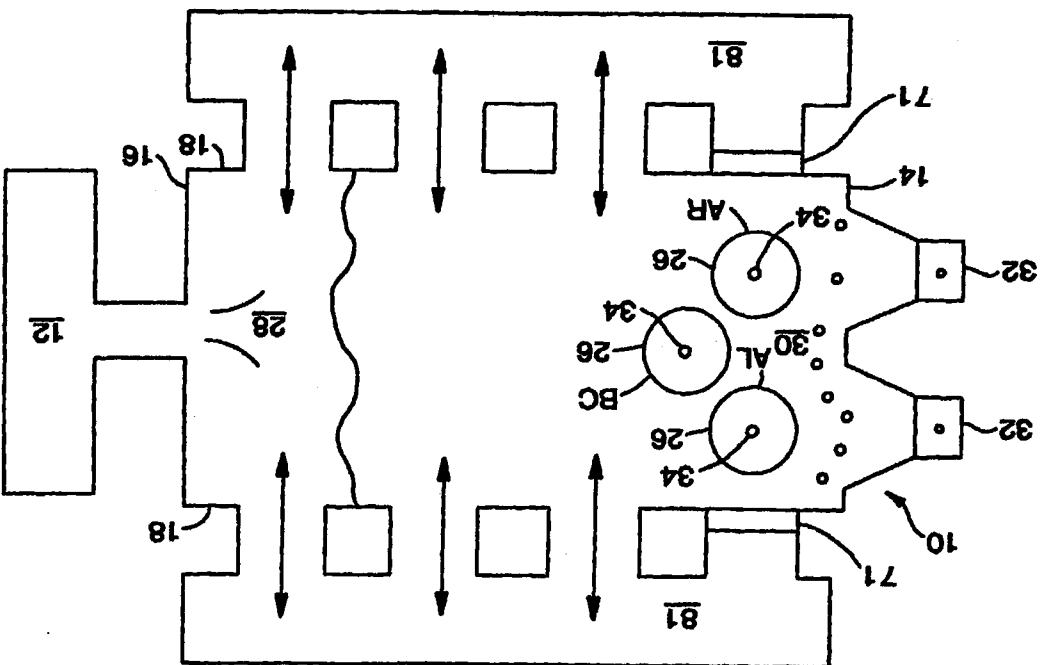


FIG. 2A

SCANNED # 80

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER

Applicant: Neil George SIMPSON & al

Docket No. 004412

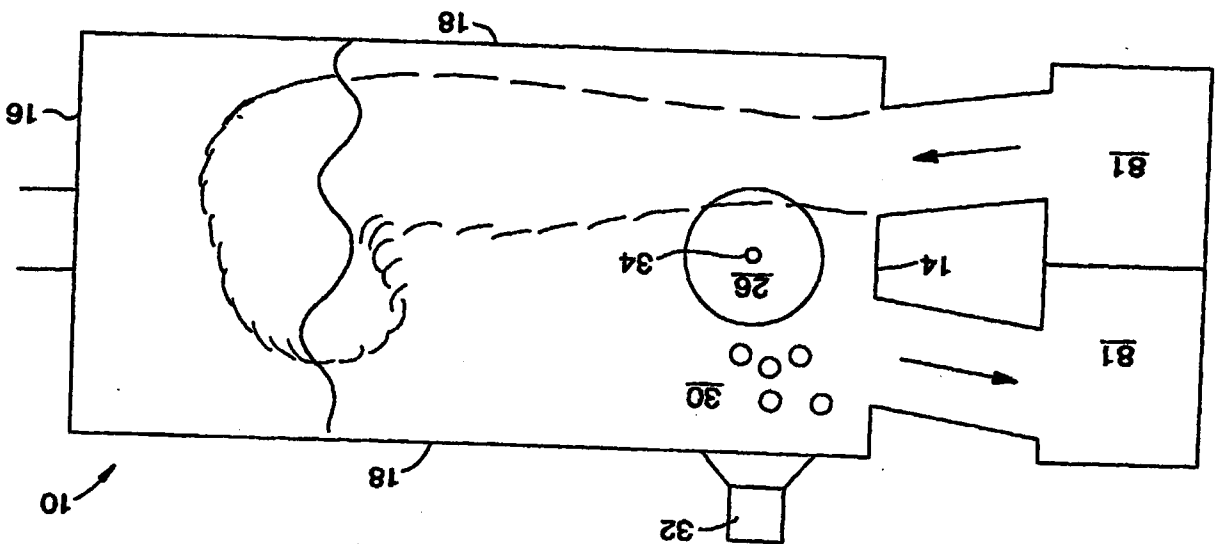


FIG. 2B

SCALED #20

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER

Applicants: Neil George SIMPSON et al
Docket No. 00A412

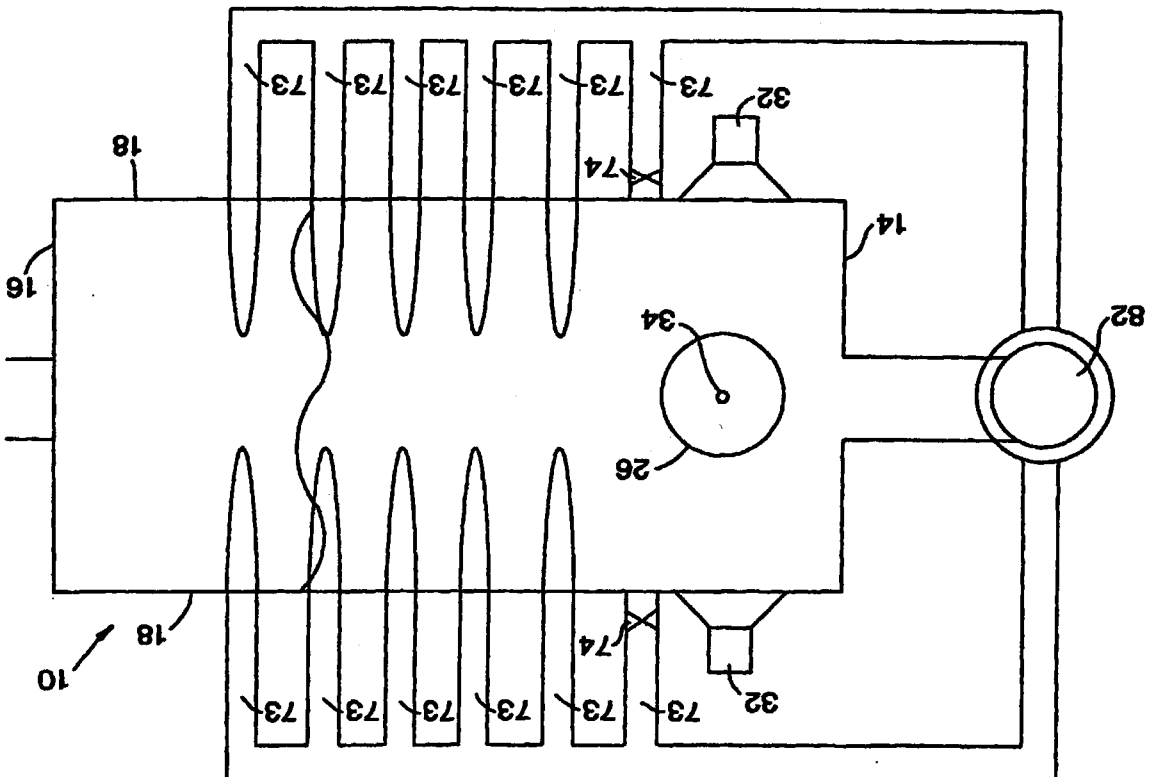


FIG. 2C

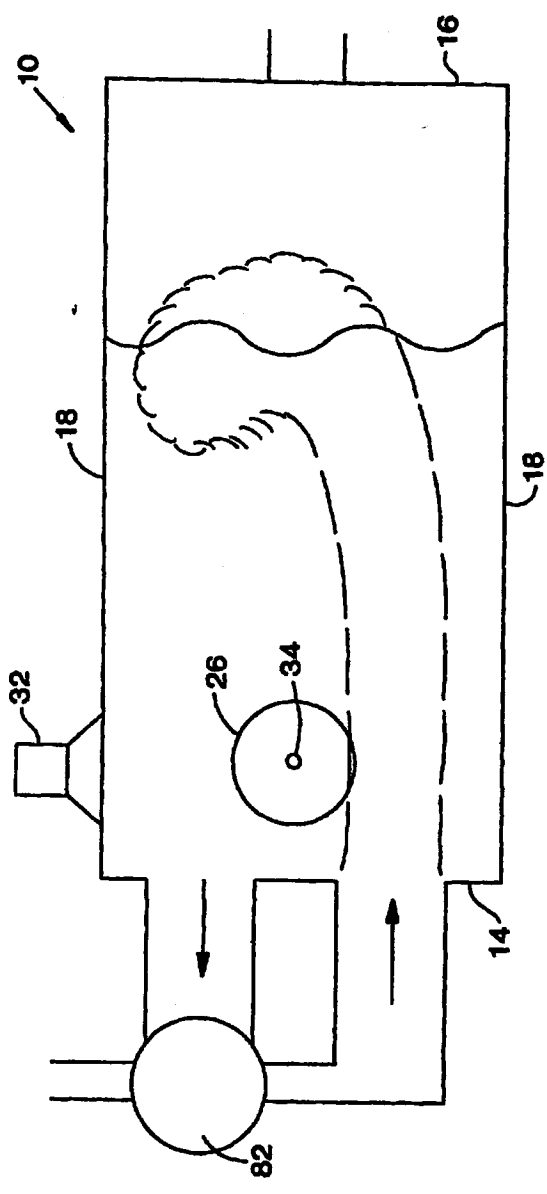


FIG. 2D

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER
Applicants: Neil George SIMPSON et al
Docket No. 00A412

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
 STAGED COMBUSTION OXYGEN-FUEL BURNER
 Applicants: Neil George SIMPSON et al
 Docten No. 004412

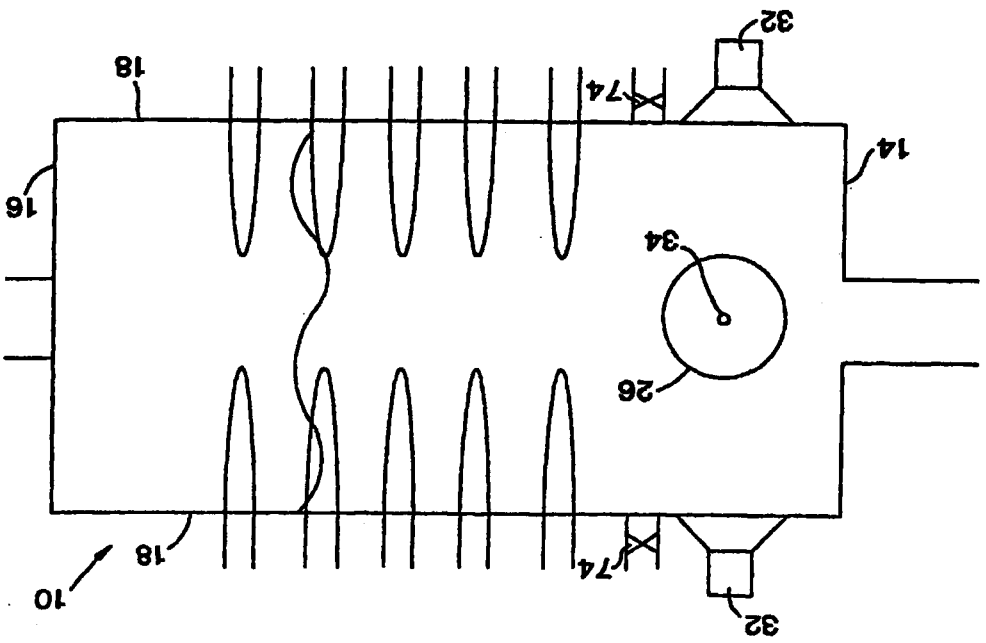


FIG. 2E

SCANNED # 20

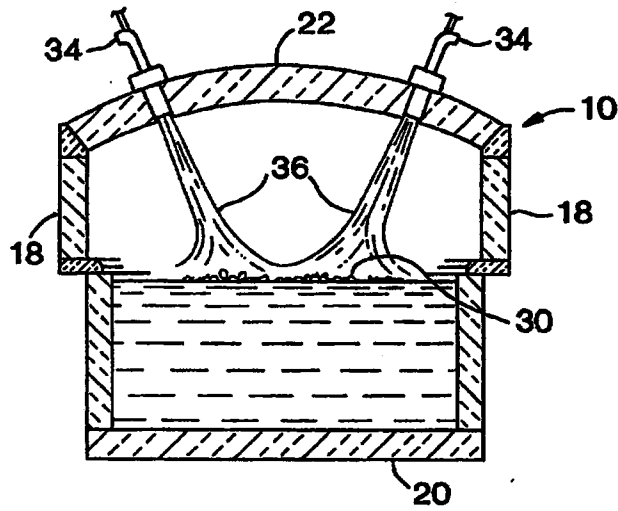


FIG. 3

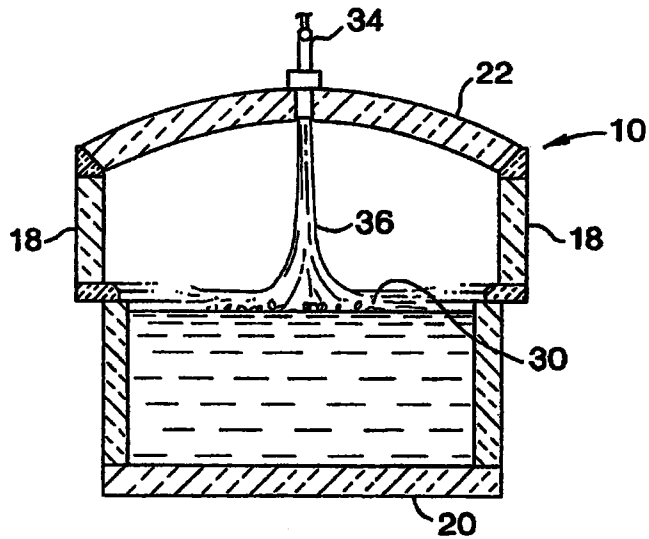


FIG. 4

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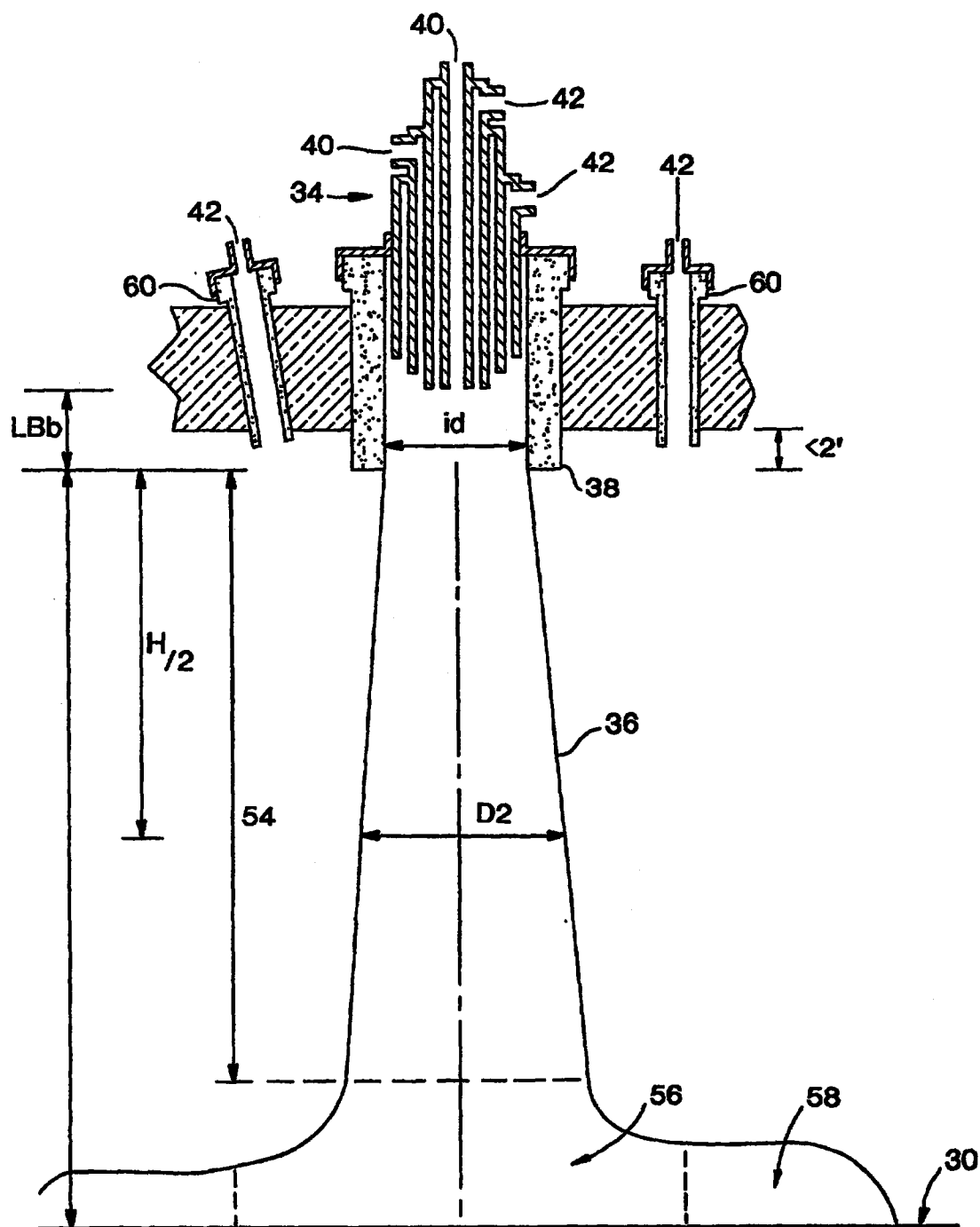


FIG. 5

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
STAGED COMBUSTION OXYGEN-FUEL BURNER
Applicants: Neil George SIMPSON et al
Docket No. 00A412

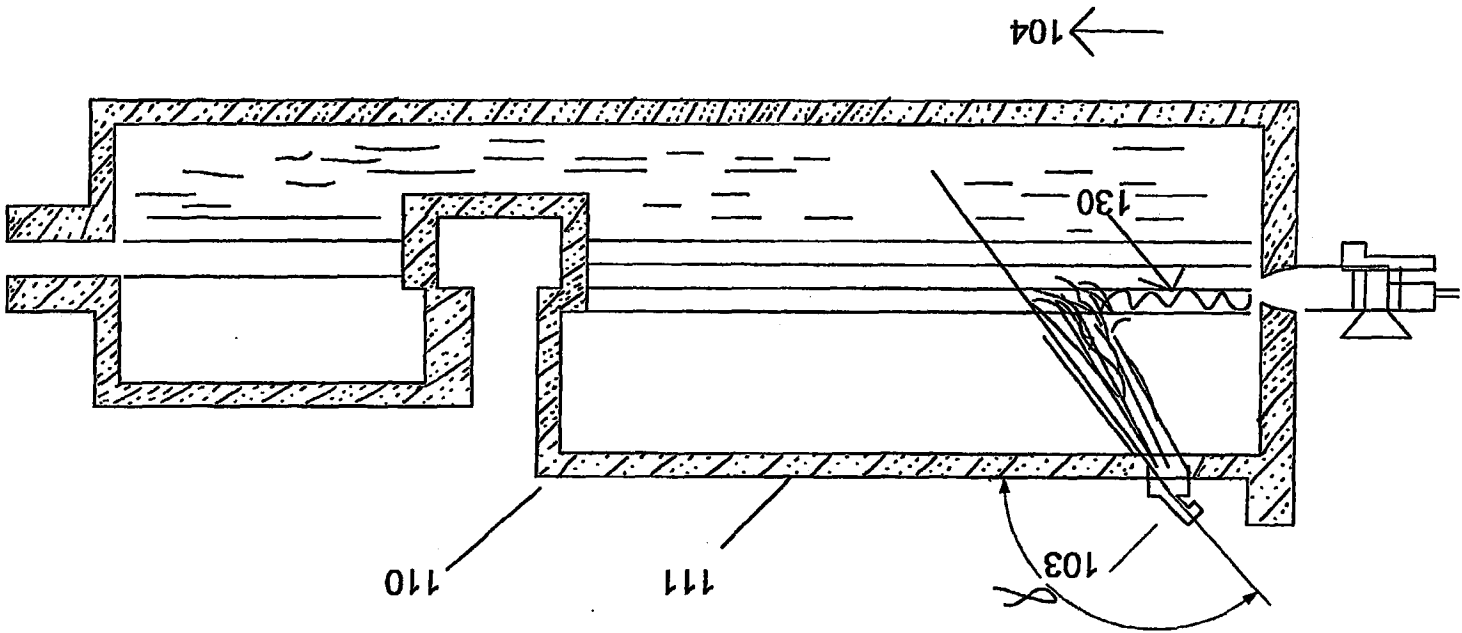


FIG. 6

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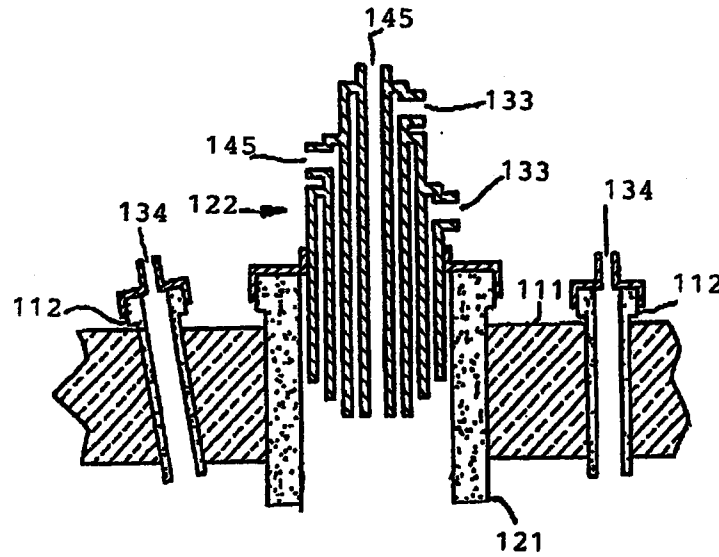


FIG. 7

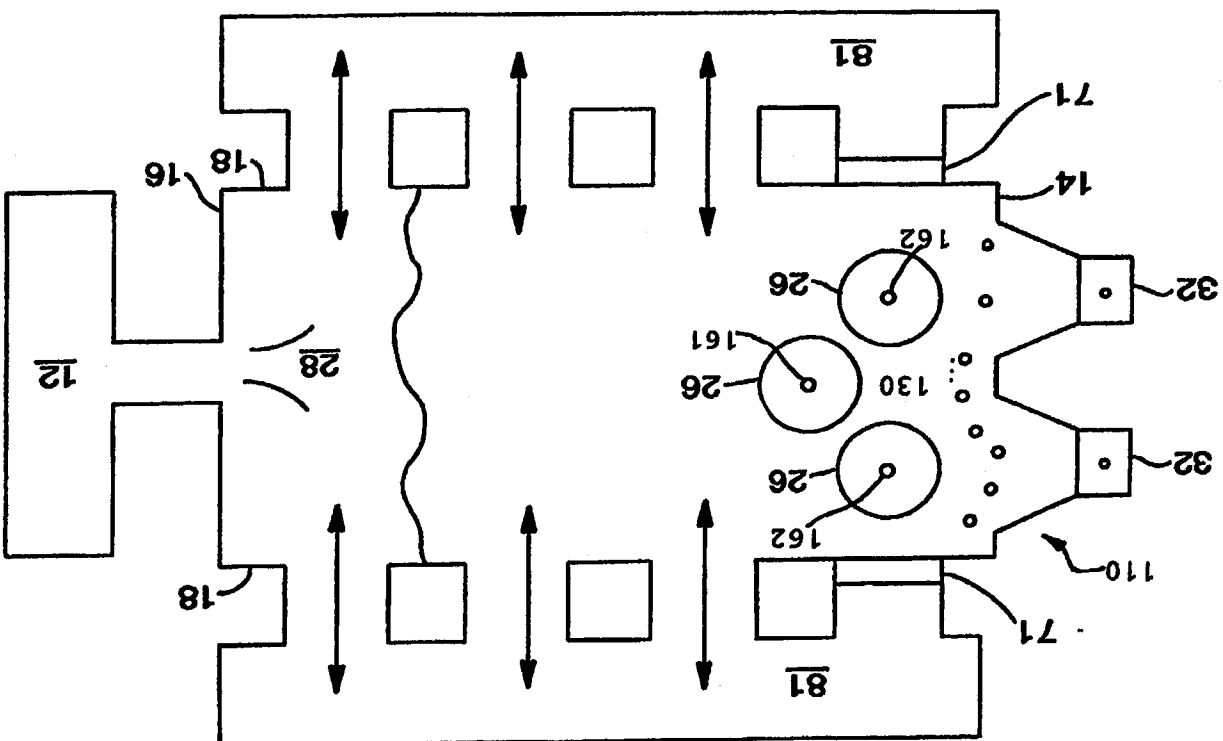


FIG. 8

METHOD OF HEATING A GLASS MELTING FURNACE USING A ROOF MOUNTED,
 STAGED COMBUSTION OXYGEN-FUEL BURNER
 Applicants: Neil George SIMPSON et al
 DocId No. 00A412

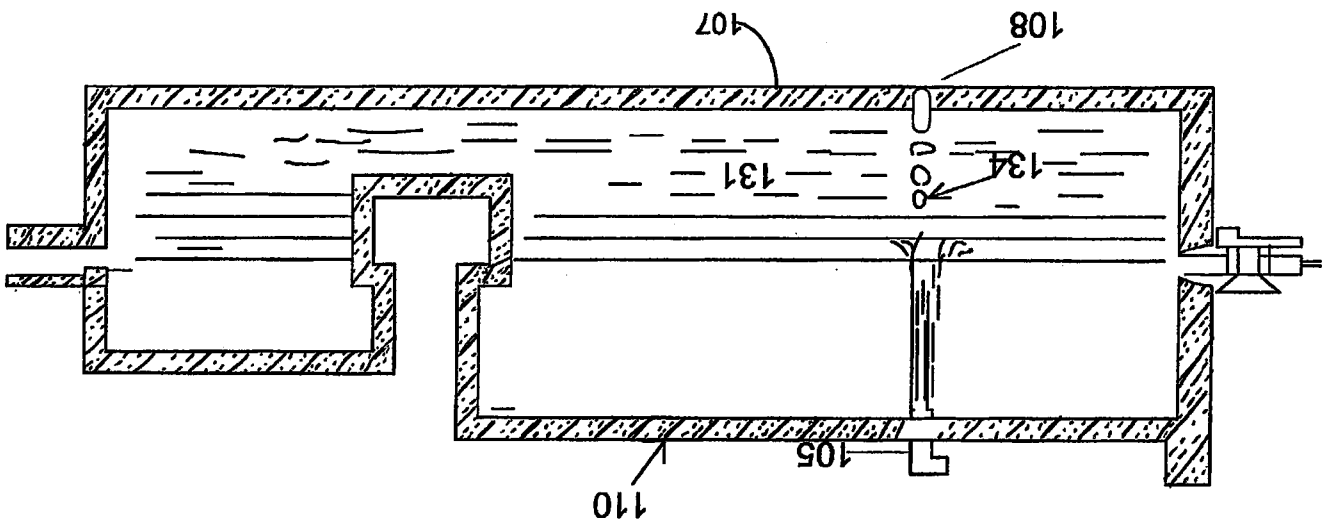
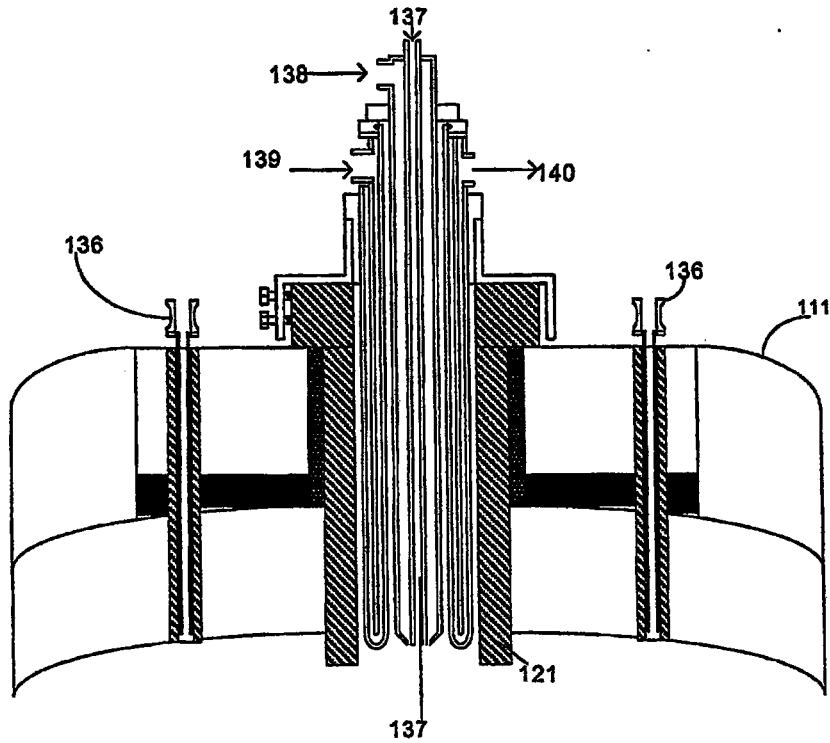


FIG. 9

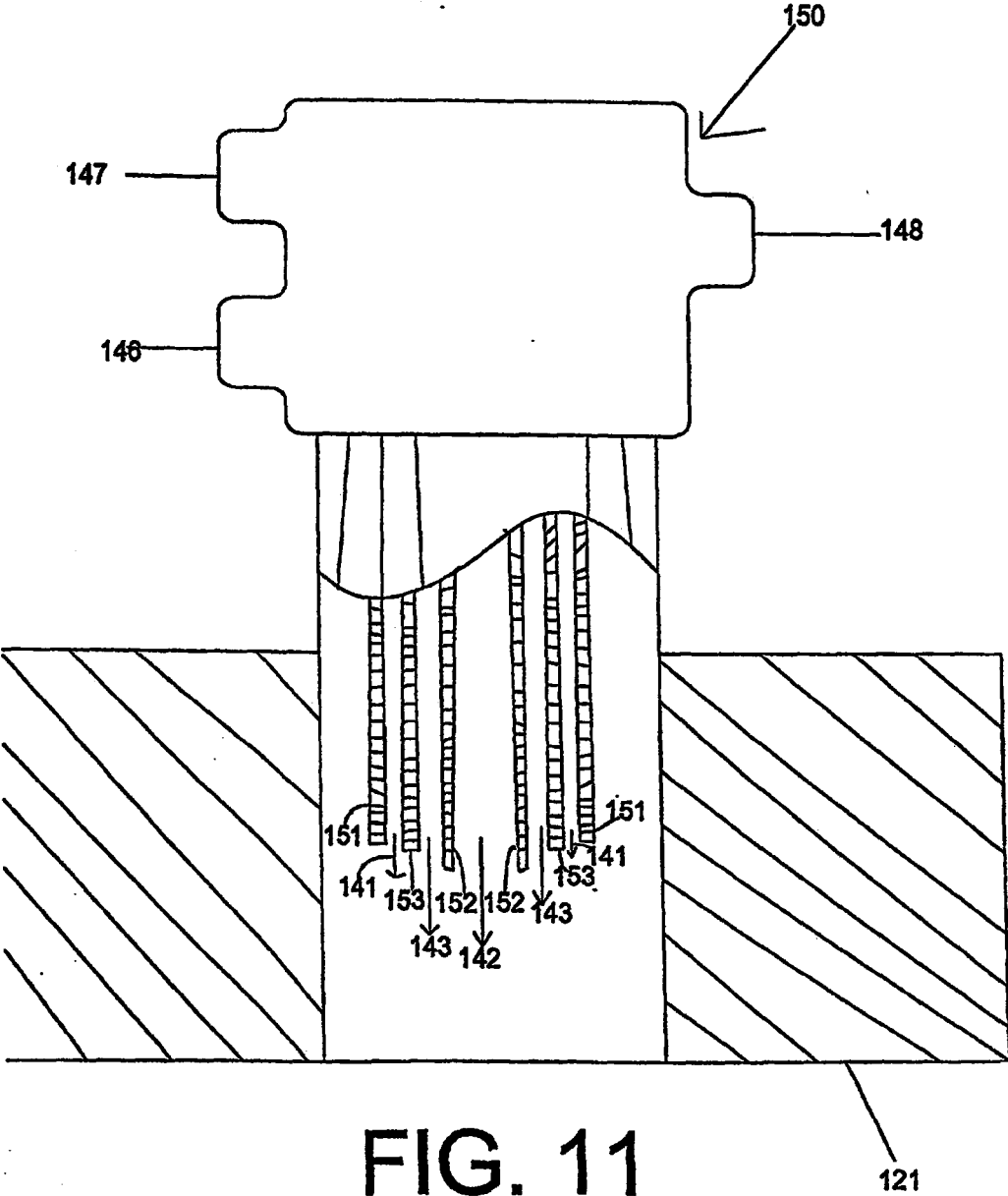
102050-2299-250

FIG. 10



14A
14B

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2do. EXAMEN DE FORMA PATENTE DE INVENCION

Folio 191

Radicación no 02-18003

Concepto Técnico no 965

Clasificación Internacional de Patentes: **C03B 5/435**

Practicado el examen de acuerdo a lo establecido en el Art. 38 de la Decisión 486 se determinó que esta solicitud de **Patente de Invención**:

- SI ☒ NO ☐ Contiene un resumen de la invención (Art.26-e).
- SI ☒ NO ☐ Contiene el título o nombre de la invención (Art.27-d).
- SI ☒ NO ☐ Contiene la descripción de la invención (Art.26-b).
- SI ☒ NO ☐ **NO ES APLICABLE** ☐ Contiene los dibujos necesarios para comprender la invención (Art.26-d)
- SI ☒ NO ☐ Contiene una o más reivindicaciones. (Art.26-c).
- SI ☐ NO ☐ **NO ES APLICABLE** ☒ Han sido desarrollados los productos y/o procedimientos a partir de recursos genéticos o de sus productos derivados de los que cualquiera de los Países Miembros es país de origen. (Art. 26- h).
- SI ☐ NO ☐ **NO ES APLICABLE** ☒ Los productos y/o procedimientos han sido obtenidos o desarrollados a partir de los conocimientos tradicionales de las comunidades indígenas, afro americanas, o locales de los países miembros, de acuerdo a lo establecido en la Decisión 391 y sus modificaciones y reglamentaciones vigentes.(Art.26-i).
- SI ☐ NO ☒ La invención se refiere a un producto relativo a un material biológico. (Art.26-J).
- SI ☒ NO ☐ **NO ES APLICABLE** ☐ La prioridad coincide con la materia reivindicada.
- SI ☒ NO ☐ **CUMPLE LOS REQUISITOS TÉCNICOS**

OBSERVACIONES Y OTROS: SI ☐ NO ☐ ver hoja(s) anexa(s)

EXAMINADOR TÉCNICO
202051

Bogotá D. C., diciembre 19 de 2003.



193

Folio 192

2020
Bogotá DC

Doctor(a)
DILIA MARIA RODRIGUEZ D'ALEMAN
Apoderado(a)

REFERENCIA:	Radicación No.	02-18003
	Trámite	002
	Evento	001
	Actuación	416
	Oficio No.	1504
	Folios	001

Teniendo en cuenta que la solicitud de privilegio de patente que se tramita bajo el expediente indicado en la referencia, reúne los requisitos de forma establecidos en los artículos 26 y 27 de la Decisión 486 de la Comisión de la Comunidad Andina, y en las demás disposiciones vigentes sobre la materia, se envía el extracto de la solicitud a la Oficina de Comunicaciones para efecto de su publicación en la Gaceta de Propiedad Industrial, conforme lo establece el artículo 40 de la misma Decisión.

Cúmplase

Dado en Bogotá DC,

22 DIC. 2003


ALIX CARMENZA CÉSPEDES DE VERGEL
Jefe de la División de Nuevas Creaciones

202051