United States Patent [19]

Koppang et al.

[11] **3,787,168**

[45] **Jan. 22, 1974**

[54] **BURNER ASSEMBLY FOR PROVIDING REDUCED EMISSION OF AIR POLLUTANT**

[75] Inventors: **Richard R. Koppang**, Cypress; **Harland L. Burge, Jr.**, Tarzana, both of Calif.

[73] Assignee: **TRW Inc.**, Redondo Beach, Calif.

[22] Filed: **Aug. 23, 1972**

[21] Appl. No.: **283,197**

Related U.S. Application Data

[63] Continuation of Ser. No. 91,333, Nov. 20, 1970.

[52] **U.S. Cl.** **431/354,** 431/115, 431/177, 239/402, 239/425

[51] **Int. Cl.** **F23d 13/40**

[58] **Field of Search** 431/115, 177, 182–184, 431/187, 188, 348, 350–354; 239/417, 422, 425, 399, 400

[56] **References Cited**

UNITED STATES PATENTS

2,011,283	8/1935	Huff	431/354
3,182,712	5/1965	Zink et al.	431/177
3,644,076	2/1972	Bagge	431/350

FOREIGN PATENTS OR APPLICATIONS

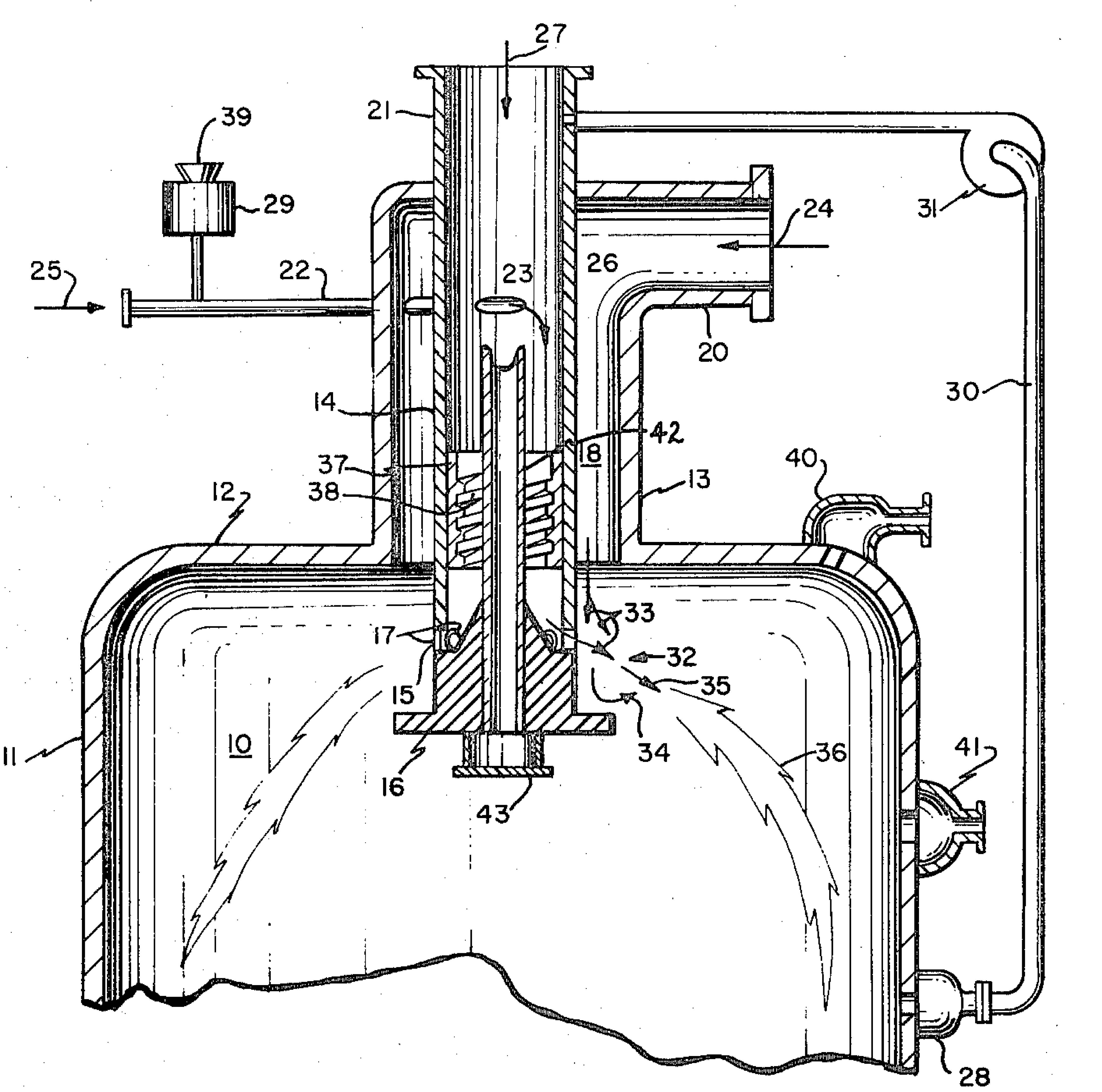
401,868	11/1933	Great Britain	431/115

Primary Examiner—Carroll B. Dority, Jr.
Attorney, Agent, or Firm—Daniel T. Anderson & William B. Leach

[57] **ABSTRACT**

A pair of conduits, coaxially arranged, provide flow paths for carrying combustible reactants to a combustion zone. The central conduit, otherwise known as a distribution tube, extends to within the combustion zone and includes a disc element at the combustion zone end thereof for deflecting an oxidizing reactant moving axially along the exterior of the distribution tube. A fuel reactant introduced into the distribution tube is carried to the combustion zone end thereof where it issues through radial ports and impinges the oxidizing reactant to produce a hollow cone flame. Additionally, a mixing element is included within the distribution tube to impart centrifugal motion to liquid fuels which are then subject to being atomized in the region of the radial ports. Temperature conditioning of the fuel-atomizing gas may optionally be performed to reduce liquid fuel surface tension and to promote vaporization.

5 Claims, 2 Drawing Figures



PATENTED JAN 22 1974

3,787,168

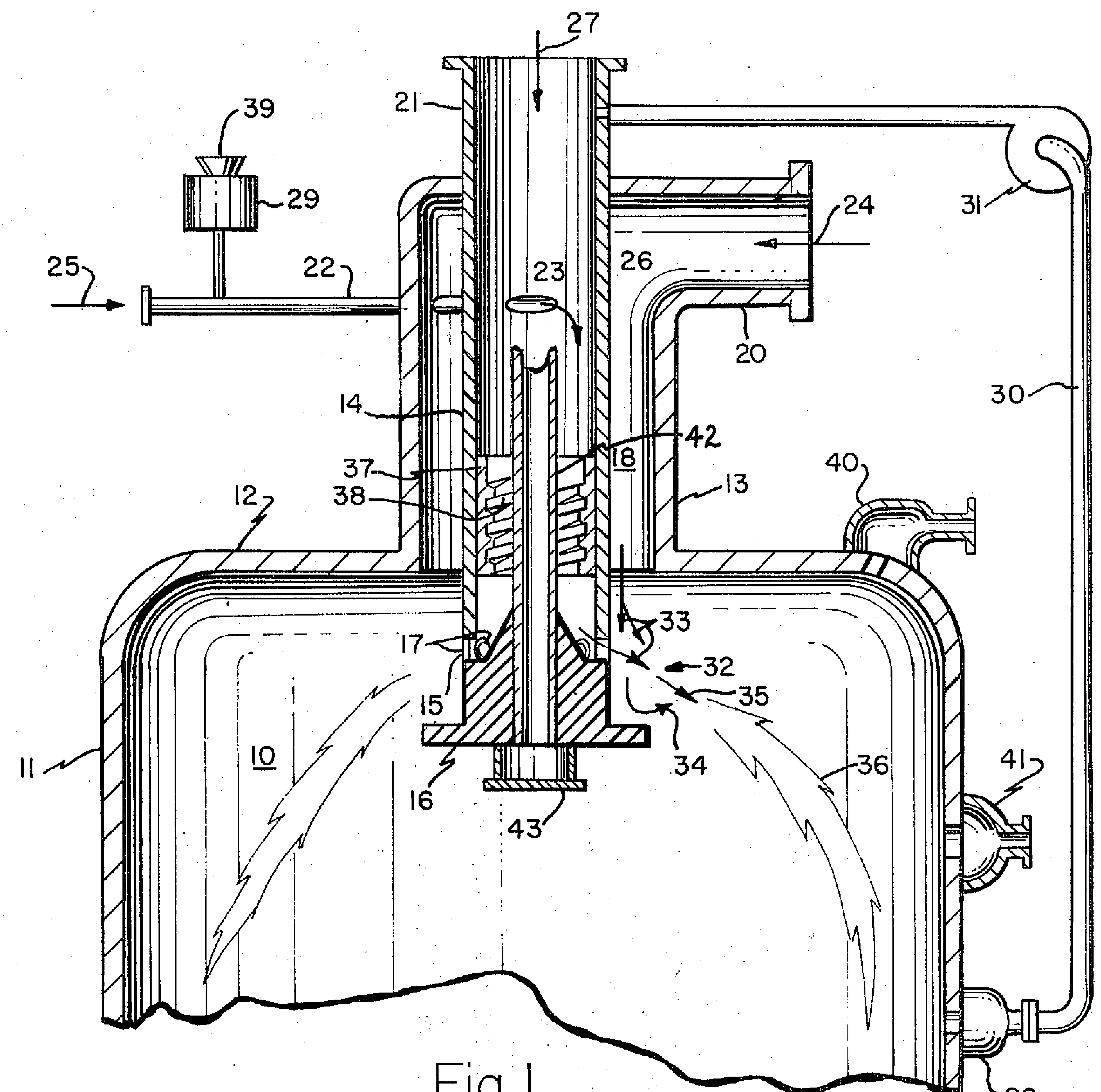


Fig. 1

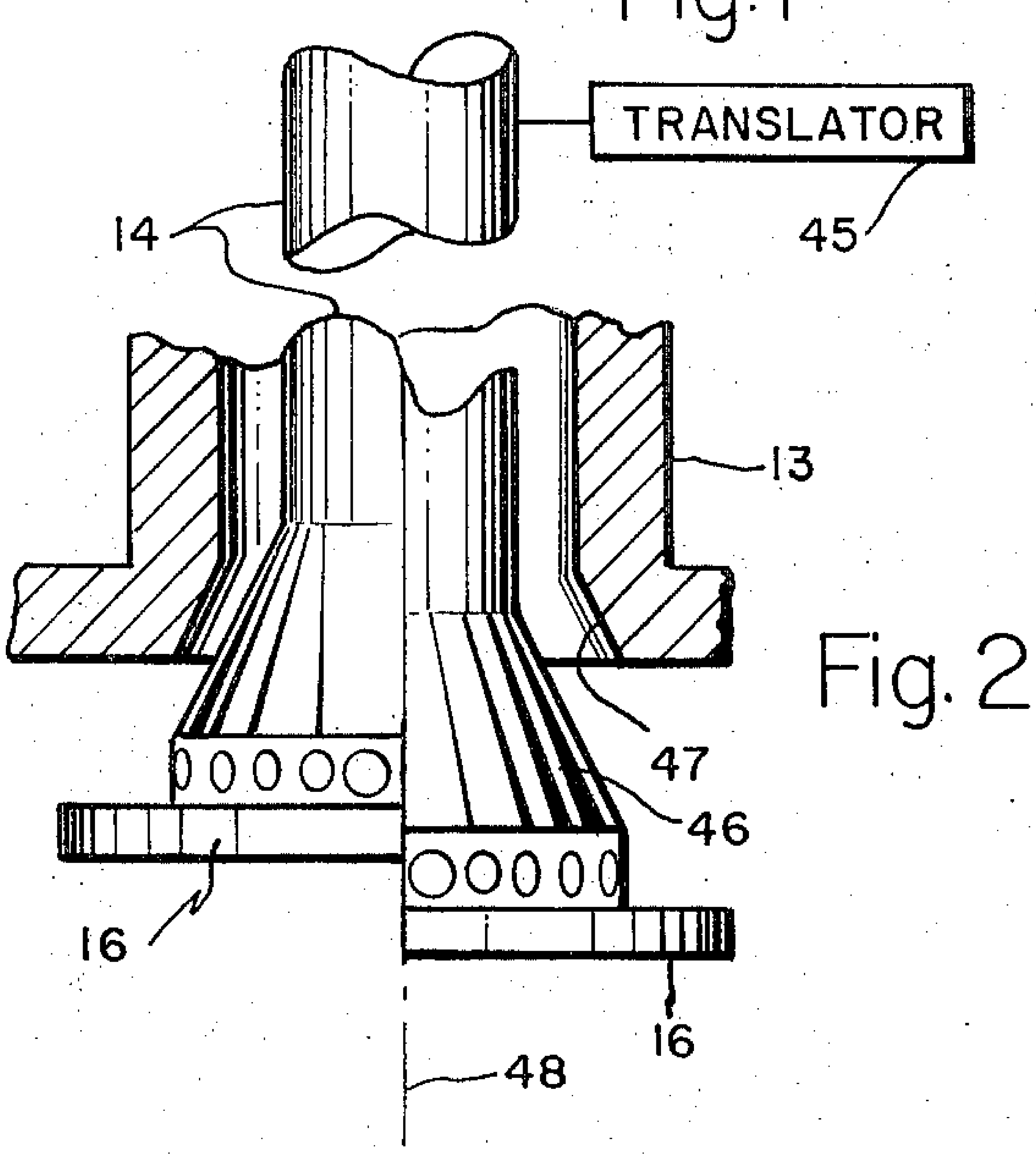


Fig. 2

Harland L. Burge Jr.
Richard R. Koppang
INVENTORS

BY William B. Leach

ATTORNEY

BURNER ASSEMBLY FOR PROVIDING REDUCED EMISSION OF AIR POLLUTANT

This is a continuation, division, of application Ser. No. 91,333, filed Nov. 20, 1970.

BACKGROUND OF THE INVENTION

The invention relates generally to burner assemblies used for the combustion of fossil fuels. More particularly the invention relates to burner assemblies that provide desired flame characteristics which reduce the emission of gaseous and particulate air pollutants.

Typical burner assemblies provide two or more orifices through which a fuel or an oxidizer is ejected into an external mixing zone. Mixing takes place in the external mixing zone by the impingement of one reactant stream with another thereby providing atomization of the fuel. Once the reactants have been ejected from the orifices, further treatment of that reactant stream is not attempted. However, simple impingement of one reactant stream with another does not result in optimum mixing.

It is also typical of present day burner devices to provide a fuel passage and orifice which ejects the fuel directly into an external mixing zone. Atomization of the fuel takes place in the external mixing zone by the impingement of the fuel stream with an oxidizer stream. Preconditioning of the fuel prior to its ejection from the orifice is seldom attempted. Typical burner assemblies may be found in the 1933 U.S. Pat. to Zulver, 1,934,837; the 1966 U.S. Pat. to Schreter et al, 3,254,846 and the 1965 U.S. Pat. to Elverum, Jr., 3,205,656.

It is generally known that in order to reduce the emission of oxides of nitrogen, it is desirable to minimize the residence time that hot nitrogen molecules are in contact with unreacted oxygen, and to conduct the combustion process at minimum temperatures. The residence time may be controlled by completing the combustion process rapidly and at near homogeneous stoichiometric conditions. Flame temperature reduction may be accomplished by radiating heat away from the flame and by diluting the reactants with an inert gas. These conditions will also result in reduction of carbon monoxide, hydrocarbon, and particulate emission.

In the present invention, good atomizing and mixing of the reactants contribute to rapid and complete combustion and therefore to reduced residence time. Atomizing and mixing also assue uniform mixture ratio conditions throughout the combustion zone, thus temperature conditions are uniform. Also, in the present invention, radiation from the flame is enhanced by shaping the flame into a substantially hollow-cone with thin walls.

Accordingly, it is an object of the present invention to provide a burner assembly in which there is improved mixing of the reactants in the external mixing zone.

It is also an object of the present invention to provide a burner assembly in which pretreatment of the fuel is provided prior to injection into the external mixing zone.

It is a further object of the present invention to provide a burner assembly in which the shape of the combustion flame may be selectively controlled.

It is yet another object of the present invention to provide a burner assembly in which there is a reduced emission of gaseous and particulate air pollution.

SUMMARY OF THE INVENTION

In accordance with the teachings of the invention the burner assembly includes a set of coaxial conduits defining two flow paths which exit into a combustion zone. The distribution tube, or inner conduit, includes an array of radial ports or orifices near the combustion zone end of the distribution tube. Thus, air or any gaseous oxidizer exiting from the annular orifice is intercepted by a fuel exiting from the radial orifices. Mixing occurs as a result of an exchange of momentum between the reactant streams and an aerodynamically formed screen effect. Further mixing is caused by deflection of some of the air from a deflector disc at the end of the distribution tube.

The burner may further include means within the distribution tube for causing liquid fuels to be entrained upon the interior walls of the distribution tube. This fuel will then be subjected to shear forces at the radial ports that will assist in atomizing the fuel. By controlling the momentum of the reactant streams, properly sizing the deflector disc, and selectively positioning the array of ports, the flame will take the shape of a hollow cone having a relatively thin wall which is conducive to the low emission of pollutants.

Other objects, advantages, and inventive features of the invention will be apparent from the more detailed description which follows and from the drawings wherein like characters indicate like parts and which form a part of this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial view in partial cross section and partly in block diagram showing a burner assembly in communication with a combustion chamber and which incorporates the present invention; and

FIG. 2 is a view in partial cross section and partly in block diagram showing an alternative embodiment of the burner assembly of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a combustion zone or chamber **10** is generally defined by a cylindrical wall **11** and an end wall **12.** The combustion chamber **10** is broken away at its lower end and further detail thereof is not shown for simplicity in the drawings. The combustion chamber, however, may be an element in a power generating system, industrial heater, or space heater.

A cylindrical conduit **13** enters the combustion chamber through the end wall **12.** A second conduit **14,** hereinafter referred to as a distribution tube, is coaxially mounted within the conduit **13** and extends to within the combustion chamber. The one end **15** of the distribution tube **14** carries a cylindrical disc element **16.** The distribution tube **14** is further characterized by an array of radial ports or orifices **17** which are circumferentially disposed around the distribution tube near the one end **15** thereof. The conduit **13** together with the distribution tube **14** serve to define an annular flow path **18.**

The burner assembly further includes means for introducing an oxidizer from any convenient source into the annular flow path **18** which may simply comprise an oxidizer supply conduit **20.** The burner assembly also includes means for introducing a mixing gas from any convenient source into the distribution tube **14** which may simply consist of a mixing gas supply tube **21** which when taken together with the distribution tube form a continuous flow path. Additionally, the burner assembly includes means for introducing a fuel from any convenient source into the distribution tube **14** which may take the form of a fuel supply tube **22** which exits into the distribution tube at orifice **23.**

The operation of the burner assembly as thus far described may now be examined. An oxidizing gas, such as air, is introduced into the oxidizer supply conduit **20** as indicated by the arrow at **24** and may be supplied from any convenient oxidizer source. The oxidizer gas flows down the annular path **18** to create a shroud of oxidizer gas around the distribution tube **14.**

A fuel, such as methane, is introduced into the fuel supply tube **22** as indicated at arrow **25** and may be supplied from any convenient fuel source. The fuel enters the distribution tube **14** through an orifice **23** as indicated by the arrow **26.** The fuel is joined by a mixing gas introduced as indicated by the arrow **27.** The mixing gas may simply be an oxidizer gas, an inert gas such as nitrogen, or combustion gas products recirculated from the combustion chamber **10** through a manifold **28** and return duct **30.** The recirculation circuit may include a centrifugal pump **31** or other means to induce recirculation flow such as a jet pump, or simply a fan.

The fuel and mixing gas pass down the distribution tube **14** toward the radial ports **17** and become an admixture through turbulent mixing of the gases. This admixture passes through the radial ports creating a plurality of gas jets around the distribution tube each of which impinges the shroud of oxidizing gas.

This impingement results in a mixing of the fuel admixture and the oxidizing gas in an external mixing zone generally designated by the numeral **32** and the gas flow is generally shown by the arrows **33.** The external mixing is enhanced by the premixing which occurred within the distribution tube **14.** The external mixing is further enhanced by oxidizing gas which passes between the fuel jets and is deflected by the deflector disc **16.** The deflected oxidizing gas, indicated at **34,** impinges the main stream, indicated at **35,** where further mixing occurs. Thus, there is provided a very thoroughly mixed set of reactants which aids in assuring a complete combustion process, local control of oxidizer and fuel mixture ratio, and therefore reduced of air pollutants.

In addition to thorough mixing, it is desirable to provide a combustion flame which is in the general form of a hollow cone with thin walls. Such a flame is shown at **36.** The shape of the flame may be controlled by the geometry of the burner and the fluid stream momentum ratios. Applicants have found that the ratio of the momentum in the oxidizer shroud to the momentum of the fuel admixture stream should range from 6:1 to 15:1. There are also two geometric ratios. One is the ratio of the deflector disc diameter to the distribution tube diameter. As this ratio increases, the included cone angle increases. The other ratio is the distance between the deflector disc **16** and the ports **17.** This ratio affects the shape of the conical flame by varying the included angle. By way of example, a burner assembly constructed with a 4.5 inch diameter deflector disc, a 3.0 inch diameter distribution tube, and a **3.9** inch diameter oxidizer conduit produced in the order of 2×10^6 BTU/hour output.

Another feature of the present invention is the inclusion of a mixing element mounted or formed within the distribution tube **14.** A hollow cylinder device **37** serves as such an element. It includes helical surfaces **38** which serve to impart centrifugal forces to the fuel and mixing gas. When liquid fuels, such as oil, are used, the liquid is centrifuged outwardly and entrained on the internal walls of the distribution tube **14.** When the liquid fuel reaches the radial ports **17,** the mixing gas subjects the liquid to high shear forces which break up the liquid into a fine foglike mist. This action provides excellent premixing of the fuel and mixing gas prior to additional mixing in the external mixing zone **32.** The centrifuging of liquid fuels is enhanced by introducing the fuel tangentially into the distribution tube **14** thereby imparting to the fuel centrifugal motion prior to reaching the mixing element **37.**

The introduction of fuel through fuel supply tube **22** may include means for including pulverized solid matter such as a pulverizing and conditioning mechanism **29** into which is placed solid materials through a hopper **39.** The premixing features of the present invention are particularly suitable to the treatment of pulverized solid matter.

Further flame temperature and combustion characteristic control may be provided by the use of one or more secondary gas manifolds **40, 41.** Air introduced into the upper secondary gas manifold **40** enables additional combustion to take place if the burner assembly is operated to the fuel rich side of stoichiometric conditions. Air may also be introduced through the lower manifold **41** to induce rapid dissipation of the flame temperature which is desirable for the reduction of oxides of nitrogen. The recirculation of combustion gases as heretofore described is also useful in lowering the combustion temperatures. Preheating of the fuel is also an expedient means for controlling the combustion characteristics.

Additional temperature dissipation is provided by introducing cool gas to the interior of the conical flame. For this purpose, a cooling gas tube **42** is mounted coaxially within distribution tube **14.** Any convenient means may be used to provide cooling gas thereto. Cooling gas tube **42** extends through deflector disc **16** so as to inject cooling gas into the interior of the flame **36.** Another deflector **43** may be suspended from the deflector disc **42** so as to direct the cooling gas radially outwardly, and along the flame front to carry away heat.

Other features of the burner assembly are shown in FIG. **2.** The distribution tube **14** is coupled through appropriate linkage to a translator device **45** which includes means for imparting axial movement to the distribution tube **14.** The combustion end, or one end **15,** of the distribution tube includes a tapered surface **46** to provide a sealing surface that is engageable with a mating tapered surface **47** when the distribution tube **14** is drawn toward the oxidizer outlet.

FIG. **2** is split along centerline **48** to show the distribution tube **14** in two of its infinitely selectable positions. Axial translation results in a change in the oxidizer annulus area, thus causing the flow rate to change when the upstream supply pressure is held constant. In this manner, turndown operation may be accomplished by area throttling while retaining the design point mixing characteristics.

There has thus been disclosed a burner assembly which provides for internal mixing of the fuel followed by external mixing immediately upstream of the flame. The external mixing is accomplished both by momentum exchange between directly impinging fuel and oxidizer streams and by a deflected oxidizer stream impinging the foregoing directly impinging streams. Furthermore, the temperature of the flame is controlled by shaping the flame to provide a high degree of radiation, and by means for variably controlling the constituents of the reactants.

We claim:

1. A burner assembly for combusting two or more reactants with a minimal yield of oxides of nitrogen, comprising:

a conduit;

a distribution tube mounted substantially coaxially within said annular conduit with one end thereof protruding from within said conduit and extending to within a combustion zone, said conduit forming with said distribution tube a substantially annular passage;

a deflector disc affixed to said one end of said distribution tube and having a diameter in excess of that of the distribution tube, said distribution tube being characterized by a circumferential array of radially directed ports proximate said deflector;

means for introducing an oxidizer at a preselected mass flow rate into said annular passage, the oxidizer forming a shroud around said distribution tube;

means for introducing a fuel at another preselected mass flow rate into said distribution tube; and

a mixing element mounted inside said distribution tube including means for imparting centrifugal motion to fluids passing thereby.

2. The burner assembly of claim **1** wherein said means for introducing a fuel includes:

means for introducing the fuel tangentially to said distribution tube.

3. The burner assembly of claim **1** wherein the means for introducing a fuel further includes:

means for adding pulverized solid matter to a gaseous fuel.

4. The burner assembly of claim **1** further comprising:

a cooling gas tube coaxially extending through said distribution tube and said deflector and exiting into the interior of the combustion zone.

5. The burner assembly of claim **4** further comprising:

another deflector suspended from one said deflector disc to radially direct cooling gas issuing from said cooling gas tube.

* * * * *