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APPARATUS FOR THE COMBUSTION OF COMBUSTIBLE AND VAPORIZABLE SUBSTANCES

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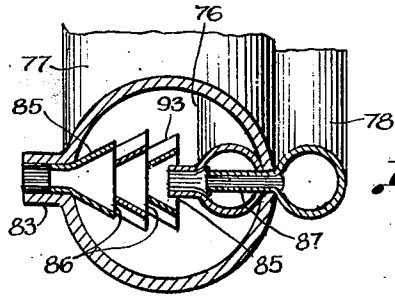
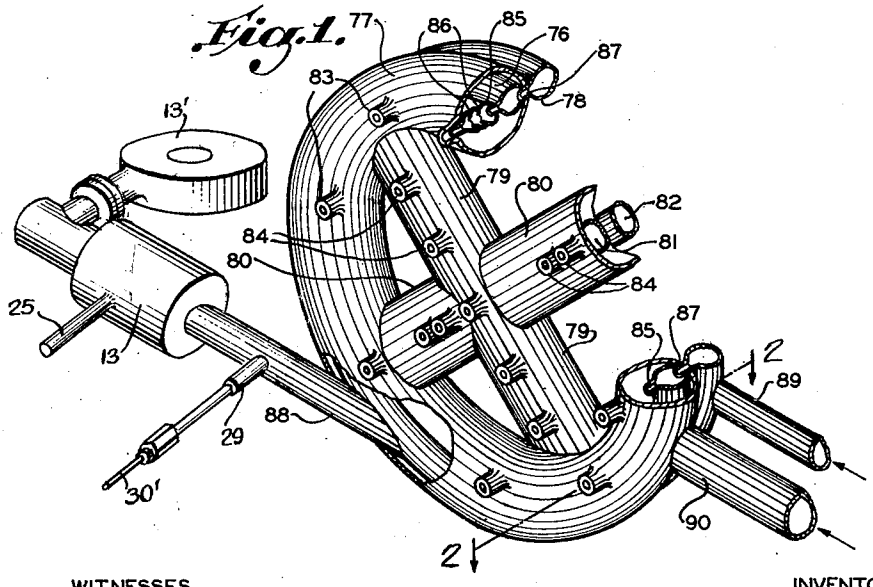



Fig. 2.

Fig. 1.




WITNESSES.

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## APPARATUS FOR THE COMBUSTION OF COMBUSTIBLE AND VAPORIZABLE SUBSTANCES

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This invention pertains to the combustion of fuels and other vaporizable and combustible substances.

The invention provides novel means for the combustion of fuels and other substances, preferably at relatively high heat releases, and particularly apparatus for changing the state of aggregation of combustibles and vaporizable substances and distributing them to assure more complete combustion. The invention is applicable to a wide variety of uses such as disc, grid or ring burners, gas turbine systems, fluid heaters, rocket or jet propulsion devices, vapor generators, fog dispelling apparatus and apparatus for drying, smelting, sintering or baking. Apparatus of the invention, through the distribution of the combustibles or vaporizable substances, flame dispersion and apportionment obtainable therewith, permits furnaces or other devices of which it is a part to be of more compact construction and lighter weight than hitherto practicable.

Apparatus embodying and for carrying out the invention comprises one or more combustion chambers provided with means to facilitate vaporization, gasification, raising to or beyond fire point, or otherwise greatly increasing the combustibility and potential combustion speed of fuel oil or other combustible or vaporizable substance fed into the stream of gases of combustion around or beyond the combustion chamber proper of a furnace. Furnaces suitable for the purpose are disclosed in our copending applications Serial No. 479,010 filed March 13, 1943, now Patent Number 2,500,925, issued March 21, 1950; Serial No. 506,670, filed October 18, 1943, now Patent Number 2,569,446, issued October 2, 1951 and Serial No. 509,080 filed November 5, 1943, now Patent Number 2,464,791, issued March 22, 1949. Although combustion chambers of many types other than those disclosed in these copending applications may be used to carry out the invention, the furnaces disclosed therein have the advantages of requiring but a relatively small space and of being of a minimum weight. The substance to be burned or vaporized is introduced into contact with the stream of gases produced in the combustion chamber of a furnace preferably by nozzles connected to a manifold, as disclosed in our copending application Serial No. 509,080, filed November 5, 1943, or through injectors at the combustion chamber exit. If the substance is in a liquid or solid state, it is vaporized or otherwise prepared for high speed combustion either by the hot gases

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in or from the combustion chamber of the furnace, by contact with adjacent parts of the furnace which have become heated by gases, by the injectors which may be heated from the combustion chamber, or by distributing apparatus beyond the combustion chamber throat which is heated to a high degree. Any one or more of these methods of vaporization may be used. After vaporization of the substance and its mixture with gases of combustion, the mixture is ejected, preferably at high velocities, through the exit nozzles of distributing devices. Relatively high air pressure is employed in the combustion chamber windbox to serve the function of: (1) furnishing oxygen for combustion; (2) supplying sufficient force to intermix the substance or substances raised to or beyond the fire point or otherwise prepared for virtually instantaneous ignition; (3) distributing the mixture of substances to individual nozzles of a distributing device; (4) maintaining a high velocity through these nozzles; and (5) aspirating surrounding air by the gas-vapor issuing from the nozzles. Localization of the aspirating effect may be obtained by using hollow rings or polygonal-shaped registers around individual distributing devices, around a group of distributing devices or around a single nozzle of a distributing device. The distributing devices may be entirely enclosed by air ducts or have air ducts positioned on one or more sides thereof.

Perfection of these devices will depend upon the optimum proportioning of the parts to assure maximum advantages from all of these variables. The spacing and the arrangement of the nozzles of the distributing devices, as well as their free areas, are important considerations. Also optimum proportioning of air admitted to, around, or alongside the nozzles is desirable, lest the quantity or velocity either be inadequate or plethoric which would result in incomplete oxidation, blowing out, or undue dilution of the stream from the nozzles. Regulation of air flow surrounding the nozzles is a matter of importance in connection with lighting off the mixture of gas and air at the face or faces of the distributing devices. It is frequently desirable temporarily to halt or greatly to diminish air flow while initial ignition is being secured, then to advance it to support increased flow rates and combustion speed. Substances, whether liquid or solid, or in any other state of aggregation, may be employed for feeding the distributor of distributing devices although satisfactory results can be secured through the use of the same material as that

used for firing the combustion chamber. Another important consideration is the apportionment of the injectors used to supply the substances to be vaporized, raised beyond the fire point or otherwise prepared for high speed combustion, either to the combustion chamber or the distributing devices of the present invention, since the rate of flow from the nozzles depends upon such apportionment as well as upon the area of the nozzles and speed of travel of the mixture expelled from the combustion chamber exit.

The invention will be understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is an isometric view, partly broken away, of apparatus embodying the invention, and

Fig. 2 is an enlarged cross-sectional view taken on line 2—2 of Fig. 1.

Like characters of reference refer to the same or to similar parts throughout the several views.

A preferred fuel distributor ring is disclosed in Figs. 1 and 2. In this form, a distributing ring 76 is enclosed in an annular air duct 77. Outside the duct 77 and adjacent the distributing ring 76, is a supplementary annular air duct 78 of substantially the same diameter as the ring 76. The duct 77 has tubular cross-arms or chordal members 79 and 80 extending diametrically through its central space, the cross-arms intersecting and in communication with each other and in communication with the duct 77 at opposite ends thereof. The distributing ring 76 has cross arms or chordal members 81 similar to the cross arms 79 and 80, which extend inside the cross arms 79 and 80, while the supplemental air distributing ring 78 has cross arms or chordal members 82 similar to the cross arms 79 and 80, which extend outside the cross arms of the duct 77 and adjacent to the cross arms 81. The duct 77 has a plurality of circumferentially spaced nozzles 83 on one side thereof and a plurality of diametrically spaced nozzles 84 on the cross arms 79 and 80. As shown more clearly in Fig. 2, the ring 76 has a plurality of nozzles 85 in alignment with nozzles 83 and in communication therewith. The nozzles 85 have air inlets 86 through which air from the air conduit 77 enters the nozzles. The cross arms 82 have nozzles similar to the nozzles 85 in alignment with the nozzles 84 and in communication therewith. The supplemental air duct 78 has a plurality of nozzles 87, each of which is in alignment with nozzles 85 and in communication therewith. The cross arms 82 of the ring 78 have nozzles in alignment and in communication with the nozzles in the cross arms 81. Air under pressure enters the duct 77 through the conduit 90 and enters the supplemental air duct 78 through the conduit 89, while the mixture of air and substances such as issues from the blower or compressor 13', fuel feed line 25, wind box 13, fuel atomizer conduit 30', atomizer 29, enters the distributor ring 76 through the inlet conduit 88. With the arrangement of air ducts and distributor ring disclosed in this form of the invention, exceedingly short, fast burning flames, which may be termed supercharged, are obtained. While the cross arms 79, 80, 81 and 82 may be omitted if desired, these arms will be of utility in certain types of turbines. The forms of the invention shown in Figs. 1 and 2, may be considered as gas-air distributing devices embodying multiple miniature furnaces of the general type or types previously disclosed in our copending applications Serial Nos. 479,010, 506,670 and 509,080, but firing gasified or largely gasified fuel oil instead of atomized fuel oil and, at the same time, possessing means by which individual furnaces or the streams of gas to the individual furnaces may be secured.

Certain of the nozzles 85 are provided with fins 93.

In operation, the gasified fuel discharged by nozzles 85 is supercharged by air passing through the nozzles 87 from the air line 78, the flame is ejected into the furnace formed by the finned frusto-conical air directing members 85 between which air from the conduit 77 passes through the annular passages 36 into the gas power outlet 83.

The invention disclosed herein may be manufactured and used by or for the Government of the United States for governmental purposes without payment of royalty thereon.

It will be understood that changes may be made in the form, location and relative arrangement of the several parts of the apparatus disclosed herein without departing from the principles of the invention. Accordingly, the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. Apparatus for producing combustion from combustible and vaporizable substances comprising a first annular tubular member, means for supplying such a substance in admixture with a stream of products of combustion to the interior of the member, another annular tubular member, said first member having outlet openings discharging into said other annular tubular member, means for supplying air to the interior of the other member, the other member having outlet openings in alignment with the outlet openings of the first member, a third annular tubular member, and means for supplying air to the third member, the third member having air outlet openings and passage means therefrom in alignment with the outlet openings of the first member and adapted to discharge air into the first member.

2. Apparatus for producing combustion from combustible and vaporizable substances comprising a first annular tubular member, a second annular tubular member, said first member being disposed substantially within said second annular tubular member, means for supplying such a substance in admixture with a stream of products of combustion to the interior of the first member, means for supplying air to the interior of the second member, the first member having outlet openings discharging into the second member, said second member having outlet openings in communication with the atmosphere and in alignment with said openings in said first member a third annular tubular member adjacent the second member, and means for supplying air to the interior of the third member, the third member having connections with the first member through which air is discharged from the third member into the first member.

3. Apparatus for producing combustion from combustible and vaporizable substances comprising a first annular tubular member, a second annular tubular member, said first member being disposed substantially within said second annular tubular member, means for supplying such a substance in admixture with a stream of products of combustion to the interior of the first member, means for supplying air to the interior of the second member, the first member having outlet openings discharging into the second mem-

ber, said second member having outlet openings in communication with the atmosphere and in alignment with said openings in said first member, a third annular tubular member adjacent the second member, and means for supplying air to the interior of the third member, the third member having connections with the first member through which air is discharged from the third member into the first member, said connections being in alignment with the outlet openings of the first and second members.

4. Apparatus for producing combustion from combustible and vaporizable substances comprising a first annular tubular member, means for supplying such a substance in admixture with a stream of products of combustion to the interior of the member, another annular tubular member, said first member having outlet openings discharging into said other annular tubular member, said other member having outlet openings in communication with the atmosphere and in alignment with said openings in said first member and means for supplying air to the interior of the other member, the first and other annular members having tubular chordal members connected with their interiors respectively, the chordal members having outlet openings in alignment with each other.

5. Apparatus for producing combustion from combustible and vaporizable substances comprising a first annular tubular member, a second annular tubular member, said first member being disposed substantially within said second annular tubular member, means for supplying such a substance in admixture with a stream of products of combustion to the interior of the first member, means for supplying air to the interior of the second member, the first member having outlet openings discharging into the second member, said second member having outlet openings in communication with the atmosphere and in alignment with said openings in said first member a third annular tubular member adjacent the second member, and means for supplying air to the interior of the third member, the third member having connections with the fist member through which air is discharged from the third member into the first member, the first, second and third annular members having tubular chordal members connected with their interiors respectively, the first and second chordal members having outlet openings in alignment with each other, and the third chordal member having outlet connections which discharge into the first chordal member at points in alignment with the outlet openings thereof.

6. Apparatus for producing combustion from combustible and vaporizable substances comprising distributing means for receiving a mixture of heated gas and the substance, the distributing means comprising an annular tubular member having a plurality of outlet openings through which the mixture is discharged in jets, and a second annular tubular member having outlet openings through which said jets discharge means supplying air to said second member, means in the second annular member for directing air to said jets, and means for supplying air to the first annular tubular member at points in alignment with the outlet openings in the first member.

7. Apparatus for producing combustion from combustible and vaporizable material, said apparatus comprising; a first annular tubular member; a second annular tubular member; said first member having outlet openings arranged to discharge into said second member; said second member having outlet openings; means for supplying said material in admixture with a stream of products of combustion to the interior of said first member; means for supplying air to the interior of said second member; and inlet air-directing means having an inlet portion adjacent said first member and in alignment with one of said outlet openings in said second member; said air directing means being constructed and arranged to receive a jet discharged from the outlet openings of said first member and air from said second member.

8. Apparatus for producing combustion from combustible and vaporizable material, said apparatus comprising; a first annular tubular member; a second annular tubular member; a third annular tubular member; said first member having a first series of outlet openings arranged to discharge into said second member; said second member having a second series of outlet openings arranged in communication with the atmosphere and in alignment with said first series; said third member having a third series of outlet openings and passage means therefrom arranged to discharge into said first member, means for supplying said material in admixture with a stream of products of combustion to the interior of said first member, means for supplying air to the interior of said second member; and means for supplying air to the interior of said third member.

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