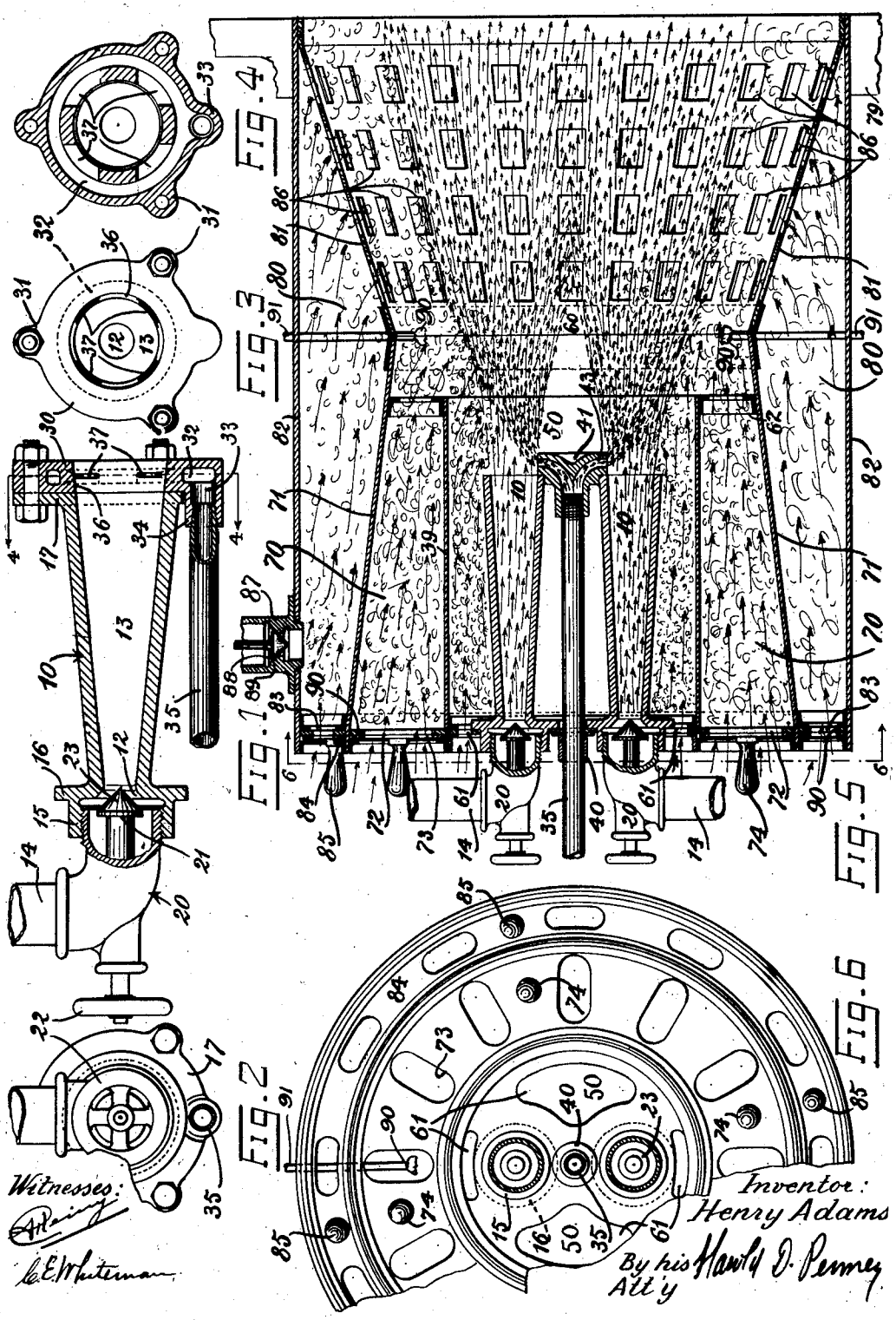
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FUEL BURNING APPARATUS AND METHOD

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FUEL BURNING APPARATUS AND METHOD

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This invention relates to a new method and apparatus for controllably burning liquid and other flowable fuels for use with many kinds of furnaces.

This invention relates particularly to improvements and variations of the method and structure set forth in my copending applications, Serial Nos. 614,419 and 622,335, which relate more particularly to furnaces for smelting and reducing ores. My present invention is for use with smelting and reducing furnaces and the like, cement kilns, locomotive, marine and stationary boilers and the like, and other uses too numerous to mention.

My invention herein described is shown in connection with a burner which briefly stated comprises a cylindrical housing having therein a forwardly flaring projector for fluid under pressure and a nozzle for spraying fuel across the discharge end of the projector. The housing is provided with walls forming a forwardly opening chamber around the projectors and having air inlet openings in the rear wall of the housing, and also walls forming a combustion and expansion chamber forward of the projector and additional chambers around the projector chamber discharging into the expansion chamber air received through damper controlled ports in the rear wall of the housing.

A special form of nozzle and projector is also shown for use without the above described housing.

One object of the invention is to produce the finest possible liquid fuel mist and commingle it as thoroughly as possible with sufficient oxygen to afford combustion in one operation and retain a rich combustible mixture from ignition to complete combustion.

Another object of the invention is to produce complete expansion of the steam or compressed air passing through the projector thus to obtain full velocity thereof.

Another object is to provide a combustion chamber permitting the progressive expansion of the combusting mixture and means for supplying induced or forced air throughout the chamber as the combustion progresses and advances in the chamber. As the gases enter the furnace proper, further expansion takes place.

Other objects of the invention are to improve generally the simplicity of such devices and methods and to provide a burner which is durable, economical to manufacture, install and operate and which will not get out of order.

In the accompanying drawings, showing by way of example, two of many possible embodiments of the invention,

Fig. 1 is an axial sectional view, partly in elevation of the special nozzle and projector;

Fig. 2 is a fragmental rear end elevation of the projector;

Fig. 3 is a front end elevation showing the nozzle and the interior of the projector;

Fig. 4 is a transverse vertical sectional view of the nozzle taken on the line 4—4 of Fig. 1, looking in the direction of the arrow of said line;

Fig. 5 is a longitudinal vertical sectional view, partly in elevation of the housing with nozzle and projectors therein; and

Fig. 6 is a fragmental rear end elevation showing the rear wall of the housing.

The projectors 10 (Fig. 5) are shown in a cylindrical housing open at the forward or discharge end and comprising an outer cylindrical side wall 82 and a rear wall 90 provided with an outer annular series of tertiary draft ports 83, an intermediate series of secondary draft ports 72 within the outer series. The forward end of the side wall 82 is secured in a large opening of the wall 79 of a boiler furnace or the like.

The projectors 10 are forwardly projecting, and forwardly flaring so as to give complete expansion, and maximum velocity of the pressure fluid. Each projector comprises a rearwardly opening tapped and flanged head 15 (Fig. 1) seated in a seat opening in said rear wall 90 with the flange 16 against said wall. Said head is formed with a conical valve seat orifice 12 opening into and feeding the nozzle projector. An elbow valve body screwed in said tapped head 15 carries a needle valve stem mounted in said body alined with said seat orifice and provided at the exterior end with a handwheel 22 and at

the inner end with a forwardly pointing conical valve member 23 adapted to move toward and close said seat orifice 12. Pressure pipes 14 introduce compressed air, steam or other fluid into said valve bodies and thence out through the projector.

A fuel feed pipe 35 (Fig. 5) extends axially through a feed pipe opening in said wall 90 to near the forward end of the projectors 10 and is positioned by a flanged collar 40 mounted on the pipe and the rear face of the rear wall. A spray nozzle 41 on the forward end of the feed pipe is provided with laterally curved passages terminating in spray orifices 43 directed right-angularly across the discharge end of the projectors 10 for spraying fuel into the blast of the projector whereby the liquid fuel is completely atomized. It is noted however, that the invention is not limited to liquid fuel, as distinguished from powdered or gaseous fuel.

By reference to Fig. 5 it will be seen that the nozzle 41 provides means for separating into two streams the commingled fluid and fuel carried along by the fluid discharged from the projectors, which streams converge and combine in the expansion chamber 60.

A cylindrical partition 39 mounted on said rear wall and terminating slightly forward of the projectors forms a forwardly opening projector chamber 50 around the feed pipe and projectors and communicates with air inlet ports 61 whereby air is drawn in by the blasts from the projectors.

A foraminous annular support 62 mounted on the forward end of the outer face of said partition is secured to the forward end part of a forwardly tapering truncated conical wall 71 projecting beyond said support and mounted at its rear end on said rear wall between said secondary and tertiary series of ports 73 and 83, thereby forming a secondary chamber 70 surrounding the prjoector chamber 50 and receiving air through said secondary ports 72 and discharging it through the openings of said support 62. A forwardly flaring truncated conical wall 81 forming a central combustion and expansion chamber 60 and provided with a large number of passage openings 86 is mounted on and joins the forward edges of said outer wall 82 and said forwardly tapering wall to form therewith a tertiary chamber 80 communicating with and receiving air through said tertiary draft ports 83 and discharging through said passage openings 86 into the expansion chamber 60. Separate damper rings 73 and 84 slidably mounted on the rear face of the rear wall 90 over said secondary and tertiary ports 72 and 83 are provided respectively with correspondingly shaped openings registerable with said ports. Handles 74 and 85 are mounted on said rings 73 and 84 respectively by which the rings are adjusted for controlling the inlet of air. An additional air pressure valve 87 is mounted on said wall 82 near its rear end and is provided with a conical seat 88 discharging into the tertiary chamber and a conical valve member 89 movable in said valve for closing on said seat.

The burner of Figs. 1 to 4 comprises a forwardly flaring nozzle projector 10 provided at the forward end with a lateral flange 17. At the rear end the rearwardly opening flanged head 15 is formed with a conical seat orifice feeding the projector the same as in Fig. 5, as are also the valve body 20, valve member 23, and a pressure pipe 14. An annular spray nozzle 30 mounted on said lateral flange 17 of the projector is provided with an annular passage 32 provided with a rear boss 34 having a conduit 33 receiving the feed pipe 35. The nozzle is also provided with thin inwardly pointing spray orifices 37 directed through the inner face 36 right-angularly across the discharge end of the projector.

The operation of the device is simple, and is obvious from the foregoing. The pipes 14 and 35 being connected respectively to sources of high pressure superheated steam, air or other suitable pressure fluid, and a suitable liquid fuel, the conical member 23 is adjusted to give the desired rate of flow and complete expansion and greatest velocity of the pressure fluid and a mixture with the fuel to give the proper richness of the combustible mixture. Combustion takes place at the smallest part of the expansion chamber, and combustion is supported by air drawn in through the openings 61 and the chamber 50 by induction of the blasts from the projectors 10. If desired, the air may be fed in under pressure.

The expansion of the combusting gases is accommodated by the flaring shape of the chamber 60, and as the combustion proceeds, it is further supported by air drawn in through the ports 72 and 83 and the secondary and tertiary chambers. The dampers 73 and 84 are adjusted to give to the burning gases at either end of the combustion chamber just the proper amount of air to fully support the combustion without too much diluting or cooling the mixture.

The chambers 50, 70 and 80 also serve as heat insulating envelopes around the various seats of combustion to prevent the escape of heat through the walls 82 and 90 and at the same time to heat the incoming combustion supporting air to avoid cooling the flame.

After the burning gases pass through the wall 79 into the furnace, further expansion and combustion takes place. By this method, large savings of both fuel and pressure steam are effected.

The projector of Figs. 1 to 4 may be used in connection with chambers such as the chambers 50, 60, 70 and 80 or directly in a furnace or directly against an object to be heated. The operation of the projector itself is similar to the projector of Fig. 5.

While my fuel burning apparatus and method have been very successful, I have never mounted any ignition means on the apparatus. The igniting may be accomplished by the insertion of a lighted taper by hand or in any usual and obvious old way without mounting an igniting means. However, if desired, ignition means may be applied in the form of pilot jet burners 90 formed on the ends of small tubes 91.

I claim as my invention:

1. A fuel burner comprising projectors for fluid under pressure disposed in parallelism and adapted for permitting gradual expansion of the fluid from entrance to discharge of the fluid from the projectors, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors whereby the fuel is driven along by and commingles with and is controlled by the fluid in the disposition of the commingled fluid and fuel, and means appurtenant to the fuel pipe for separating the commingled fluid and fuel into streams which due to the expansion of the commingled fluid and fuel converge and later combine.

2. A fuel burner comprising projectors for fluid under pressure disposed in parallelism and having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors having a discharge channel provided with diverging outlets each of which discharges the fuel into and substantially at right angles to the path of the fluid discharged from the projector adjacent thereto, the fluid from the projectors being discharged in advance of discharge of the fuel from the fuel pipe.

3. A fuel burner comprising projectors for fluid under pressure disposed in parallelism and having flaring interiors of greatest diameter at their discharge ends, and a fuel pipe disposed between the projectors provided with discharge channels each of which terminates in alinement with the flaring interior side of the adjacent projector at the end of the projector and is spaced away slightly from the end of the projector for discharging fuel into and substantially at right angles to the path of the fluid discharged from the projector, the fluid from the projector being discharged in advance of discharge of the fuel from the fuel pipe.

4. A fuel burner comprising projectors for fluid under pressure disposed in parallelism and having flaring interiors of greatest diameter at their discharge end, and a fuel pipe disposed between the projectors and having a nozzle provided with diverging discharge channels each of which terminates in alinement with the flaring interior side of the adjacent projector at the end of the projector and is spaced away slightly from the end of the projector for projecting fuel into and substantially at right angles to the path of the fluid discharged from the projectors, the fluid from the projector being discharged in advance of discharge of the fuel from the fuel pipe and the nozzle of said pipe separating the streams of commingled fluid and fuel which due to the expansion of the commingled fluid and fuel converge and later combine.

5. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and adapted for permitting gradual expansion of the fluid from entrance to discharge of the fluid from the projectors, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the expanding fluid discharged from each of the projectors, a forwardly opening projector chamber surrounding the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, and means for inlet of air into the projector chamber at the rearward end thereof.

6. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors, a forwardly opening projector chamber surrounding the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means comprising a needle valve for introducing fluid under pressure into the projectors, means for operating said fluid introducing means, means for inlet of air into the projector chamber, and means for operating said air inlet means.

7. A fuel burner comprising projectors for fluid under pressure disposed in parallelism having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors having a nozzle provided with discharge channels each of which terminates in alinement with the interior side of the adjacent projector and is spaced away slightly from the end of the projector for projecting fuel into and substantially at right angles to the path of the fluid discharged from the projector, a forwardly opening projector chamber surrounding the projectors and fuel discharge pipe into which chamber the projectors and fuel pipe discharge, means comprising a needle valve for introducing fluid under pressure into the projectors, means for operating said fluid introducing means, means for inlet of air into the projector chamber, and means for operating said air inlet means, said nozzle providing means for separating in the projector chamber the commingled fluid and fuel into streams which due to the

expansion of the commingled fluid and fuel converge and later combine.

8. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and adapted for permitting gradual expansion of the fluid from entrance to discharge of the fluid from the projectors, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors, a forwardly opening projector chamber surrounding the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means for inlet of air into the projector chamber at the rearward end thereof, a combustion and expansion chamber communicating with the projector chamber, means for inlet of air into the combustion and expansion chamber, a chamber around the projector chamber and between the projector chamber and the combustion and expansion chamber, means for inlet of air into said intermediate chamber, and means for outlet of air from said intermediate chamber into the combustion and expansion chamber.

9. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and adapted for permitting gradual expansion of the fluid from the entrance to discharge of the fluid from the projectors, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors, a forwardly opening projector chamber surrounding the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means for inlet of air into the projector chamber at the rearward end thereof, a combustion and expansion chamber communicating with the projector chamber and provided with a number of openings for passage of commingled fluid and fuel therefrom, means for inlet of air into the combustion and expansion chamber, a chamber around the projector chamber and between the projector chamber and the combustion and expansion chamber, means for inlet of air into said intermediate chamber, and means for outlet of air from said intermediate chamber into the combustion and expansion chamber.

10. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors, a forwardly opening projector chamber around the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means for inlet of air into the projector chamber, a combustion and expansion chamber communicating with the projector chamber, means for inlet of air into the combustion and expansion chamber, a chamber around the projector chamber and between the projector chamber and the combustion and expansion chamber, means for inlet of air into said intermediate chamber, and foraminous means for outlet of air from said intermediate chamber into the combustion and expansion chamber.

11. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharged from each of the projectors, a forwardly opening projector chamber around the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means for inlet of air into the projector chamber, a combustion and expansion chamber communicating with the projector chamber, means for inlet of atmospheric air into the combustion and expansion chamber, means for introducing air under pressure into the combustion and expansion chamber, a chamber around the projector chamber and between the projector chamber and the combustion and expansion chamber, means for inlet of air into said intermediate chamber, and means for outlet of air from said intermediate chamber into the combustion and expansion chamber.

12. A fuel burner comprising projectors for fuel under pressure disposed in parallelism and having interiors of increasing diameter from their inlet to discharge ends, a fuel pipe disposed between the projectors for discharging fuel into and substantially at right angles to the path of the fluid discharge from each of the projectors, a forwardly opening projector chamber around the projectors and fuel pipe into which chamber the projectors and fuel pipe discharge, means for inlet of air into the projector chamber, a combustion and expansion chamber communicating with the projector chamber, means for inlet of atmospheric air into the combustion and expansion chamber, means comprising a needle valve for introducing air under pressure into the combustion and expansion chamber, a chamber around the projector chamber and between the projector chamber and the combustion and expansion chamber, means for inlet of air into said intermediate chamber, and means for outlet of air from said intermediate chamber into the combustion and expansion chamber.

13. In combination, a housing open at the forward or discharge end and comprising an outer cylindrical side wall and a rear wall provided with an outer annular series of tertiary draft ports, an intermediate series of secondary ports within the outer series,

said rear wall being provided with the secondary series with a central feed pipe opening, diametrically disposed large air inlet ports, diametrically disposed projector seat openings and smaller air inlet ports; fuel projectors on said rear wall; a wall forming a projector chamber around and forward of said projectors and communicating with said inlet ports; a converging wall forming a secondary chamber around the projector chamber and communicating with said inner draft ports; diverging walls forming an expansion chamber forward of the projector, and an additional chamber around the secondary chamber fed by said outer draft ports and discharging air into the expansion chamber; and separate damper rings slidably mounted on the rear face of the back wall over said secondary and tertiary ports and provided respectively with corresponding shaped openings registerable with said ports.

14. In combination, a housing open at the forward or discharge end and comprising an outer cylindrical side wall and a rear wall provided with an outer annular series of tertiary draft ports, an intermediate series of secondary ports within the outer series, said rear wall being provided with the secondary series with a central feed pipe opening, diametrically disposed large air inlet ports, diametrically disposed projector seat openings and smaller air inlet ports; fuel projectors on said rear wall; a wall forming a projector chamber around and forward of said projectors and communicating with said inlet ports; a converging wall forming a secondary chamber around the projector chamber and communicating with said inner draft ports; diverging walls forming an expansion chamber forward of the projector, and an additional chamber around the secondary chamber fed by said outer draft ports and discharging air into the expansion chamber; separate damper rings slidably mounted on the rear face of the back wall over said secondary and tertiary ports and provided respectively with corresponding shaped openings registerable with said ports; and handles mounted on said rings by which the rings are adjusted for controlling the inlet of air.

15. In combination, a housing open at the discharge end and provided at the inlet end with outer and inner draft ports and air inlet ports; forwardly projecting and flaring valved pressure nozzle projectors in said inlet end; a fuel spray nozzle directing fuel across the discharge end of the projectors; a wall forming a projector chamber around and forward of said nozzle and projectors and communicating with said inlet ports; a converging wall forming a secondary chamber around the projector chamber communicating with said inner ports; a diverging forward wall forming an expansion chamber forward of the projector and cooperating with said converging wall to form a tertiary chamber around the secondary chamber communicating with said outer ports and discharging air into the expansion chamber; an air pressure valve mounted on the side wall of the housing near its rear end and provided with a conical seat discharging into the tertiary chamber; and a conical valve member movable in said valve for closing on said seat.

16. In combination with a pair of projectors for fluid under pressure, a fuel pipe disposed between the projectors having a nozzle provided with diverging discharge channels each discharge end of which is located slightly away from the discharge end of the adjacent projector for discharging fuel into and transversely to the path of the fluid discharged from the projector and providing space for expansion of the fluid after leaving the projector before meeting the fuel discharged transversely to its path.

17. In combination with a pair of projectors for fluid under pressure having interiors of increasing diameter from their inlet to outlet ends, a fuel pipe disposed between the projectors having a nozzle provided with a bifurcated discharge channel each discharge end of which is located slightly away from the discharge end of the adjacent projector for discharging fuel into and transversely to the path of the fluid discharged from the projector and providing space for expansion of the fluid discharged from the projector before meeting the fuel discharged transversely to its path.

18. In combination with a pair of projectors for fluid under pressure, a fuel pipe disposed between the projectors having a nozzle provided with diverging discharge channels each discharge end of which is located slightly away from the discharge end of the adjacent projector for discharging fuel into and transversely to the path of the fluid discharged from the projector and providing space for expansion of the fluid after leaving the projector and before meeting the fuel discharged transversely thereto, said nozzle being located between the discharge ends of the projectors and extending beyond the discharge ends of the projectors and thereby separating the commingled fluid and fuel into streams which due to the expansion of the commingled fluid and fuel converge and later combine.

19. In combination with a pair of projectors for fluid under pressure having interiors of increasing diameter from their inlet to their outlet ends, a fuel pipe disposed between the projectors having a nozzle provided with diverging discharge channels each discharge end of which is located slightly away from the discharge end of the adjacent projector for discharging fuel into and transversely to the path of the fluid dis-

charged from the projector and providing space for expansion of the fluid discharged from the projector before meeting the fuel discharged transversely to its path, said nozzle extending across the end of the fuel pipe at right angles thereto and adjacent the discharge ends of the projectors and in length extending beyond the discharge ends of the projectors and thereby separating the commingled fluid and fuel into streams which due to the expansion of the commingled fluid and fuel converge and later combine.

20. A process comprising, projecting substantially parallel laterally confined separated streams of high pressure fluid; laterally progressively expanding the confined streams; discharging each stream; injecting liquid fuel transversely into the streams near their discharge whereby to atomize the fuel and to mix it with the fluid and cause it to be carried along by the stream; introducing air to, and causing combustion of, the mixture of each stream near the point of mixture; combining the burning streams into a single stream; introducing air to the streams at the point of their combination; and supplying air to said single stream beyond the point of combination.

21. A process comprising, projecting laterally confined separated streams of high pressure steam; laterally progressively expanding the confined streams; discharging each stream; causing an interval of free expansion after said discharge; injecting liquid fuel transversely into the streams after said interval whereby to atomize the fuel and to mix it with the steam and cause it to be carried along by the steam; and introducing air to, and causing combustion of, the mixture of each stream near the point of mixture; and combining the burning streams to form a single stream.

22. A process comprising, projecting a laterally confined stream of high pressure fluid; laterally progressively expanding the confined stream; discharging the stream; injecting liquid fuel transversely into the stream near its discharge whereby to atomize the fuel and to mix it with the fluid and cause it to be carried along by the stream; introducing air to the fuel and fluid substantially, at and after the point of mixture; causing combustion of the mixture near said point; and supplying air to the mixture beyond the point of combination.

23. A process comprising, projecting laterally confined separated streams of high pressure steam; laterally progressively expanding the confined streams; discharging each stream; injecting liquid fuel transversely into the streams near their discharge whereby to atomize the fuel and to mix it with the steam and cause it to be carried along by the steam; introducing air, the fuel and steam substantially at the point of mixture; causing combustion of the mixture near said point; combining the burning streams; introducing air to the streams at the point of their combination; and supplying air to the mixture beyond the point of combination.

24. An apparatus comprising, nozzles tapering toward their inlet ends for projecting and laterally progressively expanding laterally confined separated streams of high pressure fluid and discharging them; means for injecting liquid fuel transversely into the streams near their discharge whereby to atomize the fuel and to mix it with the fluid and cause it to be carried along by the stream; and means for introducing air to each stream near the point of mixture; said nozzles being positioned for combining the ignited streams into a single stream.

25. An apparatus comprising, nozzles tapering toward their inlet ends for projecting and laterally progressively expanding laterally confined separated streams of high pressure steam and discharging them; means for injecting liquid fuel transversely into the streams near their discharge whereby to atomize the fuel and to mix it with the steam and cause it to be carried along by the steam; and means for introducing air to the fuel and steam of each stream near the point of mixture; said nozzles being substantially parallel and positioned for combining the ignited streams.

26. An apparatus comprising, a pair of nozzles for projecting separated streams of steam and discharging them; means for injecting liquid fuel transversely into the streams near their discharge whereby to atomize the fuel and mix it with the steam and cause it to be carried along by the steam; said nozzles being substantially parallel and positioned for combining the ignited streams to form a combined stream; means for introducing air to the streams at the point of their combining; means for laterally confining and laterally expanding the combined stream and means for supplying air to the combined stream beyond the point of combination.

Signed at 934 Park Ave., in the county of Union and State of New Jersey, this 26th day of September, A. D. 1923.

HENRY ADAMS.