Oct. 26, 1965 E. M. RUDZKI ETAL 3,213,918

LIQUID-GASEOUS FUEL BURNER

Filed Sept. 4, 1963

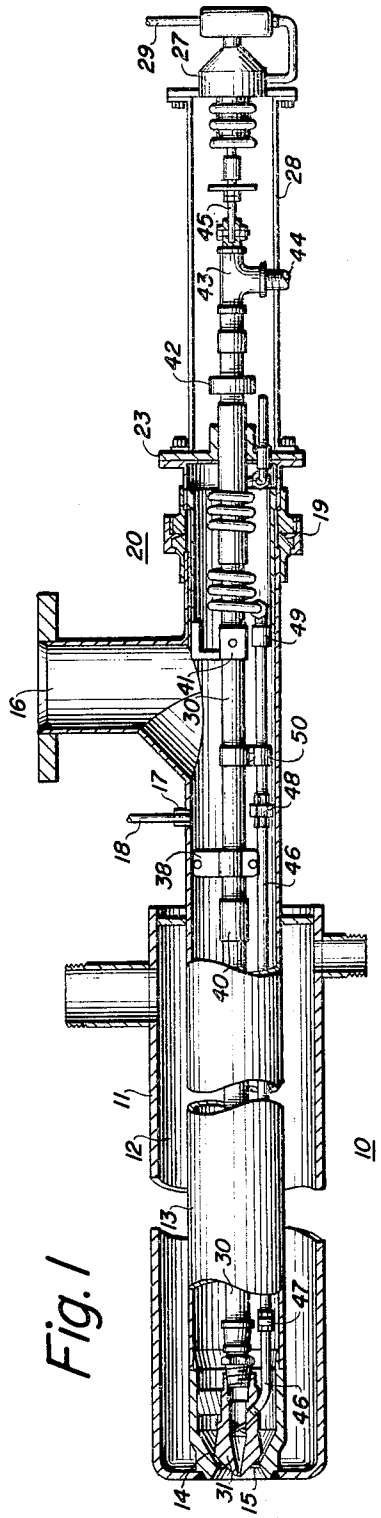


Fig. 1

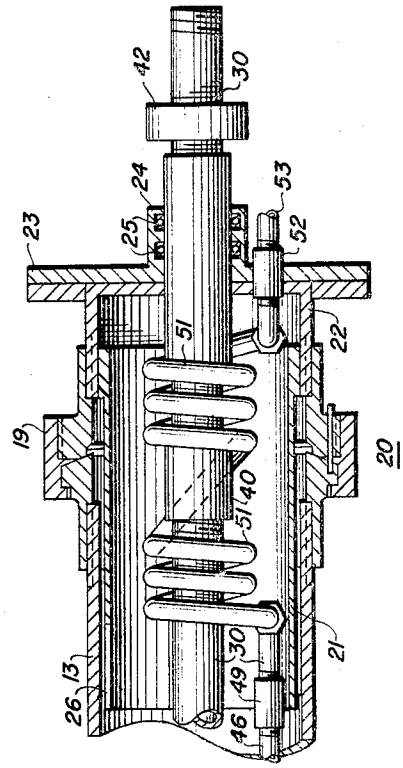


Fig. 3

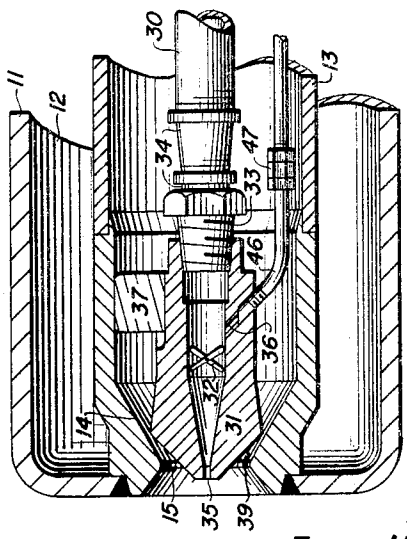


Fig. 2

INVENTORS

Eugene M. Rudzki

BY Richard J. Reinbold

Bradford K. Pease

United States Patent Office 3,213,918 Patented Oct. 26, 1965

3,213,918

LIQUID-GASEOUS FUEL BURNER

Eugene M. Rudzki and Richard J. Reinbold, Bethlehem, and Bradford K. Pease, Allentown, Pa., assignors, by mesne assignments, to Bethlehem Steel Corporation, a corporation of Delaware

Filed Sept. 4, 1963, Ser. No. 306,510
5 Claims. (Cl. 158—11)

This invention relates to an improved combination liquid-gaseous fuel burner particularly suited for intermittent operation in a metallurgical furnace. More specifically it is directed to a burner in which liquid fuel is atomized by low pressure gas, i.e. gas at a pressure no greater than 15 p.s.i.g., under varying operating conditions, and wherein the liquid fuel nozzle is continuously purged by a fluid medium during the idle portion of an operating cycle.

In the metallurgical industry various types of fuels such as oil, tar or gas are used to heat furnaces. In some instances a combination of these fuels are used, as for example in the large open hearth furnaces utilized to make steel. In a conventional open hearth burner firing a combination of gaseous and liquid fuel, both fuels pass through the water cooled burner casing in separate tubes and become mixed upon their discharge from the burner. The liquid fuel is atomized by steam, at the rear of the burner, before it passes through its tube into the furnace. However, the use of atomizing steam reduces the flame temperature and increases the volume of combustion products passing through the checkers and flues.

It is an object of the present invention to provide a burner wherein liquid fuel is atomized, without the use of steam, by low pressure gas.

Another object is to provide an improved liquid-gaseous fuel burner which will produce a higher flame temperature than is produced by this type burner at the present time.

Another object is to provide a liquid-gaseous fuel burner which, as compared to conventional burners, will decrease the volume of combustion products passing through a furnace operating under similar conditions.

Another object is to provide a liquid-gaseous fuel burner that utilizes a pressure nozzle for initial atomization of the liquid fuel prior to its atomization by the gas.

It is a further object to provide a liquid-gaseous fuel burner wherein there is a continuous purge of the liquid fuel nozzle during the idle periods of an operating cycle to prevent the accumulation of foreign matter in the nozzle orifice. Other objects and advantages of this invention will be apparent from the following specification and the accompanying drawings, in which

FIG. 1 is a side elevation, partly cross sectional, of the improved oil burner of the present invention;

FIG. 2 is a sectional view of the discharge end of the burner; and

FIG. 3 is a view of the back end of the burner.

For purposes of illustration this invention will be described with particular relation to open hearth burners adapted to burn a combination of liquid and gaseous fuel, but it is not necessarily limited thereto. Those familiar with steelmaking operations know that a single burner is used at each end of an open hearth furnace, and, in heating the charge, the burners are fired alternately. Some liquid gaseous fuel burners have a plurality of ports in the liquid nozzle which allow the burner to remain in service when some of the ports become obstructed; other burners of this type require high pressure gas to provide the desired degree of atomization of the liquid fuel. Our invention utilizes low pressure gas and provides a novel means of automatically and continuously purging the liquid fuel nozzle of a liquid-gaseous burner during the idle portion of an operating cycle. By purging the liquid fuel nozzle immediately after the fuel has been shut off, the accumulation therein of carbonized residual fuel is prevented. By continuing the purging for the entire period of time the burner is inactive, the pressure and cooling effect of the purge medium prevent the adherence of slag and other foreign matter to the nozzle. The purge medium is always available at the discharge end of the burner but only flows through the nozzle when the liquid fuel pressure within the nozzle drops below the pressure of the purge medium.

Referring now to the drawings in detail, the invention is illustrated as embodied in a pressure responsive gas atomizer burner **10**. The portion of the burner which projects into the furnace is enclosed by a casing **11** which forms a chamber **12** adapted to have a suitable coolant circulated therethrough. A gaseous fuel pipe **13** extends longitudinally through casing **11** and projects beyond the back end of said casing, as shown in FIG. 1. The front end of gaseous fuel pipe **13** has a forwardly and inwardly inclined inner surface **14** which terminates in a circular axial orifice **15**. Atomizing gas flows into fuel pipe **13** through inlet connection **16**, and the pressure of the gas within the fuel pipe **13** is transmitted to a controller, not shown, on the furnace panel board, through pressure tap **17** and pressure impulse line **18**. Joined to the rear end of fuel pipe **13** by means of union **19**, is back plate assembly **20**, as shown in FIG. 3.

Back plate assembly **20** comprises a sleeve **21**, of slightly smaller outside diameter than the inside diameter of fuel pipe **13**, connected to casing **22**, and back plate **23**, which is bolted to the flanged back end of casing **22**. The front end of casing **22** is threaded to receive one half of union **19**. The other half of union **19** is screwed to the threaded back end of casing **13**. Axially located in back plate **23** is seal assembly **24** with O-ring seals **25**. A narrow slot **26** is machined in the forward section of sleeve **21** for a purpose to be hereinafter more fully described. A positioner **27** is mounted on back plate assembly **20** by means of bracket **28**. Positioner **27** is remotely connected by impulse line **29** to the furnace panel board, from which the operation of the burner is controlled.

Extending longitudinally within fuel pipe **13** is liquid fuel tube **30**. The rear portion of fuel tube **30** extends through seal assembly **24** of back plate **23** and beyond the rear end of gaseous fuel pipe **13**. Liquid fuel nozzle **31** with insert **32** is connected to the forward end of the liquid fuel tube. Between the liquid fuel tube **30** and liquid nozzle **31** are interposed check valve **33** and suitable fittings **34**, all axially assembled to allow the continuous unobstructed passage of liquid fuel, in a forward direction, through the assembly. There is a single axial orifice **35** in the forward end of nozzle **31**, and in its side wall, closely adjacent orifice **35**, is purge opening **36**. Guide fins **37**, spaced 120° apart, on the rear of nozzle **31** and guides **38** mounted on fuel tube **30** insure that the fuel tube moves axially within the fuel pipe **13** and that the nozzle **31** cooperates, in a manner hereinafter more fully described, with the inclined inner surface **14** of fuel pipe **13** to form a variable annular opening **39** which terminates in orifice **15**. Fuel tube **30** is made in sections joined by fittings **40** to facilitate assembly and disassembly. A backward motion stop **41** is mounted on fuel tube **30**, within fuel pipe **13**, near its back end. The L-shaped extension of stop **41** moves within previously mentioned slot **26** of sleeve **21** of back plate assembly **20** and prevents fuel tube **30** from moving to the rear more than a limited distance. Outside the back end of fuel pipe **13**, a forward motion stop **42** is mounted on fuel tube **30** and prevents it from moving forward more than a limited distance. Tube **30**, at its back end, is connected to one branch of fitting **43**. Another branch of fitting **43** is connected, by means of a flexible tube **44**, to an oil supply system, not shown. The

third branch of fitting 43 is coupled to shaft 45 of positioner 27.

Also disposed within gaseous fuel pipe 13 is purge conduit 46. At its forward end, this conduit is connected to nozzle 31 at purge opening 36. Just to the rear of this connection, check valve 47 is axially mounted in conduit 46 in a manner to allow the unobstructed flow of the purge medium through said conduit in a forward direction but to prevent the flow, in the opposite direction, of liquid fuel into said conduit. Purge conduit 46 is formed in sections, joined by fittings 48 and 49, to facilitate maintenance. In addition to being connected to fuel nozzle 31 on the forward end of fuel tube 30, purge conduit 46 is fastened to liquid fuel tube 30 by clamps 50 so that tube 30 and conduit 46 move as a unit. A portion of conduit 46, near its back end, is formed into a coil 51 which encircles fuel tube 30. Coil 51 acts as an expansion means which prevents the failure of conduit 46 due to thermal stresses and permits it to move, without breaking, in conjunction with fuel tube 30. The back end of coil 51 of conduit 46 is joined to fitting 52, in back plate 23, which in turn is connected by means of pipe 53 to a source, not shown, of purge medium.

The burner of this invention has the liquid fuel introduced concentrically within the gas stream as these fuels are discharged from their respective passageways at the forward end of the assembly. In addition to the atomization created by the pressure atomizing fuel nozzle 31, impingement of the gas upon the liquid further atomizes it. The degree of atomization caused by the gas is dependent upon its velocity, and the pressure and velocity of the gas are sustained at a maximum rate by maintaining the annular opening 39 at the minimum cross-sectional area required to pass the desired amount of gas.

The control of the burner, including the regulation of the fuel rate, takes place at the furnace instrument panel. The flow rate of liquid fuel fired during an open hearth heat is generally maintained constant, and any changes in the firing rate, made in accordance with the firing schedule, are accomplished by varying the gas flow. The pressure and flow of fuel through the burner is adjusted by controllers on the furnace panel board. The gas pressure controller is connected by impulse line 18 to pressure tap 17, on burner fuel pipe 13, and by impulse line 29 to positioner 27. Variations in pressure within fuel pipe 13 are transmitted to the gas pressure controller on the panel board and then relayed to the positioner 27. The positioner compensates for these variations in pressure of the gas by axially displacing liquid nozzle 31, to which it is remotely connected. The displacement of the liquid nozzle varies the cross-sectional area of annular opening 39 and maintains a constant and maximum gas velocity through said opening independent of the flow rate of gas into fuel pipe 13.

The alternate firing of the furnace burners is also regulated at the instrument panel and usually operates on a fixed time cycle. When the fuel to a burner is shut off, the pressure within the liquid fuel tube 30 immediately drops. When this pressure drops below the pressure of the purge medium in conduit 46, the purge medium, always available within said conduit, opens check valve 47 in said conduit, and the purge medium flows through nozzle 31 and out through orifice 35. Any residual fuel remaining in the nozzle chamber is evacuated by the purge medium, and coking or charring of residual liquid fuel within the nozzle is prevented. Check valve 33 is automatically closed by the pressure of the purge medium which is thus prevented from entering fuel tube 30. The purge medium flows continuously through the fuel nozzle during the time the burner is idle, and the pressure and cooling effect of the medium prevent slag and other foreign matter from being deposited on the nozzle.

When the furnace reverses and the inactive burner, the nozzle of which was continuously purged, goes into service, the liquid fuel, at a higher pressure than the purge medium, opens check valve 33 and again flows through tube 30, check valve 33, nozzle 31, and orifice 35. Check valve 47 in the purge conduit closes and prevents the liquid fuel from flowing through that line.

The backward motion stop 41 and the forward motion stop 42 mounted on fuel tube 30 operate as stops of this nature normally function and, by restricting movement of the fuel tube and purge conduit, prevent the gas from being shut off completely under adverse conditions and prevent the burner from being damaged.

In the specific embodiment of this invention as described, the liquid fuel nozzle 31 was designed to pass 150 GPH of blended pitch at a pressure of 150 p.s.i.g. through orifice 35, which was 0.014" in diameter. Steam at a pressure of about 110 p.s.i.g. was utilized as the purge medium, and the pressure of the gas was maintained at approximately 14 p.s.i.g. The liquid nozzle 31 illustrated in FIGURES 1 and 2 has an insert 32 which produces a full cone spray pattern, and while various nozzles may be utilized, the pattern of atomized droplets produced by this type nozzle was found to be most advantageous for our service. The positioner 27 was a direct acting positive displacement type, but other positioners may be utilized.

In the burner described above, the purge steam consumption varied between 30 and 40 pounds per hour as compared to the 1050 pounds of steam per hour previously consumed, under similar conditions, by burners utilizing conventional steam atomization of liquid fuel. In plants where there is a limited amount of steam available for all purposes, the reduction in steam consumption realized by the use of our burner is of considerable importance. Other benefits realized from the use of the specified burner are flame temperatures approximately 100° F. higher than those produced by a conventional burner, greater availability of high temperature heat, and a decrease in the volume of combustion products of about 4%.

Although certain novel features of our invention have been shown and described, it will be understood that changes and modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. A liquid fuel burner adapted for intermittent operation in a furnace comprising, within said burner:

(a) a liquid-fuel-supply tube terminating at its outer end in a restricted orifice,

(b) a first check valve in said liquid-fuel-supply tube located to the rear of and closely adjacent to said tube orifice and arranged to permit forward flow of liquid fuel through said supply tube and check valve and out of said tube orifice and to prevent back flow of fluid through said first check valve,

(c) a purging-medium-supply conduit communicating with said liquid-fuel-supply tube between said tube orifice and said first check valve,

(d) a second check valve in said purging-medium-supply conduit closely adjacent to said tube orifice and arranged to permit forward flow of purging medium through said purging-medium-supply conduit and second check valve and out of said tube orifice and to prevent back flow of fluid through said second check valve,

(e) a pipe surrounding said liquid-fuel-supply tube, said first check valve, said purging-medium-supply conduit, and said second check valve,

(f) means to intermittently supply liquid fuel to said liquid-fuel-supply tube for ejection through the tube orifice therein, and

(g) means to supply purging medium to said purging-medium-supply conduit for ejection through the tube orifice in said liquid-fuel-supply tube during periods when liquid fuel is not being ejected therethrough.

2. A liquid-gaseous fuel burner adapted for intermittent operation in a furnace comprising, within said burner:

(a) a liquid-fuel-supply tube terminating at its outer end in a restricted orifice,

(b) a first check valve in said liquid-fuel-supply tube located to the rear of and closely adjacent to said tube orifice and arranged to permit forward flow of liquid fuel through said supply tube and check valve and out of said tube orifice and to prevent back flow of fluid through said first check valve,

(c) a purging-medium-supply conduit communicating with said liquid-fuel-supply tube between said tube orifice and said first check valve,

(d) a second check valve in said purging-medium-supply conduit closely adjacent to said tube orifice and arranged to permit forward flow of purging medium through said purging-medium-supply conduit and second check valve and out of said tube orifice and to prevent back flow of fluid through said second check valve,

(e) an atomizing-gas-supply pipe surrounding said liquid-fuel-supply tube, said first check valve, said purging-medium-supply conduit, and said second check valve, said atomizing-gas-supply pipe terminating at its outer end in an orifice adjacent to said liquid-fuel-supply tube orifice,

(f) means to intermittently supply liquid fuel to said liquid-fuel-supply tube for ejection through the tube orifice therein,

(g) means to supply atomizing gas to said atomizing-gas-supply pipe, and

(h) means to supply purging medium to said purging-medium-supply conduit for ejection through the tube orifice in said liquid-fuel-supply tube during periods when liquid fuel is not being ejected therethrough.

3. A liquid-gaseous fuel burner adapted for intermittent operation in a furnace comprising

(a) a liquid-fuel-supply tube terminating at its outer end in a restricted orifice,

(b) a first check valve in said liquid-fuel-supply tube located to the rear of and closely adjacent to said tube orifice and arranged to permit forward flow of liquid fuel through said supply tube and check valve and out of said tube orifice and to prevent back flow of fluid through said first check valve,

(c) a purging-steam-supply conduit communicating with said liquid-fuel-supply tube between said tube orifice and said first check valve,

(d) a second check valve in said purging-steam-supply conduit closely adjacent to said tube orifice and arranged to permit forward flow of purging steam through said purging-steam-supply conduit and second check valve and out of said tube orifice and to prevent back flow of fluid through said second check valve,

(e) an atomizing gas supply pipe surrounding said liquid-fuel-supply tube and said purging-steam-supply conduit and terminating at its outer end in an orifice adjacent to said liquid-fuel-supply tube orifice.

(f) means connecting said liquid-fuel-supply tube and said purging-steam-supply conduit so that said tube and conduit move as a unit with respect to the gas supply pipe and in response to variations in the pressure of the atomizing gas,

(g) means to intermittently supply liquid fuel to said liquid-fuel-supply tube for ejection through the tube orifice therein,

(h) means to supply atomizing gas to said atomizing-gas-supply pipe, and

(i) means to supply purging steam to said purging-steam-supply conduit for rejection through the tube orifice in said liquid-fuel-supply tube during periods when liquid fuel is not being ejected therethrough.

4. The liquid-gaseous fuel burner of claim 3 wherein expansion means are incorporated in said purging-steam-supply conduit.

5. A liquid fuel burner adapted for intermittent operation in a furnace comprising:

(a) a liquid-fuel-supply tube terminating at its outer end in a restricted orifice,

(b) a first check valve in said liquid-fuel-supply tube located to the rear of and closely adjacent to said tube orifice and arranged to permit forward flow of liquid fuel through said supply tube and check valve and out of said tube orifice and to prevent back flow of fluid through said first check valve,

(c) a purging-medium-supply conduit communicating with said liquid-fuel-supply tube between said tube orifice and said first check valve,

(d) a second check valve in said purging-medium-supply conduit closely adjacent to said tube orifice and arranged to permit forward flow of purging medium through said purging-medium-supply conduit and escond check valve and out of said tube orifice and to prevent back flow of fluid through said second check valve,

(e) means to intermittently supply liquid fuel to said liquid-fuel-supply tube under pressure greater than atmospheric for ejection through the tube orifice therein, and

(f) means to continually supply purging medium to said purging-medium-supply conduit under pressure greater than atmospheric but less than that under which liquid fuel is supplied to said liquid-fuel-supply pipe for ejection through the tube orifice in said liquid-fuel-supply tube during periods when liquid fuel is not being ejected therethrough.

References Cited by the Examiner

UNITED STATES PATENTS

1,587,529	6/26	Hoyt	239—112
1,841,698	1/32	Barber	158—11
2,818,110	12/57	Rulseh	158—36
1,953,248	9/60	Troland	239—112 X
3,043,366	7/62	Wentworth	158—36

JAMES W. WESTHAVER, *Primary Examiner.*

MEYER PERLIN, *Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,213,918 October 26, 1965

Eugene M. Rudzki et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 14, for "0.014″ " read -- 0.104″ --; column 6, line 12, for "rejection" read -- ejection --; line 35, for "escond" read -- second --.

Signed and sealed this 31st day of May 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents