June 27, 1972 SHUZO MIYAZAKI 3,672,808

METHOD AND APPARATUS OF CONTINUOUS STEAM-ATOMIZING FUEL COMBUSTION FOR BOILER FURNACE

Filed Oct. 15, 1970 2 Sheets-Sheet 1

FIG. 1

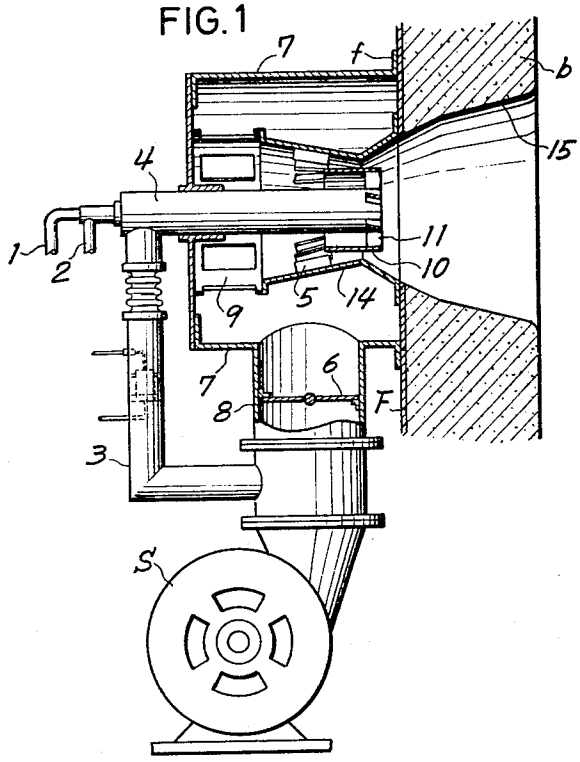
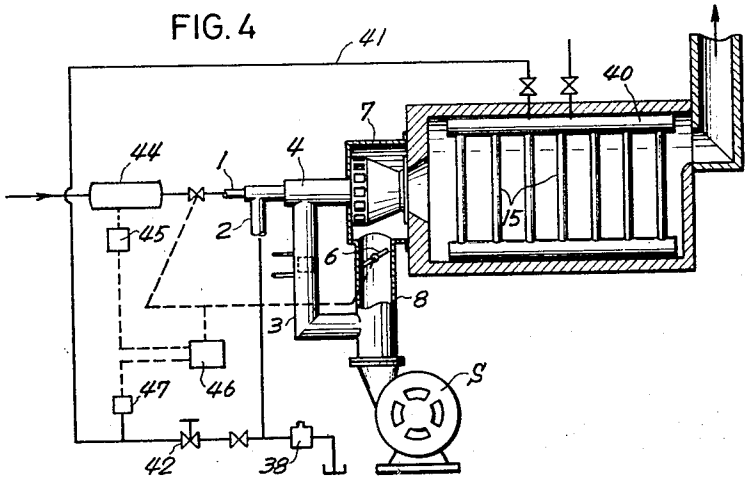


FIG. 4



June 27, 1972 SHUZO MIYAZAKI 3,672,808
METHOD AND APPARATUS OF CONTINUOUS STEAM-ATOMIZING
FUEL COMBUSTION FOR BOILER FURNACE
Filed Oct. 15, 1970 2 Sheets-Sheet 2

FIG. 2

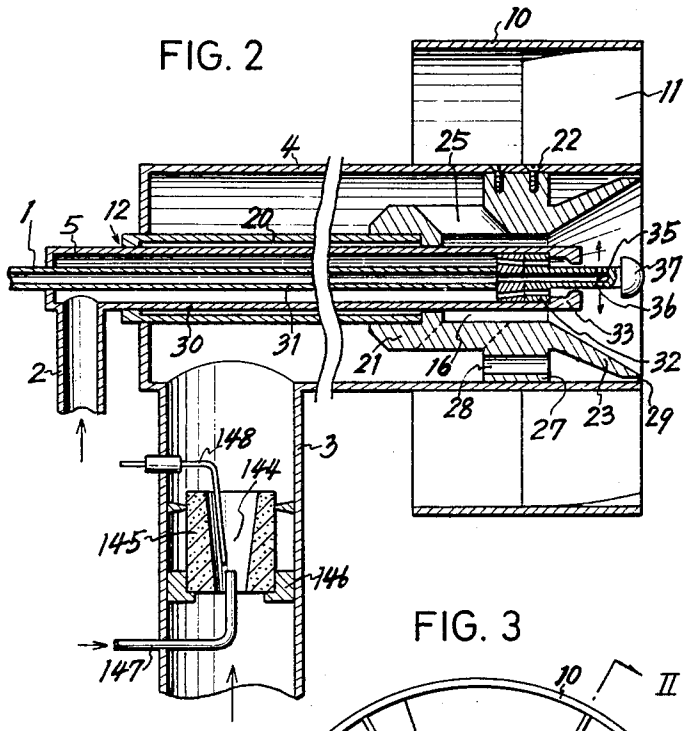
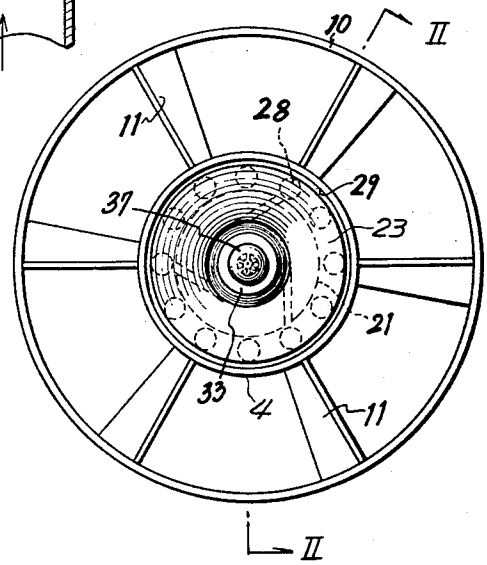


FIG. 3



United States Patent Office 3,672,808
Patented June 27, 1972

3,672,808

METHOD AND APPARATUS OF CONTINUOUS STEAM-ATOMIZING FUEL COMBUSTION FOR BOILER FURNACE

Shuzo Miyazaki, Tokyo, Japan, assignor to Japan Furnace Industry Co. Ltd., Tokyo, Japan

Filed Oct. 15, 1970, Ser. No. 80,906
Int. Cl. F23n 1/04
U.S. Cl. 431—2 10 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for initiating combustion in a steam-atomizing furnace using the pressurized source of combustion air to atomize the fuel during startup when the steam pressure is insufficient to do so. A damper is provided in the air inlet to build up the air pressure upstream of the damper so that the latter air pressure may be directed through the atomizing nozzle. When the furnace is up to temperature and steam is generated by the furnace, the damper is opened to obtain efficient combustion of the fuel which is then atomized by the steam. A supplemental air heater is provided to elevate the temperature of the pressurized air during the startup.

This invention relates to method and apparatus of continuous steam-atomizing fuel combustion for boiler furnace of forced draft combustion system.

Generally there are various types of oil burners for steam boiler use such as oil pressure type, rotary type, low pressure or high pressure air-atomized oil burner, steam-atomizing oil burner. Among these conventional burners, the steam-atomizing oil burner has been preferably available because of its merits that (1) steam generated in the boiler may be directly used as an atomizing medium, and that (2) the very high turn-down ratio of combustion amount permits the burner to easily follow the load variation in the steam boiler. Especially the recent trend of reducing the size of combustion chamber of steam boiler itself, and using a high pressure in furnace requires a high-pressure, high-loaded combustion oil burner. This rapidly increases the demand for a steam-atomizing burner. For example, the turn-down ratio of burner is changing from the conventional ratio 10:4 to 10:1 or 12:1. The furnace pressure is also changing from the conventional 20–50 mm., column of water, to 150–300 mm., column of water. The combustion chamber load is also changing from 200,000 Kcal./m.^{3} hr. to 1,500,000–2,500,000 Kcal./m.^{3} hr. Such technical requirements have developed an increasing application for a steam atomizing burner because of its high-loaded combustion and wide range controllability. On the other hand, operation of the steam boiler is rapidly being automated. Almost all small-sized steam boilers of evaporation amount of less than 30 t./h. have adopted semi-automatic or full automatic operation system. Since a steam atomizing burner may not be operated under the steamless condition in automatic operation, (1) the operation should be started by the aid of a starter oil pressure burner until steam generates and then the burner is changed to a steam atomizing burner for continuing operation, or (2) an air compressor should be separately provided for making an atomized air flow at the time of starting. If there is a steam source, the steam from this source may be used for starting, but such a steam source is rarely available in the site where a relatively small sized boiler is installed. Moreover almost all of small-sized boilers which are, as a general rule, controlled in an unattended manner, rely upon starter button system for automatic operation, so that it should essentially be operated continuously from starting.

An object of the newly developed apparatus of the present invention is to fulfill these requirements, that is, to utilize the excellent high-loaded combustion caused by steam injection and to maintain continuous operation from starting to normal operation. In view of the fact that almost all of small- or medium-sized boilers of the day use a forced draft combustion system provided with a blower for supplying combustion air, the present invention has for its feature to utilize the high pressure air of the blower as atomizing air, thereby establishing easy starting and automatic change for continuous operation very economically without any separate source of air flow for atomizations.

The structure and operation of the present invention will be now explained in detail with reference to the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a fuel burner of the present invention;

FIG. 2 is an enlarged sectional view of FIG. 1, illustrating operation of the steam-atomizing burner under steamless starting condition;

FIG. 3 is a front view taken from the right end face of FIG. 2; and

FIG. 4 is a flow sheet showing the connection between the feed of fuel and steam in the burner of the present invention and the blast from a blower.

Referring to FIG. 1, there is shown a vertical sectional view of an embodiment of the oil burner according to the present invention. The oil burner illustrated is fixed to a front wall *b* of a boiler furnace. A wind box **7** of cylindrical configuration is fluid-connected to a secondary combustion air inlet duct **8** which is integrally provided with a combustion air adjusting dumper **6**. The wind box **7** is fixed to a front panel F of a boiler furnace wall *b* by a front plate-mounting flange *f*. The furnace wall *b* for the front panel F is provided with a funnel-shaped burner tile hole **15** for stabilizing combustion. On inside of the front surface of the wind box **7** is concentrically provided an air rectifying cylinder **9** with suitable openings, said cylinder is connected to a burner throat **14** reduced radially at its middle portion. The air fed through air rectifying cylinder **9** is portionally throttled at the burner throat **14** and then fed into the furnace along inside surface of the burner tile hole **15** while expanding toward the interior of the furnace. Air deflectors **5** are provided all over the inside wall of burner throat **14**. The air deflectors **5** are each arranged with a fixed angle relative to the axis line of the throat so as to cause the air introduced along inside wall of the throat to swirl. A steam atomizer **12** is built in the central portion of an atomizing cylinder **4** which is provided through the central portion of the air cylinder **9** and throat **14**. As shown in detail in FIG. 2, an air inlet passage **3** provided in the base portion of the atomizing cylinder **4** receives atomizing air from an intermediate passage between the air flow adjusting dumper **6** in the air inlet duct **8** of the blower S and an outlet of the same blower so as to introduce the primary air directly into the atomizing cylinder **4**. In the base portion of atomizer **12** passing through the center of the atomizing cylinder **4** is provided an atomizing steam inlet **2** and a fuel inlet pipe **1** as explained in detail hereinafter. A swirler **11** provided on the outer periphery of the end portion of the atomizing cylinder **4** causes the air introduced in the proximity of the atomizing cylinder **4** to stabilize the firing. Reference numeral **10** denotes an air inlet cylinder attached to the swirler **11**. An atomizer holder **20** is provided in the middle portion of the atomizing cylinder **4**. An atomizer body **21** is provided at the end of the holder **20** and a flange **27** provided in the middle portion of the atomizer body **21** is fixed to outer cylinder **4** by screws **22**. The inner surface of the atomizer

body 21 is cylindrical at its basic portion and tapered outwardly toward the end into a cup-like shape 23. The cylindrical base portion of the atomizer body 21 is tangentially provided at three locations therein with air inlet slits 25. The flange 27 in the middle of the atomizer body 21 is provided with a number of air ducts 28. The foremost end of the cup 23 makes an annular air passage 29 at a clearance between the atomizing cylinder 4 and the cup-shaped portion 23. Accordingly, the air introduced from the air inlet passage 3 into the atomizing cylinder 4 is partially guided in the chamber 16 of said atomizer body 21 through the tangential slits 25 and proceeds along the inner surface of said atomizer body 21, together with making swirling movements. The rest of the air outside the atomizer body 21 passes through the air duct 28 of the atomizer flange 27 and then runs through the annular slit 29 and is released into the furnace. The steam atomizer 30 provided at the center of the atomizer holder 20 and atomizer body 21 may be of any one of external mixing types. In accordance with the present invention, the steam atomizer is arranged such that the fuel oil is jetted out from a plurality of nozzle orifices which are substantially perpendicular to the axis of the atomizer.

In the ambodiment shown in FIG. 2, atomizing steam introduced from the steam inlet 2 through the clearance between the outer cylinder 30 of the atomizer and the oil pipe 31 provided at the center of said holder and cylinder proceeds through the steam passage of a sprayer body 32 and leaves the clearance between the sprayer body and the tip of a cap nut 33. The oil proceeds through the oil pipe 1 and the oil passage 35 at the center of the spray body 32 and leaves oil outlet port 36 along the normal direction. A substantially semi-spherical impact head 37 is provided at the tip end of the oil pipe 31, so that the oil injected in the normal direction encounters with steam injected and impinges on the impact head 37. Thus, the oil spreads in the form of fine misty particles and is completely mixed with the air. The mixture is then forced into the furnace and gasified by heat so as to burn satisfactorily. When there is no steam at the time of starting, only oil is injected from the port 36. Now assuming the nozzle is placed at an appropriate position of the opening of atomizer body 21 (for example as shown in FIG. 2), the oil injected first impinges upon the inner wall of the cup of said atomizer body 21 and then is introduced through tangential air from said air ports 15 of the atomizer body, and then spread divergently with the swirling air. The atomized oil is thus carried by the air flow along the cup edge 23 of the atomizer body and injected in the form of thin film or vapor in the same manner as in the rotary-cup atomizer. This oil film is finely atomized by high speedy air jet from the circumferentially-spaced passage of the atomizer. For obtaining high atomizing effect, it is, of course necessary to keep a larger momentum of the air, more especially. It is important to maintain a certain pressure head. For instance, in case of a small-sized boiler having the furnace static pressure of 300 mm. column of water at maximum load and the wind box static pressure of 500 mm. column of water i.e. the absolute differential pressure of 200 mm. column of water, the blower is generally designed to have the static pressure of 600–700 mm. column of water, with taking pressure loss in the piping into consideration. Now supposing that the combustion amount is $\frac{1}{10}$ at burner starting, the furnace pressure should be $\frac{1}{100}$ i.e. about 3 mm. column of water. In this condition, further assuming that a blower having the static pressure of 600 mm. column of water is operated with air flow of $\frac{1}{10}$ as throttling the dumper, the static pressure will be higher than 700 mm. column of water, depending upon the characteristic of the blower. This static pressure of about 700 mm., used as the atomizing air pressure at the time of starting will be sufficient for atomization. With generation of steam after starting, the steam automatically flows into the atomizer whereby the steam-atomizing burner is automatically turned into its operative condition. Although the differential pressure between the discharge pressure of the blower and the furnace pressure gradually decreases with increase of the boiler load, no problem for atomization occurs because the air discharged from the atomizer only acts for combustion, not for atomization, after generation of steam.

FIG. 4 shows a flow sheet when the present device is installed to the boiler. The main combustion air inlet passage 8 starting from the blower S is connected to the wind box 7 through the dumper 6 and then branches air passage 3 to feed air directly to the atomizing cylinder 4. The atomizing steam is led directly from a boiler header 40 or a steam reservoir to the steam inlet 2 of the atomizer through a piping 41 having therein a solenoid-operated valve 42. A drain trap 38 provided at the steam inlet 2 of the atomizer serves to feed dry steam to the atomizer 30 as soon as steam generates in the boiler. It will be thus understood that the fuel atomization is automatically turned into the steam atomizing manner. The amounts of combustion air flow and fuel are simultaneously controlled by a dumper 6 and an oil regulating valve 43 which are operated from a master controller 46 through a linkage mechanism 49. Reference numeral 44 denotes a heater, 45 a thermostat and 47 a pressure switch.

As above stated, the present device which uses a steam-atomizing burner may advantageously perform continuous operation from starting to normal operation without providing an atomizing medium generator to be used under steamless condition. In order to ignite the oil burner more effectively in the normal air of about 700 mm. column of water, some effective energy for atomization must be preferably given to the air. For such purpose in the present invention, small amount of suitable gas, such as liquid pressure gas, is burnt in the air inlet duct 3 and the burnt gas is to be mixed to the primary air to prepare heated air of 200°–400° C. to atomize the oil.

As shown in FIG. 2, a cylindrical ceramic pipe 145 having a combustion chamber 144 therein is supported on the stays 146 in the air inlet pipe 3 leaving a space between the air inlet pipe 3 and ceramic pipe 145. To said chamber 144 of said ceramic pipe, a gas burner pipe 147 is inserted from under side and a gas igniting electric terminal 148 is inserted from upper side near the burner pipe. When in use, gas ejected from the burner pipe 147 is ignited by electric sparks between the terminal 148 and the burner pipe 147. The burnt gas from the ceramic pipe 145 and the primary air from the pipe 3 are mixed to become hot air of 200°–400° C. The hot air may be forced from the air inlet pipe 3 via slit 25 of atomizer to the cup 23 to swirl and atomizes the oil from the spout 36. Therefore the starting of the burner in steamless condition becomes easier and burning efficiency in normal running may be improved. As stated, a small amount of gas, such as liquid pressure gas, is burned in the gas burner 147 the primary air is heated about 300° C. The gasification of the atomized oil becomes easy by the heated primary air and burning speed may be improved and continuous steady burning is obtained. Moreover, as the burnt gas in the gas burner is mixed to the primary air, nitrogen compound in the exhaust gas from the furnace is remarkably reduced.

What I claim is:

1. A continuous steam-atomizing fuel combustion method in a steam-atmozing fuel combustion apparatus for boiler use of forced draft combustion system, characterized by throttling a discharge opening of a blower of combustion air, thereby highly pressurizing the air in an air pipe when there is no steam in starting the boiler, and feeding the high pressure air into the atomizing burner thereby atomizing the fuel, firing the fuel for starting combustion, after that when steam generates in said boiler, performing atomization by the pressure of the steam and at the same time releasing said throttled condition of the blower thereby lowering the air pres-

sure, and simultaneously increasing the blast into the wind box, thus automatically the atomization under the steamless condition is switched over to the steam atomization.

2. An apparatus for continuous steam-atomizing fuel combustion, characterized by a wind box fixed to a boiler furnace, pressure means to supply combustion air including an air inlet duct, said wind box being connected to said combustion air inlet duct, an air flow control damper in said duct, an air atomizing cylinder provided at the center of said wind box, an air duct pipe branching from said duct between said pressure air supply and said damper, said branch pipe connected as an air inlet to said atomizing cylinder, a steam atomizer 30 provided in the atomizing cylinder, means to connect said steam atomizer to steam pipes of the boiler; and a controller responsive to the steam pressure created in the boiler to open said damper whereby fuel atomization may be automatically changed to the steam-atomization by the action of the said steam pressure.

3. Apparatus acocrding to claim 2 including a gas burner in said branch pipe to raise the temperature of the air forced through said pipe by closure of said damper.

4. Apparatus according to claim 3 wherein said gas burner comprises a ceramic annular element disposed substantially coaxially within said pipe and a gas supply pipe projecting axially into said annular element and terminating therein to constitute said burner.

5. Apparatus according to claim 4 including a gas-igniting electric terminal mounted in said annular member adjacent said burner pipe to generate electric sparks for igniting the gas.

6. Apparatus according to claim 2 including means to regulate the supply of fuel to said cylinder, and connections from said controller to said supply-regulating means to adjust said supply concurrently with adjustment of said damper.

7. Apparatus according to claim 6 including a heater to heat the fuel supplied to said atomizing cylinder, and connections from said controller to said heater.

8. Apparatus according to claim 2 including means to sense the steam pressure in the connection between said steam atomizer and the steam pipes, said sensing means being connected to said controller to effect said response to the steam pressure in the boiler.

9. Apparatus according to claim 2 wherein said pressure means to supply combustion air comprises a blower having its exhaust coupled to said air inlet duct.

10. Apparatus according to claim 2 wherein said damper comprises a plate mounted for pivotal movement in said air inlet duct.

References Cited

UNITED STATES PATENTS

1,598,866	9/1926	Lovell	431—19
1,599,137	9/1926	McLean	431—19
1,681,663	8/1928	Faickney	431—216

EDWARD G. FAVORS, Primary Examiner

U.S. Cl. X.R.

431—89, 190

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,672,808 Dated June 27, 1972

Inventor(s) Shuzo Miyazaki

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading change the Applicant to --Shuzo Miyazaki, Tokyo, Japan, assignor to Nippon Furnace Kogyo Kaisha, Ltd., Tokyo, Japan--

Signed and sealed this 11th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.