(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 214 187 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
06.09.2017 Bulletin 2017/36

(21) Application number: **15897894.0**

(22) Date of filing: **25.12.2015**

(51) Int Cl.:
C21B 7/00 *(2006.01)* ***F23D 1/00*** *(2006.01)*

(86) International application number:
PCT/JP2015/086225

(87) International publication number:
WO 2017/109937 (29.06.2017 Gazette 2017/26)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Trytec Co., Ltd.**
Oita-shi
Oita 870-0278 (JP)

(72) Inventor: **TAKEZAKI Hiroshi**
Oita-shi
Oita 870-0278 (JP)

(74) Representative: **Ter Meer Steinmeister & Partner**
Patentanwälte mbB
Nymphenburger Straße 4
80335 München (DE)

(54) **FUEL SUPPLY DEVICE**

(57) The fuel supply apparatus 10 includes a cylinder 30 attachable to the mounting portion of a blast tube 4 of a blast furnace 1, a hollow rotary member 40 rotatably accommodated in the cylinder 30 and having a base end through which fuel is to be fed into the rotary member 40, a pipe 20 detachably fixed to an end, adjacent to the blast furnace 1, of the rotary member 40 and having a front end through which the fuel is to be fed into the blast furnace 1, and a retainer 60 detachably fixed to the cylinder 30 and holding the rotary member 40 in the cylinder 30.

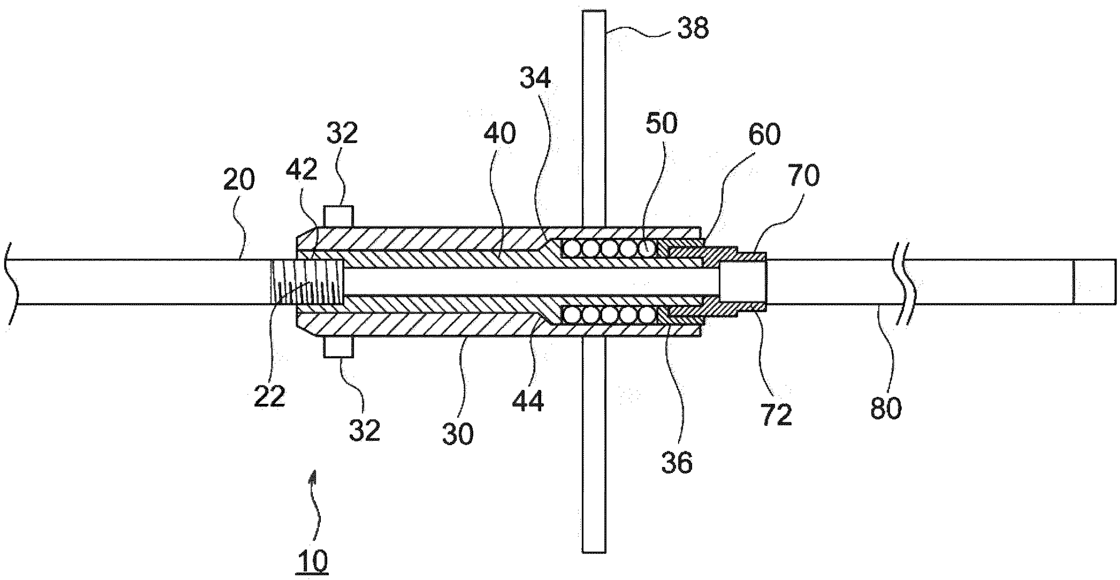

FIG. 3

EP 3 214 187 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a fuel supply apparatus, such as a burner, for injecting fuel, such as pulverized coal, from the tuyeres of a blast furnace to the interior of the furnace.

BACKGROUND ART

[0002] For a reduction in the amount of coke to be used, fuel, such as pulverized coal or heavy oil, is injected from the tuyeres of a blast furnace to cause combustion in the furnace. The fuel, such as pulverized coal, is injected together with a hot blast of air into the furnace through a PC burner (hereinafter, also simply referred to as "burner") extending through a blow tube fixed to each tuyere.

[0003] A traditional burner is made of, for example, a stainless steel material or any other special metal material that has high thermal resistance because the burner is exposed to a high temperature. Unfortunately, such a traditional burner still causes troubles, such as thermal deformation of a lance pipe, which may damage the tuyere or reduce the combustion efficiency, for example. To avoid these troubles, the traditional burner requires replacement of the damaged lance pipe with new one after every deformation, resulting in an increase in consumption of lance pipes. In addition, replacement of the burner should be performed with reducing of blasting during the suspension of the operation of the blast furnace. This requirements lead to an increase in cost.

[0004] To address these problems, a burner disclosed in JP 5105293 (PLT 1) includes a lance pipe which is likely to be deformed that can be rotated around the axis by slightly reducing spring force. The lance pipe of the burner can be appropriately rotated at the beginning of the thermal deformation under an airtight condition so that the deformed portion of the lance pipe is moved to a different position. Such a rotation can prevent further deformation of the deformed portion of the lance pipe and keep the lance pipe in a substantially linear shape for a long time, and thus can efficiently prevent damage to the tuyere and a decrease in combustion efficiency.

SUMMARY OF INVENTION

[0005] Overall maintenance of the blast furnace requires suspension of air blasting for about 12 to 72 hours once every one or two months. Production adjustment for the blast furnace also requires the suspension of air blasting. During the suspension of air blasting in the blast furnace, feed of high-temperature hot blasts of air and fuel, such as pulverized coal, to the interior of the furnace is also suspended, and the production is also suspended. Moreover, Maintenance of the burner is conducted during the suspension of air blasting in the furnace. In detail, the burner is detached from the blow tube of the furnace, and then the lance pipe is detached from the flange of the burner. Unfortunately, the lance pipe of the burner disclosed in PTL 1, which is integrated with an adaptor and a sleeve, is detached together with the adaptor from the flange. This detachment causes exposure of sealing faces between the flange and the adaptor (in detail, the inclined face along the entire outer periphery of the front end of the adaptor and the inclined face along the inner periphery of the rear end of the screw cylinder of the flange). Such exposed sealing faces are susceptible to deposition of dust and scratches thereon that may cause leakage of gases and dust particles from a gap between the sealing faces during the operation of the blast furnace. These problems force the site workers to pay sensitive attention to the maintenance of the burner, resulting in heavy workload for the site workers.

[0006] An object of the present invention, which has been made in view of these problems, is to provide a fuel supply apparatus that can keep a pipe in a substantially linear shape for a long term to efficiently prevent damage to the tuyere and a decrease in combustion efficiency of the blast furnace. The pipe of the fuel supply apparatus according to the present invention can be replaced with new one without exposure of sealing faces between a cylinder fixed to the mounting portion, such as a flange, of the blast tube of the furnace and a rotary member accommodated in the cylinder, at a reduced workload for the site workers.

[0007] The fuel supply apparatus according to the present invention comprises a cylinder attachable to a mounting portion of a blast tube of a blast furnace; a hollow rotary member rotatably accommodated in the cylinder, the rotary member having a base end through which fuel is to be fed into the rotary member; a pipe detachably fixed to an end of the rotary member, the end of the rotary member being adjacent to the blast furnace, the pipe having a front end through which the fuel is to be fed into the blast furnace; and a retainer detachably fixed to the cylinder, the retainer holding the rotary member in the cylinder, wherein the cylinder has an inner periphery having a first sealing face, the rotary member has a second sealing face, and the second sealing face comes into sealing contact with the first sealing face when the rotary member is accommodated in the cylinder.

[0008] In the fuel supply apparatus having such a configuration, the pipe is detachably fixed to the end (adjacent to the blast furnace) of the rotary member that is rotatably accommodated in the cylinder. At the beginning of thermal deformation of the pipe, the pipe can be appropriately rotated under an airtight condition, so that the deformed portion is moved to a different position. The pipe thereby can retain a substantially linear shape for a long term, which can efficiently prevent damage to the tuyere of the blast furnace and a decrease in combustion efficiency. In addition, only the pipe can be replaced with new one without exposure of sealing faces between the cylinder fixed to the mounting portion, such as a flange, of the blast tube of the blast furnace and the rotary member, at a reduced workload for the cite workers.

[0009] Fuel to be fed in the rotary member of the fuel supply apparatus according the present invention may be pulverized coal, waste plastic, hydrogen gas or heavy oil.

[0010] The fuel supply apparatus according to the present invention may further comprise an urging member biasing the second sealing face of the rotary member to the first sealing face of the cylinder.

[0011] The urging member may comprise a spring, and the second sealing face of the rotary member may be biased to the first sealing face of the cylinder by a resilient force of the spring from a compressed state.

[0012] In the fuel supply apparatus according to the present invention, the cylinder may have a first engaged portion on the inner periphery, and the retainer may have a first engaging portion detachably engaged with the first engaged portion.

[0013] In the fuel supply apparatus according to the present invention, the pipe may have a base end portion having a second engaging portion, and the rotary member may have a second engaged portion engaged with the second engaging portion.

[0014] The fuel supply apparatus according to the present invention may further include an operating portion fixed to the rotary member, the operating portion being configured to rotate the rotary member.

[0015] The fuel supply apparatus according to the present invention may further include a locking mechanism that secures the retainer engaging with the cylinder to the cylinder.

BRIEF DESCRIPTION OF DRAWINGS

[0016]

Fig. 1 is a schematic configurational view of a blast furnace which is to be supplied with fuel, such as pulverized coal, from a fuel supply apparatus according to an embodiment of the present invention.

Fig. 2 is a side view of the fuel supply apparatus according to the embodiment of the present invention.

Fig. 3 is an enlarged longitudinal cross-section of the internal configuration of the fuel supply apparatus illustrated in Fig. 2.

Fig. 4 is an exploded view of the components of the fuel supply apparatus illustrated in Fig. 2.

Fig. 5 is a perspective view of a cylinder of the fuel supply apparatus illustrated in Fig. 2 before a retainer is not fixed to the cylinder.

Fig. 6 is a perspective view of a cylinder of the fuel supply apparatus illustrated in Fig. 2 after a retainer is fixed to the cylinder.

Fig. 7 is a longitudinal cross-sectional view of the fuel supply apparatus illustrated in Fig. 2 including a pipe deformed at the front end in the tuyere of the blast furnace.

DESCRIPTION OF EMBODIMENTS

[0017] Embodiments of the present invention will now be described with reference to the accompanying drawings. Figs. 1 to 7 illustrate a fuel supply apparatus according to an embodiment of the present invention and a blast furnace which is to be supplied with fuel, such as pulverized coal, from the fuel supply apparatus. Fig. 1 is a schematic configurational view of the blast furnace which is to be supplied with fuel, such as pulverized coal, from the fuel supply apparatus according to the embodiment, and Fig. 2 is a side view of the fuel supply apparatus according to the embodiment. Fig. 3 is an enlarged longitudinal cross-sectional view of the internal configuration of the fuel supply apparatus illustrated in Fig. 2, and Fig. 4 is an exploded view of the components of the fuel supply apparatus illustrated in Fig. 2. Fig. 5 is a perspective view of a cylinder of the fuel supply apparatus illustrated in Fig. 2 before a retainer is not fixed to the cylinder, and Fig. 6 is a perspective view of a cylinder of the fuel supply apparatus illustrated in Fig. 2 after a retainer is fixed to the cylinder. Fig. 7 is a longitudinal cross-sectional view of the fuel supply apparatus in Fig. 2 illustrating a pipe deformed at the front end in the tuyere of the blast furnace.

[0018] The configuration of the blast furnace 1, which is to be supplied with fuel, such as, pulverized coal from the fuel supply apparatus 10 according to the embodiment, is now described with reference to Fig. 1. The blast furnace 1 is a vertical cylindrical structure having an outer face covered with a steel plate and an inner face lined with a refractory. The blast furnace 1 includes about 20 to 50 tuyeres 2 radially extending from the side face of the hearth of the blast furnace 1. Hot blasts of air passing through hot air-blast stoves 3 and a blast tube 4 are blown through the tuyeres 2 into the blast furnace 1. The tuyeres 2 are made of copper, and are water-cooled. A tap port for discharging molten iron and a slag port for discharging molten slag are separately disposed below the tuyeres 2. The fuel supply apparatus (PC burner) 10 according to the embodiment is configured to inject fuel, such as pulverized coal, into the blast furnace 1 through the tuyeres 2. In detail, each tuyere 2 of the blast furnace 1 has a blow tube, and a pipe 20 (described below) of the fuel supply apparatus 10 is configured to be disposed in the blow tube such that the front end portion of the pipe 20 extends from the tuyere 2 to the interior of the furnace.

[0019] The configuration of the fuel supply apparatus (PC burner) 10 according to the embodiment will now be described with reference to Figs. 2 to 6. The fuel supply apparatus 10 according to the embodiment includes a cylinder (sleeve) 30 attachable to a mounting portion, such as a flange, (not shown) of the blast tube 4 of the blast furnace 1, a hollow rotary member (adaptor) 40 rotatably disposed in the cylinder 30 and having a base end through which fuel is to be fed in the internal space of the rotary member 40, a pipe (lance pipe) 20 detachably fixed to the end (adjacent to the blast furnace 1) of the rotary member 40 and having a front end through which fuel is to be fed into the blast furnace 1, and a retainer 60 detachably fixed to the cylinder 30 and holding the rotary member 40 in the cylinder 30. A spring 50 is disposed in the cylinder 30 and functions as an urging member for biasing a second sealing face 44 (described below) of the rotary member 40 to a first sealing face 34 (described below) of the cylinder 30. An operating portion 70 for rotating the rotary member 40 is fixed, for example, by welding, to the rotary member 40. These components of the fuel supply apparatus 10 are described in detail below.

[0020] The pipe (lance pipe) 20 is a long thin pipe made of a heat-resistant material, such as stainless steel. The base end portion (fixed to the rotary member 40) of the pipe 20 has an external thread 22 (second engaging portion) such as a thread ridge on the outer periphery (refer to Fig. 3). The front end portion (adjacent to the blast furnace 1) of the hollow rotary member 40 (described below) has an internal thread 42 (second engaged portion) such as a tapped hole on the inner periphery. The external thread 22 of the pipe 20 is screwed into the internal thread 42 of the rotary member 40. The pipe 20 is thus detachably fixed to the end, adjacent to the blast furnace 1, of the rotary member 40. Fixing the pipe 20 to the rotary member 40 brings the internal space of the pipe 20 into communication with the internal space of the rotary member 40.

[0021] Several, for example, three projections 32 radially extend from the outer periphery of the cylinder or sleeve 30 substantially at an end, adjacent to the blast furnace 1, of the cylinder. The projections 32 facilitate fixation of the cylinder 30 to the mounting portion, such as a flange, (not shown) of the blast tube 4 of the blast furnace 1. The projections 32 of the cylinder 30 are inserted in the holes in the mounting portion and then rotated to fix the cylinder 30 to the blast tube 4 of the blast furnace 1. In place of the insertion and rotation of the projections 32 in the holes of the mounting portion, the cylinder 30 may be fixed to the blast tube 4 of the blast furnace 1 with keys, such as cotters. Several, for example, four fins 38 radially extend from the outer periphery of the cylinder 30. The cylinder 30 has a first sealing face 34 along its entire inner periphery. The first sealing face 34 is tapered in the longitudinal direction (i.e., the horizontal direction in Figs. 3 and 4) of the cylinder 30. The cylinder 30 has two locking holes 39 near its base end (remote from the blast furnace 1). The retainer 60 engaging with the cylinder 30 is secured to the cylinder 30 with a locking pin or rod 66 extending through the locking holes 39 (refer to Figs. 5 and 6).

[0022] With reference to Figs. 3 and 4, the hollow rotary member (adaptor) 40 has a second sealing face 44 along its outer periphery in the middle of the longitudinal direction. Accommodating the rotary member 40 in the cylinder 30 brings the second sealing face 44 into sealing contact with the first sealing face 34. The second sealing face 44 is tapered in the longitudinal direction (i.e., the horizontal direction in Figs. 3 and 4) of the rotary member 40. The close contact of the second sealing face 44 of the rotary member 40 accommodated in the cylinder 30 with the first sealing face 34 of the cylinder 30 can prevent leakage of gases and dusts from a gap between the cylinder 30 and the rotary member 40 to the exterior of the cylinder 30. The base end (remote from the blast furnace 1) of the rotary member 40 is fixed, for example, by welding, to the operating portion 70 (described below). The rotary member 40 can be rotated in the cylinder 30 by the operating portion 70.

[0023] The retainer 60 is detachably fixed to the base end (remote from the blast furnace 1) of the cylinder 30. Fixing the retainer 60 to the cylinder 30 holds the rotary member 40 in the cylinder 30. In detail, the retainer 60 has an external thread 62 (first engaging portion) such as a thread ridge on the outer periphery of the front end portion (adjacent to the blast furnace 1), as illustrated in Figs. 4 and 5. The cylinder 30 has an internal thread 36 (first engaged portion) such as a tapped hole on the inner periphery of the base end portion. The external thread 62 of the retainer 60 is screwed into the internal thread 36 of the cylinder 30. The retainer 60 is thus detachably fixed to the base end of the cylinder 30. After the engagement of the retainer 60 to the cylinder 30, the locking pin 66 is inserted through the two locking holes 39, and the retainer 60 is thereby secured to the cylinder 30, as illustrated in Fig. 6. In the embodiment, the locking holes 39 and the locking pin 66 function as a locking mechanism for securing the retainer 60 engaging with the cylinder 30 to the cylinder 30.

[0024] With reference to Fig. 3, the spring 50 is disposed around the rotary member 40 in the cylinder 30. The spring 50 is in contact with the retainer 60 at one end. Accommodating the rotary member 40 and the spring 50 in the cylinder 30 and engaging the retainer 60 with the base end of the cylinder 30 bring the spring 50 into a compressed state. The resilient force of the spring 50 from the compressed state urges the rotary member 40 to the left in Fig. 3. The second sealing face 44 of the rotary member 40 is thereby biased to the first sealing face 34 of the cylinder 30, and the first sealing face 34 is in closer contact with the second sealing face 44. In other words, the spring 50 functions as an urging member biasing the second sealing face 44 of the rotary member 40 to the first sealing face 34 of the cylinder 30. Such a spring 50 brings the second sealing face 44 into closer contact with the first sealing face 34 and thus can prevent leakage of gases and dusts from a gap between the first sealing face 34 and the second sealing face 44 with more certainty.

[0025] The operating portion 70 is hollow and is fixed, for example, by welding, to the base end, remote from the blast furnace 1, of the rotary member 40. The internal space of the operating portion 70 is in communication with the internal space of the rotary member 40. The operating portion 70 has an operated portion 72 having a polygonal (for example, hexagonal) cross-section. For example, the operated portion 72 is caught with a chain or large pliers (not shown) to rotate the operating portion 70, so that the pipe 20 and the rotary member 40 are rotated in the cylinder 30 fixed to the mounting portion, such as a flange, of the blast tube 4 of the blast furnace 1. The operating portion 70 is connectable to a fuel supply hose 80 through which fuel, such as pulverized coal, is to be fed in the internal space of the operating portion 70. The operating portion 70 may be directly connected to the hose 80 or may be connected to the hose 80 with a hollow tube. Alternatively, the operating portion 70 may be connected to the hose 80 with a valve. The operating portion 70 may be directly connected to a flexible hose through which fuel is to be fed in the internal space of the operating portion 70.

[0026] A process of assembling the fuel supply apparatus 10 will now be described with reference to Figs. 4 to 6. For simplicity, the pipe 20 and the hose 80 are not depicted in Figs. 5 and 6.

[0027] At the start of the assembly of the fuel supply apparatus 10, the rotary member 40 and the spring 50 are accommodated in the cylinder 30 such that the spring 50 is disposed around the rotary member 40. Fig. 5 illustrates the cylinder 30 accommodating the rotary member 40 and the spring 50. The retainer 60 is then fixed to the base end of the cylinder 30 to prevent detachment of the rotary member 40 and the spring 50 from the base end to the exterior of the cylinder 30. In detail, the external thread 36, such as a thread ridge, of the retainer 60 is screwed into the internal thread 36,such as a tapped hole, of the cylinder 30. After the engagement of the retainer 60, the operating portion 70 in connection with the fuel supply hose 80 is fixed, for example, by welding, to the base end of the rotary member 40. Fig. 6 illustrates the cylinder 30 with the retainer 60 fixed to the base end of the cylinder 30. At the end of the assembling process, the base end of the pipe 20 is fixed to the front end of the rotary member 40. In detail, the external thread 22, such as a thread ridge, of the pipe 20 is screwed into the internal thread 42,such as a tapped hole, of the rotary member 40. The fuel supply apparatus 10 illustrated in Figs. 2 and 3 is assembled through the process described above.

[0028] Now described is how to use the fuel supply apparatus 10. Before the start of feed of fuel, such as pulverized coal, into the blast furnace 1 with the fuel supply apparatus 10, the projections 32 of the cylinder 30 are fixed to the mounting portion, such as a flange, of the blast tube 4 of the blast furnace 1 such that the pipe 20 of the fuel supply apparatus 10 is inserted in the blow tube of the tuyere 2 of the blast furnace 1 and the front end portion of the pipe 20 extends from the tuyere 2 to the interior of the furnace. Fuel, such as pulverized coal, is fed through the fuel supply hose 80 in the internal space of the operating portion 70, so that the fuel passes through the internal space of the operating portion 70, the internal space of the rotary member 40, and the internal space of the pipe 20, in this order, and is injected through the front end of the pipe 20 in the blast furnace 1.

[0029] After a long-term use of the pipe 20 of the fuel supply apparatus 10, the pipe 20 may be thermally deformed, as illustrated in Fig. 7, causing a risk of contact with the tuyere 2 or any other component. To avoid the risk, in this embodiment, the pipe 20 and the rotary member 40 can be rotated by the operating portion 70 at the beginning of the thermal deformation of the pipe 20, thereby the position of the front end portion of the pipe 20 which is exposed to heat can be changed. Such an appropriate rotation of the pipe 20 enables uniform thermal application to the entire periphery of the pipe 20, preventing deformation, such as flexure in one direction, of the pipe 20 under it's own weight in a high temperature environment.

[0030] A process will now be described for maintenance of the fuel supply apparatus 10. The fuel supply apparatus 10 according to the embodiment requires occasional replacement of the pipe 20 because the pipe 20, in particular, the front end portion of the pipe 20, is prone to be thermally damaged in the blast furnace 1. Since the pipe 20 is detachable from the rotary member 40, the replacement of the pipe 20 does not involve detachment of the retainer 60 from the cylinder 30. Only the pipe 20 can be detached whereas the rotary member 40 resides in the cylinder 30. In other words, the pipe 20 can be replaced with new one whereas the first sealing face 34 of the cylinder 30 is in close contact with the second sealing face 44 of the rotary member 40. This configuration can prevent deposition of dusts onto the first sealing face 34 and the second sealing face 44 and scratches on the first sealing face 34 and the second sealing face 44.

[0031] The rotary member 40 of the fuel supply apparatus 10 according to the embodiment is worn and needs to be replaced with new one once a year, in general. Since the retainer 60 is detachable from the cylinder 30, the replacement of the rotary member 40 requires detachment of only the retainer 60 from the cylinder 30. This configuration can eliminate workload for the site workers in association with the replacement of the cylinder 30.

[0032] In the fuel supply apparatus 10 according to the embodiment having the configuration described above, the hollow rotary member 40 having the base end through which fuel is to be fed in the internal space of the system 10 is rotatably accommodated in the cylinder 30, the pipe 20 having the front end through which the fuel is to be fed into the blast furnace 1 is detachably fixed to the end (adjacent to the blast furnace 1) of the rotary member 40, and the retainer 60 holding the rotary member 40 in the cylinder 30 is detachably fixed to the cylinder 30. At the beginning of thermal deformation of the pipe 20, the pipe 20 can be appropriately rotated under an airtight condition such that the deformed portion is moved to a different position. The pipe 20 thereby can retain a substantially linear shape for a long term, which can efficiently prevent damage to the tuyere 2 of the blast furnace 1 and a decrease in combustion efficiency. In addition, the replacement of the pipe 20, which does not involve the exposure of the sealing faces (in specific, the first sealing face 34 and the second sealing face 44) between the cylinder 30 fixed to the mounting portion, such as a flange, of the blast tube 4 of the blast furnace 1 and the rotary member 40, can be achieved at a reduced workload for the cite workers. In other words, the retainer 60 functions as a protective cover for the first sealing face 34 and the second sealing face 44.

[0033] In the fuel supply apparatus 10 according to the embodiment, fuel to be fed into the internal space of the rotary member 40 is pulverized coal, as described above. The pulverized coal is a mere non-limiting example of the fuel to be fed into the internal space of the rotary member 40, and any other fuel, such as waste plastic, hydrogen gas, or heavy oil, may be fed into the internal space of the rotary member 40.

[0034] In the fuel supply apparatus 10 according to the embodiment, the spring 50 functions as an urging member biasing the second sealing face 44 of the rotary member 40 to the first sealing face 34 of the cylinder 30, as described above. In detail, the resilient force of the spring 50 from a compressed state biases the second sealing face 44 of the rotary member 40 to the first sealing face 34 of the cylinder 30. Since the first sealing face 34 comes into closer contact with the second sealing face 44, leakage of gases and dust from a gap between the first sealing face 34 and the second sealing face 44 can be prevented with more certainty. The second sealing face 44 of the rotary member 40 may be urged to the first sealing face 34 of the cylinder 30 with any member other than the spring 50, in the fuel supply apparatus 10 according to the embodiment. Any type of urging member (an elastic member, such as a flat spring, for example) may be used that can bias the second sealing face 44 of the rotary member 40 to the first sealing face 34 of the cylinder 30.

[0035] In the fuel supply apparatus 10 according to the embodiment, the cylinder 30 has the internal thread 36 as the first engaged portion on the inner periphery, and the retainer 60 has the external thread 62 as the first engaging portion that is engageable with the internal thread 36, as described above. The first engaged portion and the first engaging portion may have any structure other than the internal thread 36 and the external thread 62, respectively, in the fuel supply apparatus 10 according to the embodiment. Any other structures that can fix the retainer 60 to the cylinder 30 can be used as the first engaging portion and the first engaged portion.

[0036] In the fuel supply apparatus 10 according to the embodiment, the pipe 20 has the external thread 22 as the second engaging portion at the base end portion, and the rotary member 40 has the internal thread 42 as the second engaged portion that is engageable with the external thread 22, as described above. The second engaging portion and the second engaged portion may be other than the external thread 22 and the internal thread 42, respectively, in the fuel supply apparatus 10 according to the embodiment. Any other structures that can fix the pipe 20 to the rotary member 40 may be used as the second engaging portion and the second engaged portion.

[0037] In the fuel supply apparatus 10 according to the embodiment, the operating portion 70 for rotating the rotary member 40 is fixed to the rotary member 40, as described above. Such a operating portion 70 enables the cite workers to readily rotate the rotary member 40 accommodated in the cylinder 30 fixed to the mounting portion of the blast tube 4 of the blast furnace 1, and thus to readily rotate the pipe 20.

[0038] In the fuel supply apparatus 10 according to the embodiment, the locking holes 39 and the locking pin 66 function as the locking mechanism for securing the retainer 60 engaging with the cylinder 30 to the cylinder 30, as described above. Such a locking mechanism can prevent the detachment of the retainer 60 from the cylinder 30 during the use of the fuel supply apparatus 10.

[0039] The embodiment described above should not be construed to limit the scope of the present invention, and various modifications can be made on the fuel supply apparatus 10.

[0040] For example, the spring 50, which is disposed around the rotary member 40 accommodated in the cylinder 30 in the above description, may be omitted from the fuel supply apparatus 10 according to the embodiment described above. In addition, the rotary member 40 may be rotated with any means other than operating portion 70.

Claims

1. A fuel supply apparatus comprising:

a cylinder attachable to a mounting portion of a blast tube of a blast furnace;
a hollow rotary member rotatably accommodated in the cylinder, the rotary member having a base end through which fuel is to be fed into the rotary member;
a pipe detachably fixed to an end of the rotary member, the end of the rotary member being adjacent to the blast furnace, the pipe having a front end through which the fuel is to be fed into the blast furnace; and
a retainer detachably fixed to the cylinder, the retainer holding the rotary member in the cylinder, wherein
the cylinder has an inner periphery having a first sealing face,
the rotary member has a second sealing face, and
the second sealing face comes into sealing contact with the first sealing face when the rotary member is accommodated in the cylinder.

2. The fuel supply apparatus according to claim 1, wherein the fuel to be fed in the rotary member is pulverized coal, waste plastic, hydrogen gas or heavy oil.

3. The fuel supply apparatus according to claim 1 or 2, further comprising an urging member biasing the second sealing face of the rotary member to the first sealing face of the cylinder.

4. The fuel supply apparatus according to claim 3, wherein
the urging member comprises a spring, and
the second sealing face of the rotary member is biased to the first sealing face of the cylinder by a resilient force of the spring from a compressed state.

5. The fuel supply apparatus according to any one of claims 1 to 4, wherein
the cylinder has a first engaged portion on the inner periphery, and
the retainer has a first engaging portion detachably engaged with the first engaged portion.

6. The fuel supply apparatus according to any one of claims 1 to 5, wherein
the pipe has a base end portion having a second engaging portion, and
the rotary member has a second engaged portion engaged with the second engaging portion.

7. The fuel supply apparatus according to any one of claims 1 to 6, wherein a operating portion for rotating the rotating member is attached to the rotating member.

8. The fuel supply apparatus according to any one of claims 1 to 7, wherein a locking mechanism for securing the cylinder and the retainer in an engaged state is provided.

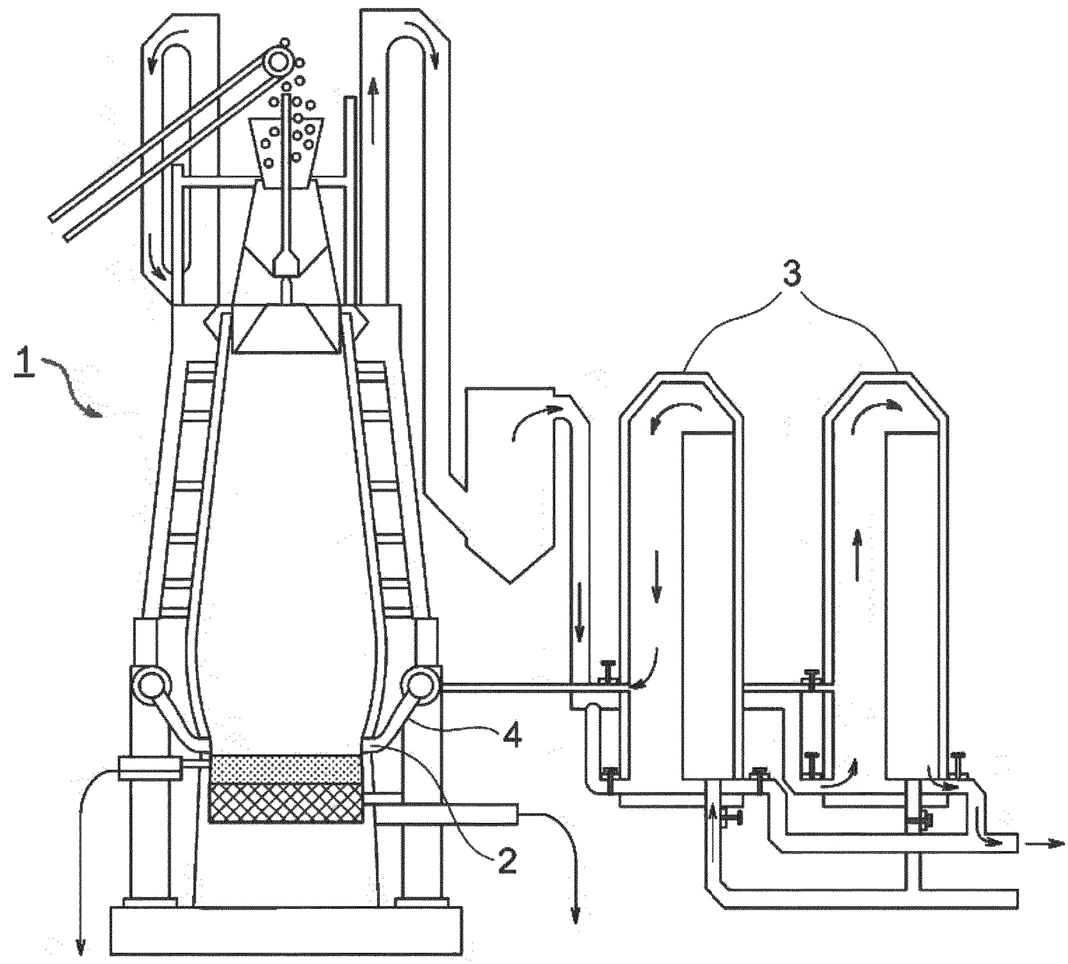

FIG. 1

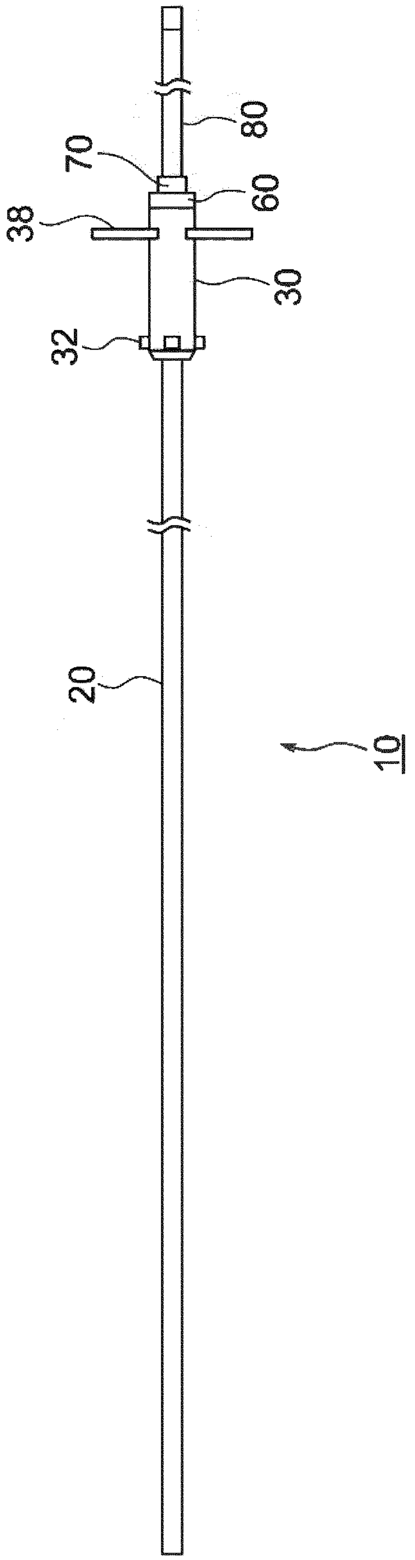

FIG. 2

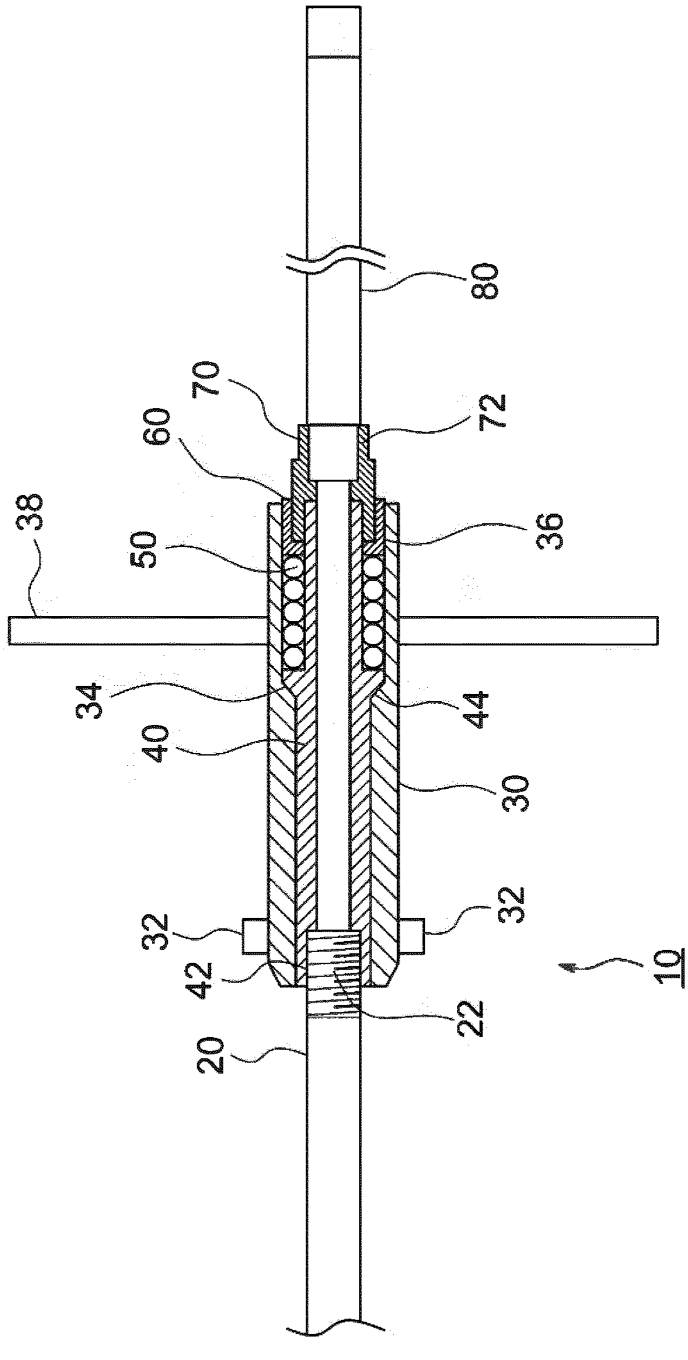

FIG. 3

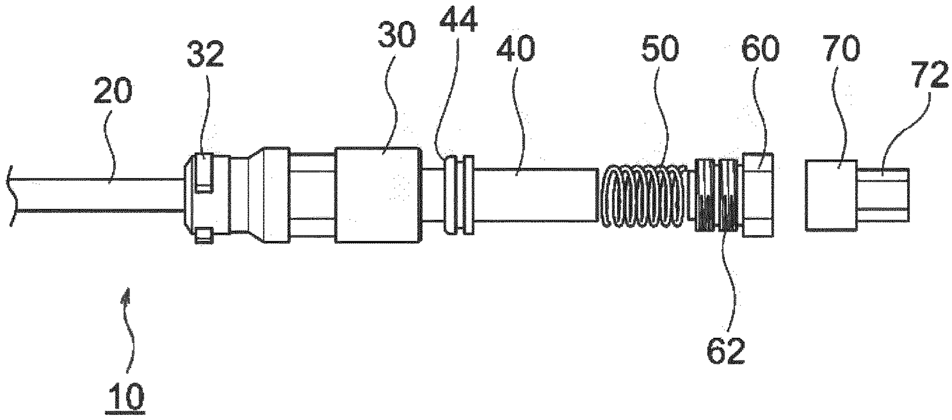

FIG. 4

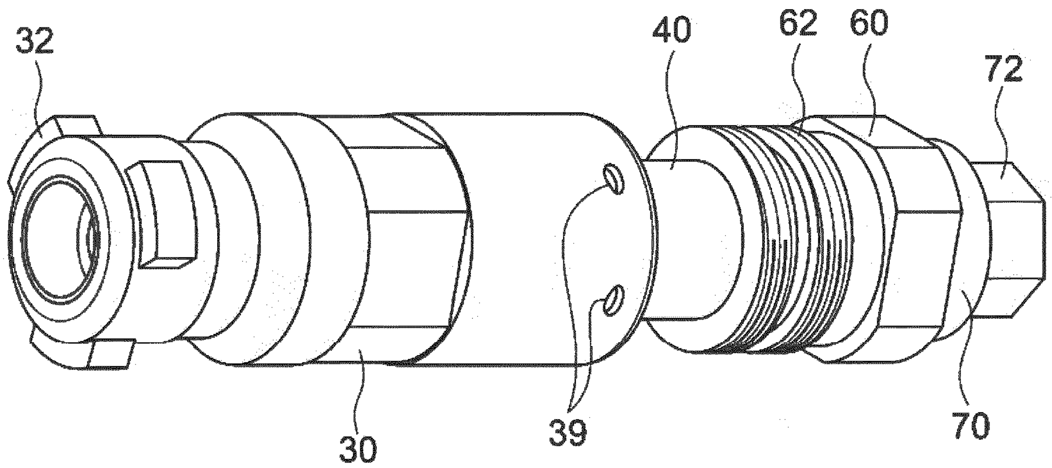

FIG. 5

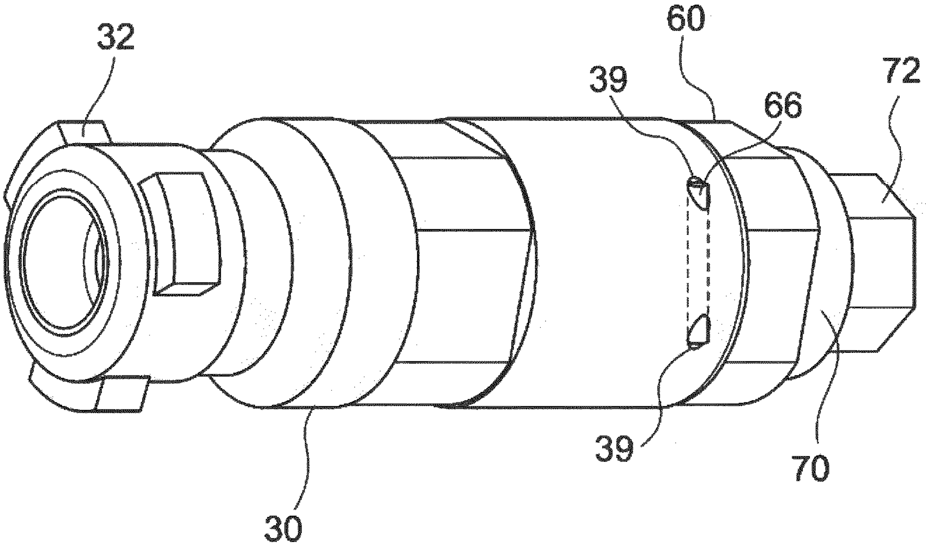

FIG. 6

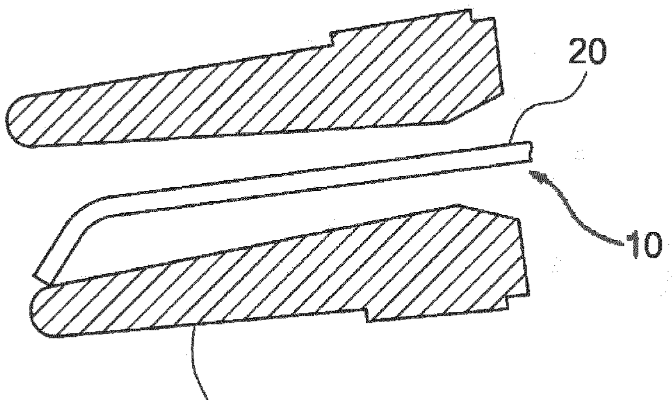

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2015/086225

A. CLASSIFICATION OF SUBJECT MATTER
C21B7/00(2006.01)i, *F23D1/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C21B7/00, F23D1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2015-21151 A (Nippon Steel & Sumitomo Metal Corp.), 02 February 2015 (02.02.2015), claims; paragraphs [0011] to [0013], [0025] to [0030]; fig. 2 (Family: none)	1-8
A	JP 2012-219336 A (Tritech Inc.), 12 November 2012 (12.11.2012), claims; paragraphs [0020] to [0032], [0034]; fig. 4 to 7 (Family: none)	1-8

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 March 2016 (02.03.16)	15 March 2016 (15.03.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2015/086225

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-521492 A (Paul Wurth S.A.), 13 September 2012 (13.09.2012), claim 1; fig. 1 & US 2012/0007291 A1 claim 1; fig. 1 & WO 2010/108880 A2 & CA 2754019 A	1-8

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 5105293 B **[0004]**