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Rossi

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[54] **FLUID DELIVERY SYSTEM FOR ROTARY KILN**

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[52] **U.S. Cl.** **432/115,** 432/105, 285/134, 137/615, 432/116

[51] **Int. Cl.** **F27b 7/36**

[58] **Field of Search** 432/105, 109, 72, 432/49, 117, 81, 84, 111, 115, 116, 103, 110; 266/20, 36; 34/179–183, 135–137; 285/134, 41; 137/594, 615

[56] **References Cited**

UNITED STATES PATENTS

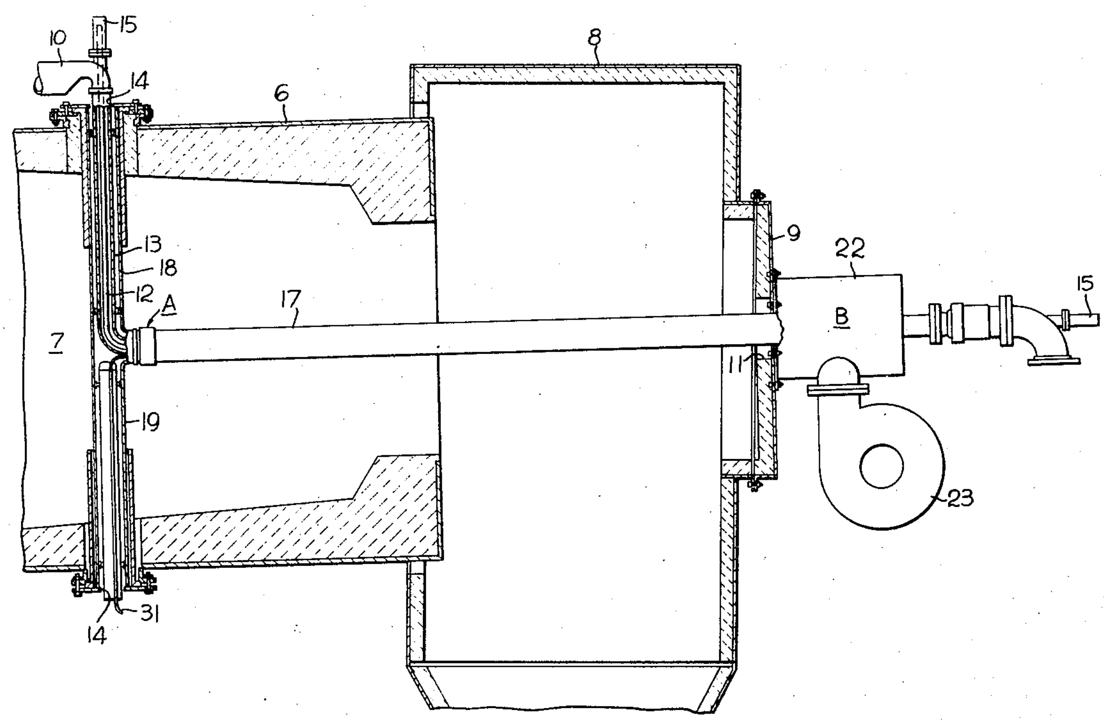
3,017,202	1/1962	Swaney	285/41
3,337,186	8/1967	Small, Jr.	137/594
3,461,037	8/1969	Knappstein et al.	432/111
2,592,899	4/1952	Hopkins	432/111

Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney—John P. Hines et al.

[57] **ABSTRACT**

A rotary kiln is disclosed with a stationary hood mounted concentrically over the material feed end of the kiln. Fuel nozzles are mounted on the outer surface of the kiln shell and are connected to a manifold also mounted on the outer surface of the kiln shell. A fuel delivery tube connected to the manifold projects radially inwardly to the interior of the kiln and then axially outwardly through the hood to the exterior of the kiln for connection to the fuel supply. A cooling air pipe surrounds the portion of the fuel tube located in the interior of the kiln. Air is forced through the pipe to cool the fuel. A flexible ball joint is provided in the cooling pipe to compensate for any misalignment between the rotating axis of the kiln and the stationary axis of the hood.

5 Claims, 3 Drawing Figures



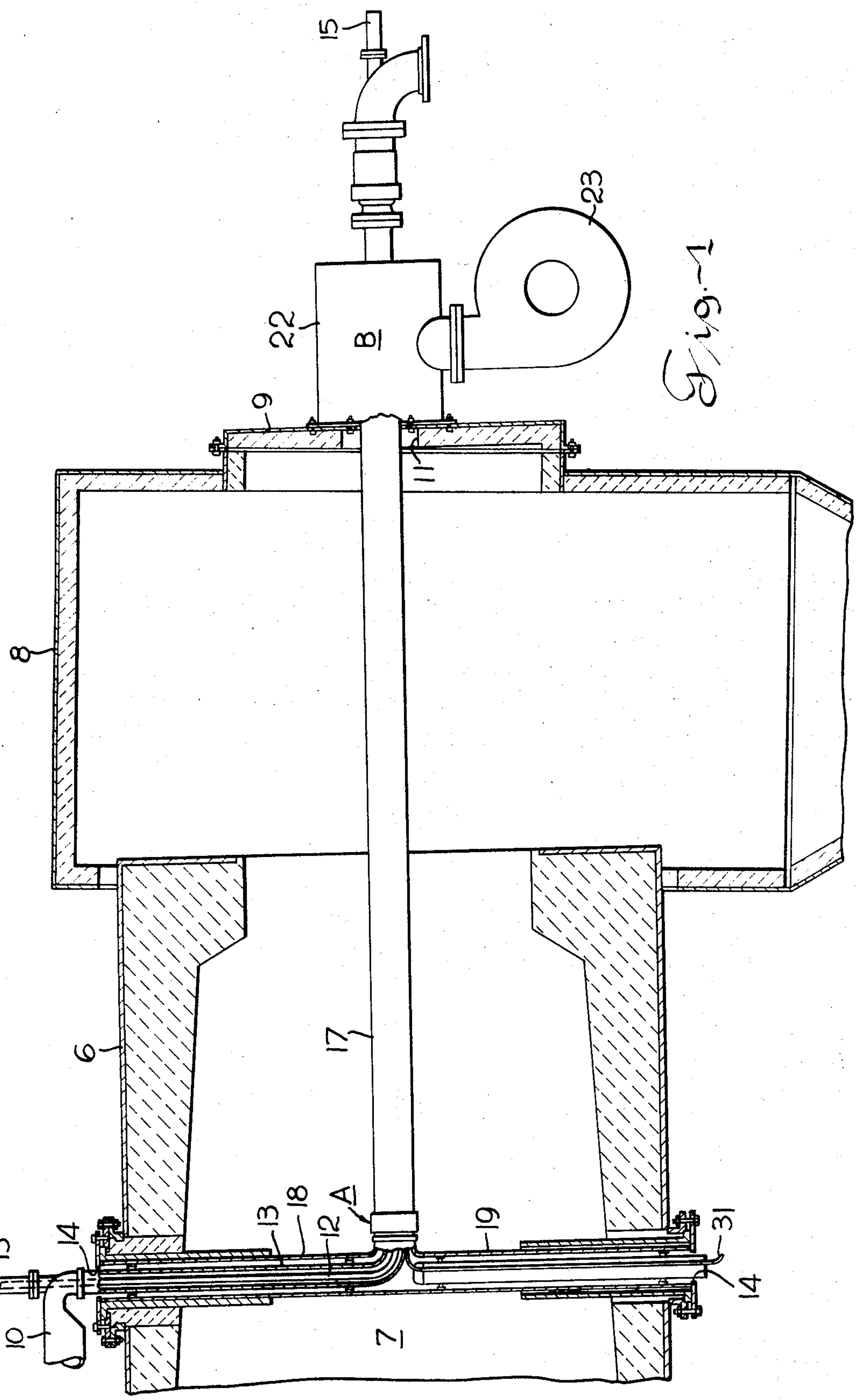

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Fig. 1

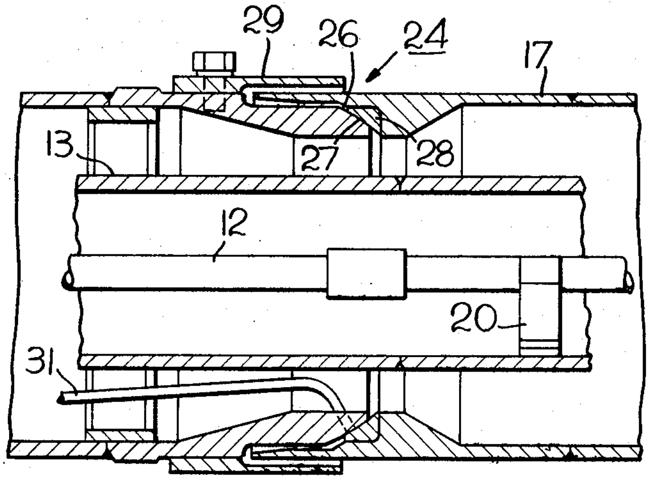

Fig. 2

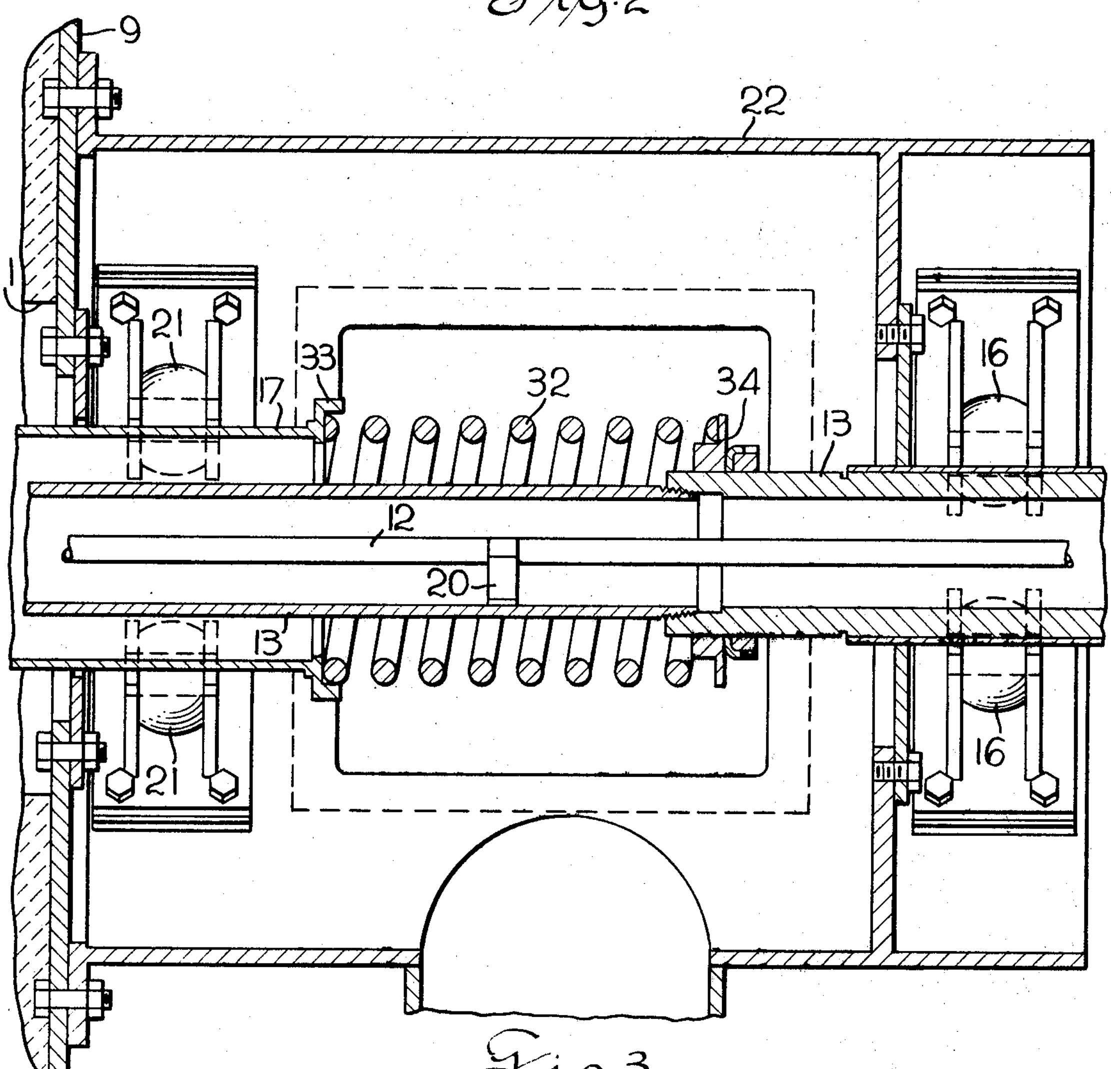

Fig. 3

FLUID DELIVERY SYSTEM FOR ROTARY KILN

BACKGROUND OF THE INVENTION

This invention relates to a fluid delivery system for rotary kilns having nozzles supported on the outer surface of the kiln, which are connected to a source of fuel by tubing extending partially through the interior of the kiln within a cooling air pipe. In particular, the present invention relates to an assembly for the cooling air pipe which permits flexing of the pipe to compensate for misalignment between the rotating and stationary portions of the kiln.

Rotary kilns for reducing iron ore to a lower state of oxidation having nozzles projecting through a kiln shell for injecting fuel and air into the kiln are disclosed in prior patents; for example U.S. Pat. No. 1,216,667 issued in 1917, U.S. Pat. No. 1,760,078 issued in 1930 and U.S. Pat. No. 2,344,440 issued in 1944. Such kilns disclose seals between nonrotating conduit structures and rotating conduit structures having a diameter larger than the diameter of the kiln. It has always been difficult to construct good seals of such large diameter because thermal expansion is proportionately greater for larger sizes and it is more difficult to provide the dimension tolerances and surface finishes needed for effective seals. For conduits and nozzles delivering only air to the kiln the problem was not serious, as there is no danger involved if the seal leaks air externally of the kiln. The economic loss from leaking air is not great. However, leaks of combustible gases could involve both danger and significant economic loss.

Other ways have been disclosed by prior art patents to inject gaseous fuel into such a kiln without creating a need for such large diameter seals. U.S. Pat. No. 1,797,130 issued in 1931 accomplishes such fuel injection with a single tube extending along the central axis of the kiln and having nozzles which project radially outward from the tube. U.S. Pat. Nos. 2,848,198, 3,182,980 and 3,196,938 provide several axially extending fuel conduits inside the kiln shell. U.S. Pat. No. 3,011,722 discloses a double wall kiln with gaseous fuel being delivered to the space between the walls. The kiln constructions disclosed in this group of patents all involve seals between stationary and rotating fuel delivery conduits having a diameter smaller than the outer diameter of the kiln but all these constructions have two disadvantages. One disadvantage is that the gaseous fuel conduits are not kept cool by exposure to the atmosphere of surrounding air, and a second disadvantage is that such conduits are hidden from view and cannot, therefore, be inspected while the kiln is in operation.

To overcome these shortcomings it is known in the prior art to provide a fluid delivery system for a rotary kiln in which fluids from stationary sources of supply are delivered through tubing to conduit mounted on the outer surface of the kiln shell with the tubing extending through cooled piping which extends axially a short distance through the interior of the kiln. This arrangement permits a small diameter rotary seal to be used and at the same time locates most of the fluid conduit on the outside surface of the kiln shell for easy inspection while the kiln is operating.

However, it is known that kilns will not continue to rotate about their geometric axis. Therefore, misalignment occurs between the kiln and the stationary hood inducing excessive bending stresses in that portion of

the piping which extends along the axes of the rotating kiln and stationary hood. To overcome these bending stresses it is known in the prior art to include a bellows connection between portions of the piping. The bellows have not been satisfactory because they rupture at a reasonably early age.

It is, therefore, the intention and general object of this invention to provide a fluid delivery system for a rotary kiln in which fluid from stationary sources of supply are delivered through tubing to conduit mounted on the outer surface of the kiln shell with the tubing extending through cooled piping which extends axially a short distance through the interior of the kiln wherein the piping is provided with a slidable pipe joint to permit relative angular motion of pipe portions to overcome misalignment between the rotating and stationary portions of the kiln.

A more specific object of the subject invention is to provide a fluid delivery system of the hereinbefore described type wherein the slidable pipe joint is a ball joint which is provided with spring bearing means to insure engagement of the sliding portions of the pipe joint during relative axial expansions and contractions between the stationary and rotating portions of the kiln.

These and other features and objects of the invention will become more fully apparent as the following description is read in light of the attached drawings wherein:

FIG. 1 is a fragmentary side elevation view of a rotary kiln having a fluid delivery system constructed in accordance with the present invention;

FIG. 2 is an enlarged view of the cooling pipe flexible ball joint identified as A in **FIG. 1**; and

FIG. 3 is an enlarged view of the spring means biasing the cooling pipe flexible ball joint into operative engagement located in the vicinity of B in **FIG. 1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to **FIG. 1**, a rotary kiln is shown having a cylindrical shell **6** supported in any well known conventional manner (not shown) to rotate about a central axis. The shell **6** is lined with a refractory material and provided with a plurality of nozzles (not shown) axially and circumferentially spaced about the surface of the kiln. The nozzles extend through the kiln shell **6** and are open to the interior or combustion chamber **7** defined by the kiln shell to provide access for fuel and air into the connective chamber.

A stationary hood **8** is mounted concentrically about the feed end of the kiln shell **6.** The kiln feed end fits into an opening provided into the hood and rotates relative thereto. The combustion chamber **7** of the kiln is thereby open to the interior of the hood **8.**

A rear wall **9** of the hood **8** is provided with an opening **11** which is in alignment with the axis of the kiln. Fluid delivery tubing in the form of an oil tube **12** and a gas tube **13** extend through the opening **11** and a short distance into the combustion chamber **7** of the kiln. The tubing **12** and **13** are then bent to extend radially outward through an opening **14** provided in the kiln shell. The tubing is connected by means of a manifold (not shown) to fuel conduit **10** supported on the exterior of the kiln for rotation therewith. The fuel conduit is then connected to the fuel nozzles.

In the particular embodiment of the invention shown herein for purposes of illustration the fuel tube **13** is for gas and the tube **12** is an auxiliary fuel tube for oil. If gas is being used the oil tube **12** is sealed by means of caps **15.**

As best shown in FIGS. **2** and **3**, auxiliary fuel tube **12** is supported within the gas or main fuel tube **13** in any conventional manner such as by spacers **20.** Each of these tubes must rotate with the kiln shell **6**, and therefore a sealing means between the stationary and rotating parts of the tubes must be provided. Since the particular construction of this sealing means is not a portion of this invention it is not shown herein. However, an example of an acceptable type of sealing means is disclosed in U.S. Pat. No. 3,661,370 issued to the same inventor as this invention on May 9, 1972.

The gas tube **13** is supported on rollers **16** which permit rotation thereof with the kiln. Since the auxiliary tube **12** is supported within the gas tube **13**, it rotates with the gas tube.

An air cooling pipe generally designated **17** surrounds the tubing **12** and **13** and extends through the opening **11** in the rear wall of the hood **8** to the interior of the combustion chamber **7.** The cooling pipe **17** has radially extending portions **18** and **19** which extend through the openings **14** through the kiln shell. The air cooling pipe **17** is supported on rollers **21** located to the rear of the hood **8** in an air plenum **22.** Cooling air delivery means herein shown schematically as a compressor **23** provides cooling air into the plenum **22** from which it flows through the pipe **17** and the radially directed portions **18** and **19** to the exterior of the kiln shell through the openings **14.** The cooling air flows about the fuel tubing thereby cooling these tubes and the fuel therein as they pass through the combustion chamber of the kiln.

Inherently kilns do not rotate on their geometric center and, therefore, it is quite likely that misalignment will occur between the opening **11** and in the rear wall of the hood **8** and the rotating axis of the kiln. Since the fuel tubing **12** and **13** are reasonably flexible, they can bend to compensate for this misalignment. However, the relatively larger air pipe **17** might fracture if excessive misalignment should occur. To overcome this possibility, a flexible ball joint generally designated **24** and shown more clearly in FIG. **2** is provided. As herein shown for purposes of illustration this flexible ball joint includes a pipe joint having two hemispherical surfaces **26** and **27** which are in slidable engagement with one another. A carbon or cast iron insert **28** may be provided to assist in the sliding movement between the joint halves. Furthermore, a shield **29** may be provided about the joint to assist in deflecting the heat from the combustion chamber from the joint. A conduit **31** extending through the air pipe portions **19** provides lubrication for the flexible joint **24.** It should also be noted that the joint will be exposed to the cooling air as it passes through the pipe. This connection will compensate for any axial misalignment existing between the hood **8** and the kiln shell **6.**

Additional means shown herein for purposes of illustration as a coil spring **32** are provided to compensate for axial expansion and contraction of the kiln and the cooling pipe. The coil spring **32** surrounds the gas tube **13** and engages a flange **33** provided at the end of the cooling pipe **17.** The other end of the coil spring is seated in a flange **34** supported on the fuel tube **13.** With this arrangement if axial expansion of the kiln and cooling pipe **17** occur, the spring **32** will be compressed and at the same time will maintain operative engagement between the two half portions of the flexible ball joint **24.**

From the above description it can be seen that a relatively inexpensive fluid delivery system has been provided for a rotary kiln wherein a small diameter radial rotary joint is possible and wherein misalignment and relative thermal expansion of the kiln and cooling pipe relative to the stationary hood is provided.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A fluid delivery system for a rotary ore reducing kiln comprising: a rotating elongated cylindrical shell defining a combustion chamber; fluid conduit means supported on the exterior of said shell for rotation therewith; a stationary hood located concentric with said kiln shell and having an opening in communication with said combustion chamber; pipe means extending through said hood axially into said chamber and including a radially disposed portion extending through said shell to the exterior thereof, said pipe means rotating with said kiln; a slidable pipe joint associated with said pipe means adapted to permit angular movement of said pipe means to compensate for misalignment between said shell and said hood; and fluid tube means extending through said pipe means connected in fluid communication with said fluid conduit means.

2. The fluid delivery system set forth in claim **1** and further comprising air supply means connected to said pipe means for supplying cooling air through said pipe means.

3. The fluid delivery system set forth in claim **1** wherein said slidable pipe joint includes complementary hemispherical surfaces slidably engaging one another.

4. The fluid delivery system set forth in claim **1** and further comprising spring biasing means engaging said pipe means to urge said slidable pipe joint portions into operative sliding engagement.

5. The fluid delivery system set forth in claim **4** wherein the cooling air flows over said spring biasing means.

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