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[54] TUYERE STOCK FOR FURNACES

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[58] **Field of Search** 122/6.6; 110/182.5; 266/41

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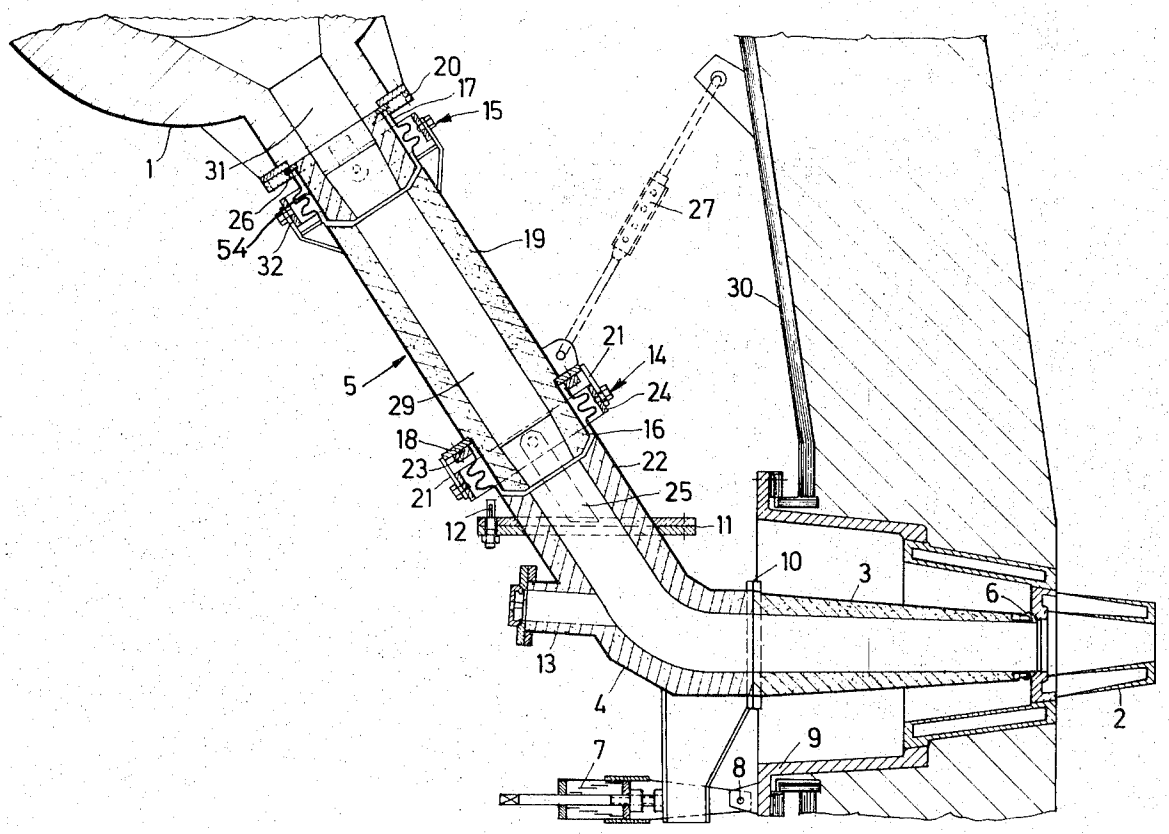
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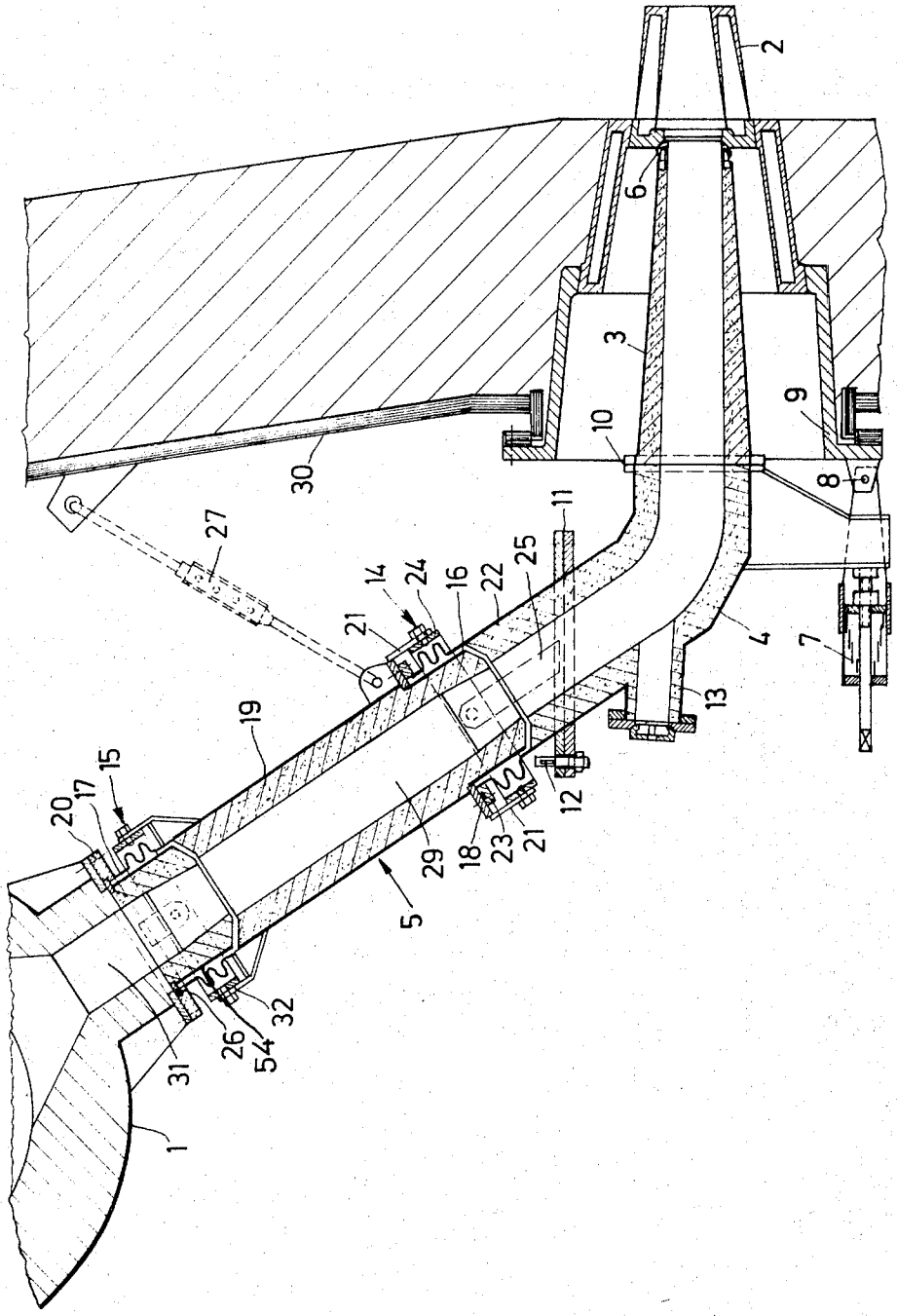
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[57] **ABSTRACT**

A feed conduit having utility in the transmission of heated fluids is disclosed. The apparatus of the present invention is characterized by a curved section, which communicates at its discharge end with a nozzle which supplies the heated fluid to the desired environment, and by a straight portion, which couples the source of heated fluid to the curved portion; the straight portion being formed from at least three members with an intermediate member being connected to the end members by means of articulated joints comprised of cardan compensators.

23 Claims, 1 Drawing Figure





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TUYERE STOCK FOR FURNACES

This is a continuation, of application Ser. No. 30,178, filed Apr. 20, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the transmission of heated fluids. More specifically, the present invention is directed to an expansible conduit which may be employed as a tuyere feed line for the delivery of preheated gas to a furnace. Accordingly, the general objects of the present invention are to provide novel and improved methods and apparatus of such character.

2. Description of the Prior Art

While not limited thereto in its utility, the present invention is particularly well suited for use as an improved tuyere feed line for shaft furnaces. In shaft furnaces, particularly in blast furnaces, preheated air is injected into the furnace through nozzles or tuyeres. The preheated air is delivered to the vicinity of the injection nozzles via a common supply conduit, normally of circular cross-section, which is mounted exterior of and around the furnace. A plurality of injection nozzles are located on the periphery of the furnace and are connected to the supply conduit by means of feed lines or conduits known in the art as tuyere stocks.

Prior art tuyere stocks typically comprise a number of tubular elements which are internally lined with a refractory material. The high temperature of the air or gas blown into the furnace causes deformation, and particularly thermally induced expansion, of the various components of the tuyere stock. In order to minimize or prevent leakage of gas being supplied to the furnace and to increase the life of the apparatus, a number of procedures have previously been adopted in an attempt to compensate for the expansion and contraction of tuyere stock components. One of these prior art compensation procedures consists of the inclusion of swivel joints or articulations between the tubular elements comprising the tuyere stock. Swivel joints have, however, been a continuous source of trouble, particularly at the temperatures presently employed for the air injected into blast furnaces of modern design. In an attempt to avoid the problems inherent in swivel joints, one or all of the joints between the tubular tuyere stock elements have been replaced by rigid connections and a compressible element has been incorporated into the tuyere stock to compensate for deformations caused by thermal expansion. These compressible elements have generally consisted of a compensator member comprising a corrugated metal bellows. It has previously been believed that such metal bellows, if intended to take up both the horizontal and vertical expansions of the tuyere stock, must comprise a relatively large number of undulations or bellows units. Also in accordance with the prior art, the interior of the compensator is protected by a comparatively long internal protective guiding tube which is of lesser diameter than the bellows and which is lined with refractory material. Since it is impossible to accurately predict the particular deformations of the tuyere stock components and particularly the compensator, the risk of deformation of the internal guide tube resulting from the extremely high temperatures of the air or gas insufflated is quite high, causes continuous trouble during operation and reduces the service life of the tuyere stock.

SUMMARY OF THE INVENTION

The present invention overcomes the above-discussed and other disadvantages and deficiencies of the prior art by providing a novel device which may be employed as a feed line for the injection of preheated air into a furnace. In accordance with the present invention, a tuyere stock is comprised of a first, straight conduit connected at a first end via a cardan compensator to the common supply pipe for the preheated fluid which is to be injected into a furnace. The other end of this straight conduit is connected, also via a joint constructed as a cardan compensator, to the actual injection nozzle. The cardan compensators compensate for the differential expansions caused by heating of the components of the apparatus, and also counteract any unforeseen deviations in the assembly.

In a preferred embodiment, the straight portion of the feed line of the present invention comprises three tubular members connected in series. The facing ends of the two outwardly disposed tubular members are respectively connected to the intermediate member by means of cardan joint compensators. The opposite end of a first, outboard tubular member is rigidly secured to the supply conduit for the preheated fluid while the opposite end of the other outer member is affixed to a curved portion of the tuyere stock which, in turn, is connected to the injection nozzle. The two outer tubular members which comprise the straight or rectilinear portion of the feed line of the present invention also function as guide and protective tubes for the undulations of the pair of cardan compensators.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawing which shows a cross-sectional, side elevational view of a tuyere feed line in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference now to the drawing, a circular conduit **1** serves as a supply of preheated air or gas which is to be injected into a furnace via an injection nozzle or tuyere **2.** The injection nozzle **2** passes through an outer wall **30** of the furnace in the manner well known in the art and is surrounded by a cooling jacket **9.** Supply conduit **1** is connected to nozzle **2** via a feed line or tuyere stock indicated generally at **5.**

Feed line **5** is comprised of welded steel plates formed into a conduit having an internal lining of refractory material. The feed line **5** is comprised of a nose or downstream section **3,** bend or elbow section **4,** and a straight section **29** which provides communication between the elbow **4** and supply conduit **1.** The straight section **29** of feed line **5** is, in turn, comprised of serially connected cylindrical tubular members **17, 19** and **22.**

The upstream end of nose section **3** of feed line **5** is affixed to the curved section **4** by means of flanges **10** which are preferably bolted together. The opposite end of nose section **3** communicates with nozzle **2** and is spring loaded against a spherical joint **6** which comprises part of nozzle **2.** Spring loading of the downstream end of the feed line against the nozzle **2** is ac-

complished by a system of springs 7 which couple the feed line to cooling jacket 9 via an articulated joint 8.

The bent section 4 of the feed line, which defines an obtuse angle, is affixed at its upstream end to the downstream cylindrical tube 22 of the straight portion 29 of the feed line. The connection of section 4 to tube 22 is by means of a substantially horizontal collar 11 and cotter bolts 12. The use of the horizontal collar and bolts 12 facilitates removal and replacement of the subassembly comprising sections 3 and 4. Section 4 is provided with an inspection port 13. Port 13 is situated upstream of the curved portion of section 4 to improve the operation and durability of the refractory lining.

The straight or rectilinear portion 29 of feed line 5 comprises, as noted above, three serially connected tubular members which are joined to one another via a pair of cardan compensators indicated generally at 14 and 15. Compensators 14 and 15 serve to compensate for horizontal and vertical expansions which take place during operation of the apparatus and also to correct for any constructional variations which may have occurred during manufacture of the components and assembly of the apparatus. It is also to be noted that the subdivision of straight portion 29 of the feed line into three members facilitates the application of the refractory lining internally thereof.

The downstream end of rectilinear feed line section 29, consisting of cylindrical member 22, is welded to the horizontal collar 11. The other end of tube 22 is attached, preferably by welding, to the flexible or bellows portion of cardan compensator 14. The other end of the bellows portion is attached to an intermediate collar 23, which also forms part of compensator 14. The intermediate tubular member 19 of rectilinear feed line section 29 is fastened by suitable means to intermediate collar 23 via a collar 18 which is affixed to member 19. The connection between tubular members 22 and 19 is achieved by means of a cardan ring 24. Two pair of articulation arms, indicated at 21 and 25, extend from ring 24. Arms 25 are affixed to the horizontal collar 11 while arms 21 are welded to collar 18 of intermediate tubular member 19. The lower end of member 19 consists of a refractory steel tube 16 which serves as a guide tube to protect the undulations of the compensator 14 from direct exposure to the heated fluid passing through the apparatus.

The second cardan compensator 14 is affixed, preferably by welding, to the upper end of tubular member 19. Compensator 15 is connected, by means of a collar 20, to the outlet 31 of supply conduit 1. It may be said that downstream section 3, elbow section 4 and cylindrical member 22 constitute a first fluid conduit means connected at one end to the furnace; that cylindrical member 17 constitutes a second fluid conduit means coupled to a fluid supply; that cylindrical member 19 constitutes a third fluid conduit means between the first and third fluid conduit means; and that opposite ends of the third fluid conduit means are connected to the first and second fluid conduit means by cardan compensators.

It is to be noted that the uppermost tubular member 17 of the tuyere stock of the present invention is constructed in the form of a guide tube of refractory steel. Tubular member 17 is accommodated in the collar 20 and firmly and rigidly inserted, by means of a clamp 26, between the supply conduit outlet 31 and the intermediate tubular member 19. As in the case of the downstream end of tubular member 19, the downstream end of member 17 protects the undulations of compensator 15 from the effects of the high temperatures of a fluid being transmitted through the apparatus. The connection between the tubular members 17 and 19 is, also as in the case of compensator 14, achieved with the aid of a cardan ring 32 having pairs of articulation arms which are affixed both to the collar 20 and to the intermediate member 19.

An important feature of the present invention resides in the fact that the two compensators 14 and 15 are provided adjacent the ends of a relatively long, straight portion of the feed tube. Accordingly, the deformations to be taken up by each of compensators 14 and 15 will remain within comparatively moderate limits and the compensators may thus be constructed with a limited number of undulations. In the embodiment shown compensators 14 and 15 each employ only two undulations. The use of a pair of compensators in accordance with the present invention offers the further advantage in that the feed tube is absolutely hermetic in operation.

A hanger member 27 is depicted as extending between outer wall 30 of the furnace and the intermediate tubular member 19. Hanger 27 serves to provide additional support for the rectilinear portion 29 of the feed tube 5 during periods when sections 3 and 4 of the feed tube are disconnected from the remainder of the apparatus.

Tuyere feed lines fabricated in accordance with the present invention have the advantage of very simple construction and can be formed of welded plates thereby greatly facilitating the application of the refractory lining. As a result of the fact that the present invention may also be assembled and adjusted in a much easier manner than prior art devices of like character, tuyere feed lines in accordance with the present invention are less expensive than those previously available.

To summarize, the feed lines in accordance with the present invention offer the essential advantage that compensation for all thermally induced deformations is achieved with a pair of cardan compensators; each compensator having a limited number of bellows units and being arranged adjacent oppositely disposed ends of a straight section of the feed line. The present invention also minimizes the component parts of the feed line which are subjected to heated fluid flowing through the device. Further, the components which provide for the compensation for thermally induced expansions are protected by guide tubes which have the characteristic of short length and thus less exposure to thermal stresses. As a result of the discussed novel features, the service life of the feed lines of the present invention is considerably increased when compared to the prior art and the efficiency of the apparatus is similarly improved since all joints between components of the invention are hermetic.

While a preferred embodiment has been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the present invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

1. Apparatus for the transmission of heated fluid comprising:

first fluid conduit defining means, said first conduit defining means being adapted for coupling at a first end to a fluid utilizing device;

second fluid conduit defining means, said second conduit defining means being adapted for coupling at a first end to a source of fluid, said second fluid conduit defining means including:

a rectilinear conduit member, said rectilinear member being tubular and having a first end adapted to be coupled to said first fluid conduit defining means;

a tubular conduit member, said tubular member being coupled at its first end to a source of fluid; and

first connecting means interconnecting the second ends of said rectilinear and tubular members, said connecting means permitting universal angular motion between said members, said first connecting means including:

means positioned externally of and extending between said members to provide an expandable hermetic fluid coupling therebetween; and

means positioned externally of said hermetic coupling means for providing a movable mechanical supporting connection between said members, said supporting connection including pivotal articulation arms connected to each of said members; and

second connecting means connecting the second end of said first conduit defining means to the second end of said second conduit defining means, said second connecting means permitting universal angular motion between said conduit means, said second connecting means including:

means positioned externally of and extending between said conduit defining means to provide an expandable hermetic fluid coupling therebetween; and

means positioned externally of said hermetic coupling means for providing a movable mechanical supporting connection between said conduit defining means, said supporting connection including pivotal articulation arms connected to each of said conduit defining means.

2. The apparatus of claim **1** wherein said supporting connection of said second connecting means comprises:

flange means affixed to one of said conduit defining means adjacent the joint between said conduit defining means, said flange means having a portion which extends radially outward; and

ring means attached to said flange means, said ring means being coaxial with said hermetic coupling, said articulation arms extending between said ring means and each of said conduit defining means, said arms being rotatably connected to said ring means.

3. The apparatus of claim **1** wherein one of said conduit defining means includes a sleeve extension, said sleeve extension being coaxial with said hermetic coupling and being positioned radially inward with respect to said coupling to provide thermal shielding therefore.

4. The apparatus of claim **3** wherein the other of said conduit defining means is provided with a socket at the end facing said sleeve extension, said socket and sleeve extension cooperating to define a joint.

5. The apparatus of claim **4** wherein said supporting connection of said second connecting means comprises:

flange means affixed to one of said conduit defining means adjacent the joint between said conduit defining means, said flange means having a portion which extends radially outward; and

ring means attached to said flange means, said ring means being coaxial with said hermetic coupling, said articulation arms extending between said ring means and each of said conduit defining means, said arms being rotatably connected to said ring means.

6. The apparatus of claim **5** wherein said second conduit defining means is lined internally with a refractory material.

7. The apparatus of claim **6** wherein said second conduit defining means is rectilinear and is longer in the axial direction than said first conduit defining means.

8. The apparatus of claim **1** wherein said first conduit defining means comprises:

a first portion which defines an obtuse angle;

means for coupling the first end of said first portion to the second end of said second conduit defining means; and

a straight portion for coupling the second end of said first portion to a fluid utilizing device.

9. The apparatus of claim **8** wherein said first portion further comprises an inspection port positioned outside of the axis of said obtuse angle and wherein said coupling means comprises:

a second straight portion for coupling the first end of said first portion to the second end of said second conduit defining means; and

flange means which defines a disconnectable horizontal connection between said second straight portion and said first end of said first portion.

10. The apparatus of claim **7** wherein said first conduit defining means comprises:

a first portion which defines an obtuse angle;

means for coupling the first end of said first portion to the second end of said second conduit defining means; and

a straight portion for coupling the second end of said first portion to a fluid utilizing device.

11. The apparatus of claim **10** wherein said first portion further comprises an inspection port positioned outside of the axis of said obtuse angle and wherein said coupling means comprises:

a second straight portion for coupling the first end of said first portion to the second end of said second conduit defining means; and

flange means which defines a disconnectable horizontal connection between said second straight portion and said first end of said first portion.

12. Apparatus for the transmission of heated fluid comprising:

first fluid conduit defining means, said first conduit defining means being adapted for coupling at a first end to a fluid utilizing device;

second fluid conduit defining means, said second conduit defining means being adapted for coupling at a first end to a source of fluid; and

third fluid conduit defining means connecting the second end of said first fluid conduit defining means to the second end of said second fluid conduit defining means, said third conduit defining

means cooperating with said first and second conduit defining means to define a three-hinged arch construction, said third conduit defining means including:

a rectilinear tubular member;

means positioned externally of and extending between a first end of said rectilinear member and said first fluid conduit defining means to provide a first expandable hermetic fluid coupling therebetween;

means positioned externally of said first hermetic coupling means for providing a first movable mechanical supporting connection between said members and first conduit defining means, said first supporting connection including pivotal articulation arms connected to each of said rectilinear member and first fluid conduit defining means;

means positioned externally of and extending between said second fluid conduit defining means and the second end of said rectilinear member to provide a second expandable hermetic fluid coupling therebetween; and

means positioned externally of said second hermetic coupling means for providing a second movable mechanical supporting connection between said second conduit defining means and said rectilinear member, said second supporting connection including pivotal articulation arms connected to each of said second conduit defining means and rectilinear member.

13. Apparatus for the transmission of heated fluid from a supply to a furnace comprising:

first fluid conduit means having first and second ends, said first conduit means being adapted for fluid coupling to a furnace at a first end thereof;

a spherical joint element for mechanically connecting said first fluid conduit means to said furnace;

second fluid conduit means having first and second ends, said second conduit means being adapted for coupling at the first end thereof to a supply of heated fluid;

third fluid conduit means between and connected to the second end of said first fluid conduit means and the second end of said second fluid conduit means, said third conduit means cooperating with said first and second conduit means to define a feed line from said supply to said furnace;

a first universal joint means connecting one end of said third fluid conduit means to said second end of said first fluid conduit means, said first universal joint means including:

flexible hermetic coupling means externally of and extending from said third fluid conduit means to said first fluid conduit means to provide a flexible hermetic coupling therebetween; and

connection means for providing an articulated mechanical connection between said third fluid conduit means and said first fluid conduit means, said connection means being external of said hermetic coupling means; and

a second universal joint means connecting the other end of said third fluid conduit means to said second end of said second fluid conduit means, said second universal joint means including:

flexible hermetic coupling means externally of and extending from said third fluid conduit means to said second fluid conduit means to provide a flexible hermetic coupling therebetween; and

connection means for providing an articulated mechanical connection between said third fluid conduit means and said second fluid conduit means, said connection means being external of said hermetic coupling means.

14. Apparatus for the transmission of heated fluids as in claim **13** wherein:

each of said first, second and third conduit means is lined internally with a refractory material.

15. Apparatus for the transmission of heated fluid as in claim **13** wherein:

said articulated mechanical connection of said first universal joint includes:

a first connecting ring;

a first set of arms extending from said first fluid conduit means and being pivotably connected to said first connecting ring; and

a second set of arms extending from said third fluid conduit means and being pivotally connected to said first connecting ring; and wherein

said second articulated mechanical connection of said second universal joint includes:

a second connecting ring;

a first set of arms extending from said third fluid conduit means and being pivotally connected to said second connecting ring; and

a second set of arms extending from said second fluid conduit means and being pivotally connected to said second connecting ring.

16. Apparatus for the transmission of heated fluid as in claim **13** wherein:

said hermetic coupling of each of said first and second universal joints is a bellows.

17. Apparatus for the transmission of heated fluid as in claim **13** wherein:

at least one of said first conduit means includes a sleeve extension, said sleeve extension extending from an end of that fluid conduit toward an adjacent fluid conduit in the vicinity of the hermetic coupling therebetween, said sleeve extension being coaxial with said hermetic coupling and being positioned inwardly with respect to said coupling to provide thermal shielding therefor.

18. Apparatus for the transmission of heated fluid as in claim **13** wherein:

one of said fluid conduit means includes a first sleeve extension, said first sleeve extension extending from an end of said fluid conduit toward an adjacent fluid conduit in the vicinity of the hermetic coupling therebetween, said first sleeve extension being coaxial with said hermetic coupling and being positioned inwardly with respect to said hermetic coupling to provide thermal shielding therefor; and

a second of said fluid conduit means includes a second sleeve extension, said second sleeve extension extending from an end of said second fluid conduit toward an adjacent fluid conduit in the vicinity of the hermetic coupling therebetween, said second sleeve extension being coaxial with said hermetic coupling and being positioned inwardly with respect to said hermetic coupling to provide thermal shielding therefor.

19. Apparatus for the transmission of heated fluid as in claim **18** wherein:

said first sleeve extension extends from said third fluid conduit toward said first fluid conduit; and

said second sleeve extension extends from said second fluid conduit toward said third fluid conduit.

20. Apparatus for the transmission of heated fluid as in claim **13** including:

spring means connected to said first fluid conduit means, said spring means loading said first fluid conduit means toward the furnace.

21. Apparatus for the transmission of heated fluid as in claim **13** wherein:

said second end of said first fluid conduit is detachably connected to the rest of said first fluid conduit; and wherein

said first fluid conduit defines an obtuse angle.

22. Apparatus for the transmission of heated fluid as in claim **21** including:

an inspection port in said first fluid conduit, said port being positioned outside of the axis of said obtuse angle.

23. A tuyere stock for shaft furnaces comprising at least three serially coupled conduit means lined with refractory material, the intermediate of said conduit means being connected at both ends to adjacent conduit means by means of universal coupling means and flexible hermetic coupling means, said universal couplings including an articulated mechanical connection comprising a connecting ring, a first set of arms extending from said intermediary conduit means and being pivotably connected to said connecting ring and a second set of arms offset by 90° from said first set of arms extending from one of said adjacent conduit means and being pivotably connected to said connecting ring.

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