Sept. 19, 1967 H. A. WHITE, JR 3,342,473

APPARATUS FOR DELIVERING AIR AND FUEL TO A BLAST FURNACE

Filed Jan. 20, 1964 3 Sheets-Sheet 1

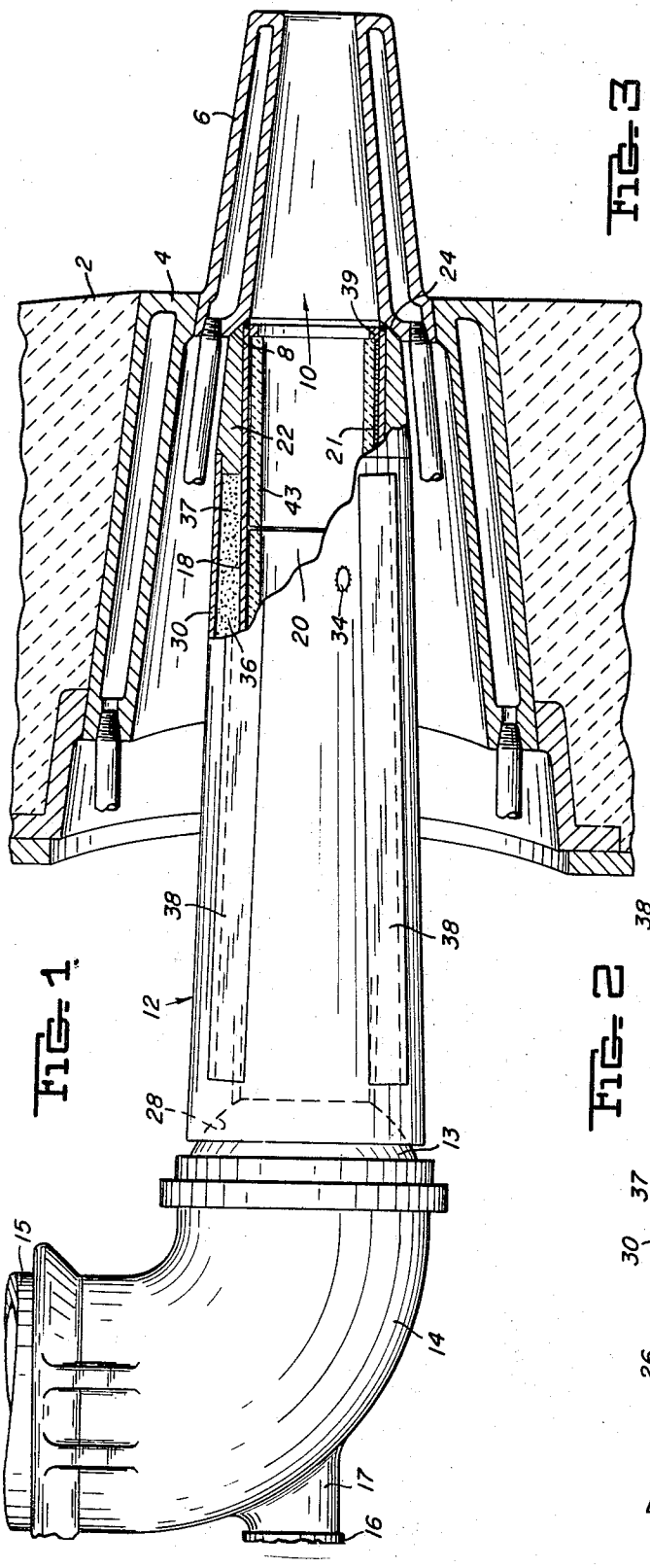


FIG. 1

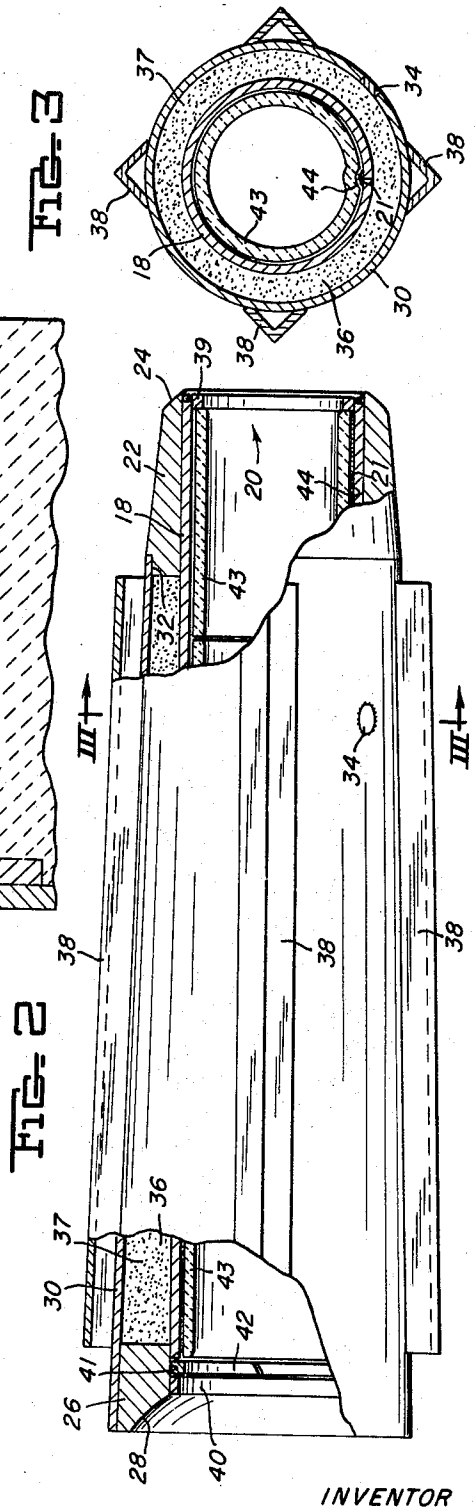


FIG. 2

FIG. 3

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FIG. 4

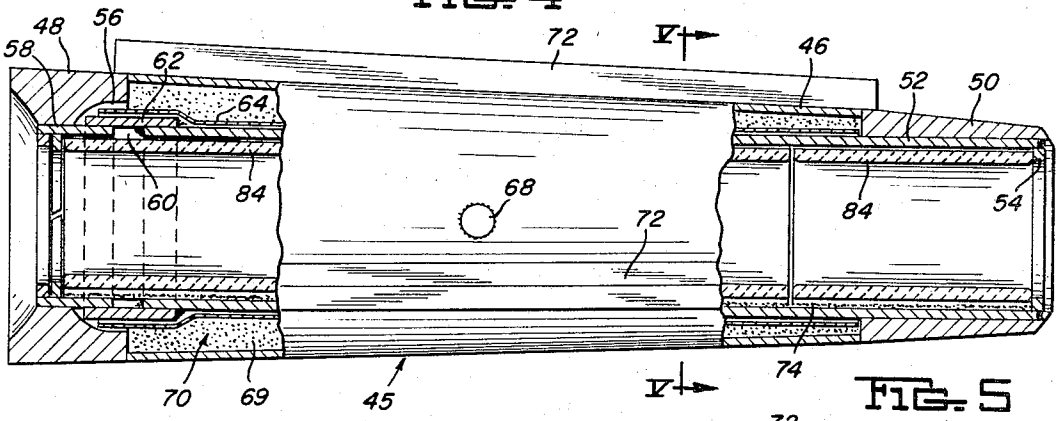


FIG. 5

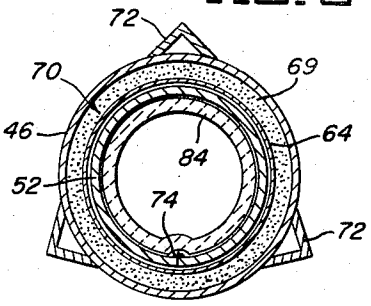


FIG. 6

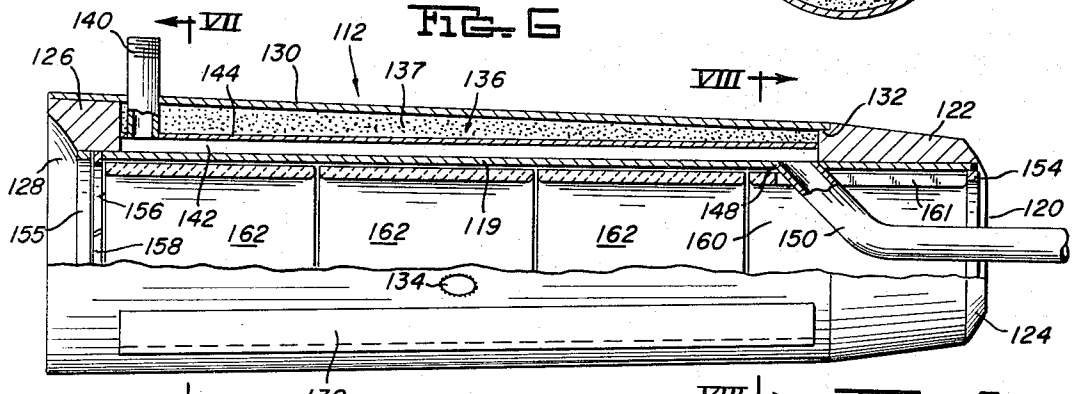


FIG. 7

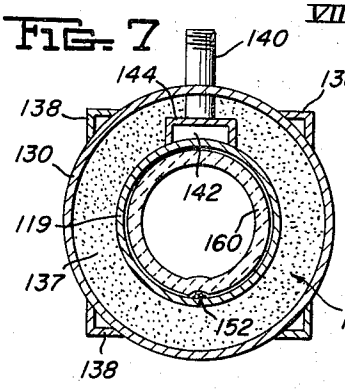


FIG. 8

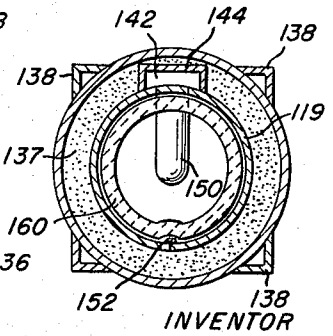
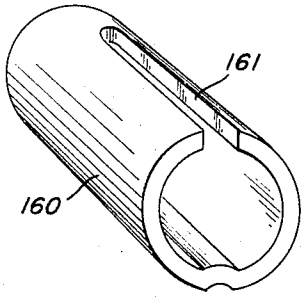


FIG. 9



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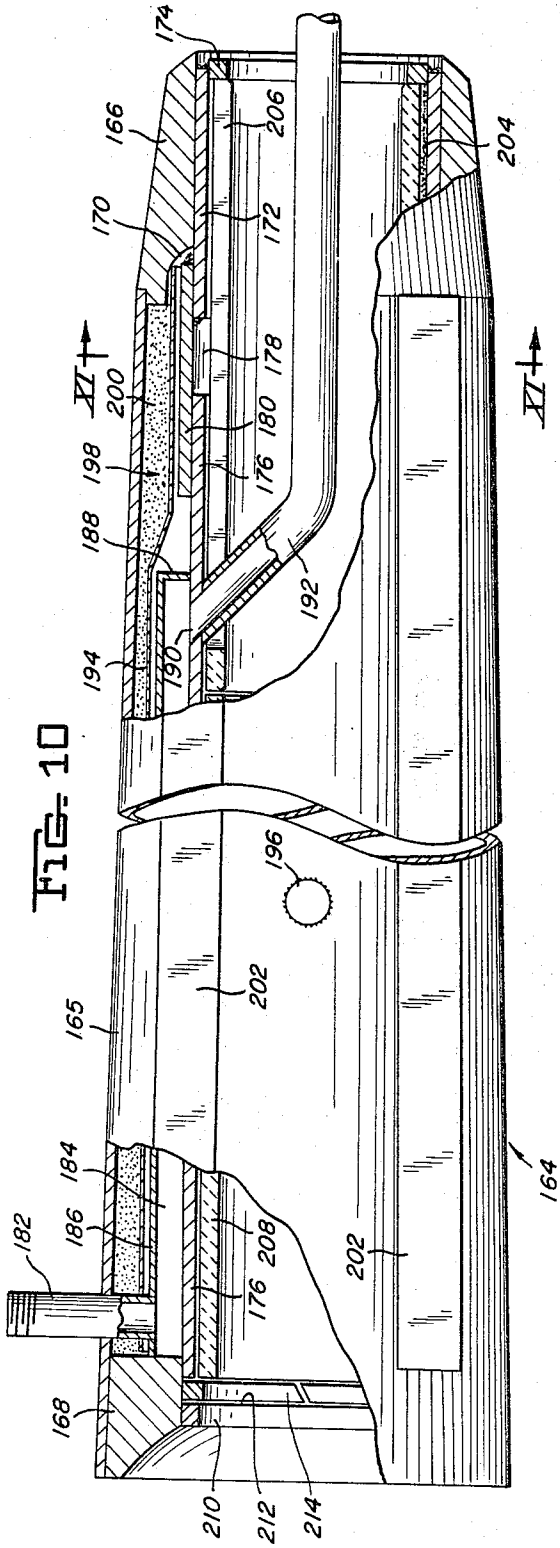


FIG. 10

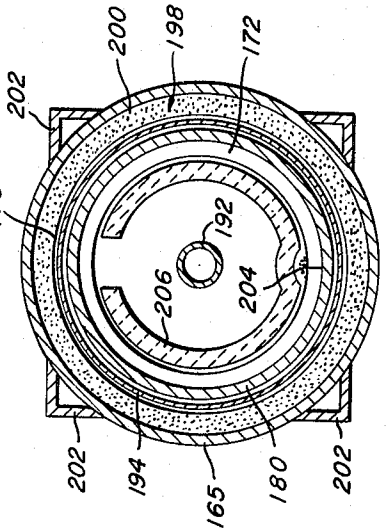


FIG. 11

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APPARATUS FOR DELIVERING AIR AND FUEL TO A BLAST FURNACE

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Filed Jan. 20, 1964, Ser. No. 338,769
12 Claims. (Cl. 266—41)

This application which is a continuation-in-part of my copending application Serial No. 136,345 filed September 6, 1961, now abandoned, relates to apparatus for delivering air or air and fuel to an iron producing blast furnace. The air is normally delivered to a blast furnace from the bustle pipe through a gooseneck, tuyere stock, blowpipe and tuyere. It is to the blowpipe that the present invention is particularly directed. The blowpipe and tuyere are substantially horizontal while the tuyere stock connected to the blowpipe is elbow shaped with a generally vertical flange on its outer end. The tuyere stock flange has a peep hole therein for observing the tuyere and conditions within the furnace. When supplemental fuel, such as natural or coke oven gas, oil, or powdered coal, is used it is generally delivered into the furnace by means of a pipe which passes through the tuyere stock flange and the blowpipe into the tuyere. Valves and other equipment are attached to the outer end of the fuel pipe and this makes it difficult to get into position to see through the pipe hole. The fuel pipe as well as the equipment at the end thereof also makes it difficult to see into the furnace.

In an attempt to solve at least some of the above difficulties it has been proposed to deliver the fuel through the side or the end of the tuyere. However, this has several disadvantages. The equipment for supplying the fuel to the tuyere is located close to the furnace where it is difficult to work on and where it adds to the difficulty of replacing tuyeres. Other disadvantages are that the fuel is not preheated and the tuyere is difficult to fabricate.

The blowpipes commonly used have solid walls of cast iron, steel or stainless steel, and weigh approximately 180 to 200 pounds. The air passing through the blowpipe to the tuyere is heated so that the blowpipe also becomes hot. There is also loss of heat through the blowpipe wall so that the air blast temperature is somewhat reduced and heat is radiated to the surrounding atmosphere. This makes working conditions very disagreeable and results in accidents. In most cases the key pin is knocked out permitting the blowpipe to fall to the floor. Since the blowpipe must be removed every time a tuyere is changed or the furnace banked and since the efficiency of the workmen is poor the annual labor cost is high. There is also considerable loss in production due to the time required to replace the blowpipe.

Insulated blowpipes, such as those shown in McKee Patent No. 2,023,025 dated December 3, 1935, have also been suggested, but these also have various disadvantages. During furnace operation hot slag, hot iron or coke may pass through the tuyere into the blowpipe and the coke in particular attacks and burns the metal of the blowpipe. If the metal is thin the slag, hot metal or coke may burn completely through in a short time. I have also found it highly desirable to provide an expansion joint somewhat similar to that shown in the McKee patent in order to obtain maximum life of the blowpipe. I have found that without such a provision the inner tube, after perhaps sixe months, will blow out in much the same way as an automobile tire. However, in addition to the disadvantages set forth above, this blowpipe has the disadvantage that it is so constructed that the insulation leaks out through the expansion joint. When this occurs the life of the blowpipe is shortened. Also the insulation is blown into the blast furnace and may interfere with the proper functioning of the furnace.

It is therefore an object of my invention to provide a blowpipe which is much lighter in weight than the conventional blowpipe, is insulated to prevent loss of heat to the surrounding atmosphere, and is protected from attack by the hot slag, hot metal and coke.

Another object is to provide apparatus for delivering air and fuel to a blast furnace which eliminates the fuel pipe through the tuyere stock flange and substantially all of the fuel pipe in the air passage through the blowpipe.

Still another object is to provide such apparatus wherein the fuel is preheated.

A further object is to provide such a blowpipe which includes an expansion joint wherein means are provided to prevent leakage of insulation from the blowpipe.

These and other objects will be more apparent after referring to the following specification and attached drawings, in which:

FIGURE 1 is a view, partly in section, of the blowpipe of my invention installed in a blast furnace;

FIGURE 2 is a view, partly in section, showing details of the blowpipe;

FIGURE 3 is a view taken on the line III—III of FIGURE 2;

FIGURE 4 is a sectional view showing a modification of my invention in which an expansion joint is provided;

FIGURE 5 is a view taken on the line V—V of FIGURE 4;

FIGURE 6 is a view, partly in section, of another embodiment of my invention;

FIGURE 7 is a view taken on the line VII—VII of FIGURE 6;

FIGURE 8 is a view taken on the line VIII—VIII of FIGURE 6;

FIGURE 9 is a perspective view of a fire clay tile used in the embodiment of FIGURE 6;

FIGURE 10 is a view, similar to FIGURE 6, of still another embodiment of my invention; and

FIGURE 11 is a view taken on the line XI—XI of FIGURE 10.

Referring more particularly to FIGURES 1 to 3 of the drawing, reference numeral **2** indicates the wall of a blast furnace having an opening therein for a tuyere cooler **4**. A tuyere **6** is received in the tuyere cooler **4** in the usual manner. A concave seat **8** is provided on the tuyere **6** around blast opening **10** for receiving one end of a blowpipe **12**. The other end of the blowpipe **12** is supported on a convex seat **13** on the furnace end of tuyere stock **14**. The other end of tuyere stock **14** is connected to a goose neck **15**. A peep hole **16** is provided in tuyere cap **17** in the usual manner. It will be understood that the tuyere stock **14** may be replaced by other supporting means and the term will be used hereafter in this broad sense. According to my invention the blowpipe **12** includes an inner tube **18**, preferably made of stainless steel, which provides an air blast opening **20**. The tube **18** has a longitudinal key **21** on its inner surface which is preferably the bead used to weld together the edges of the plate forming the tube. A tapered sleeve **22**, preferably made of mild steel, is welded to the outside of tube **18** at the furnace end thereof. The taper on the outside of sleeve **22** provides more clearance for the blowpipe **12** within the cooler **4**. The furnace end of sleeve **22** is provided with a spherical convex surface **24** which matches and is received in the concave seat **8**. A sleeve **26**, preferably made of mild steel, is welded to the outside of tube **18** at the end adjacent tuyere stock **14**. A concave spherical surface **28**, matching the convex seat **13**, is provided on the end of sleeve **26**. A tapered tube **30**, preferably of mild steel, is welded to the outside of sleeves

22 and 26, a cut out 32 preferably being provided on sleeve 22 for receiving the furnace end of the tube 30. An opening 34 is provided in the tube 30 to permit charging of space 36 between tubes 18 and 30 with light weight insulation 37, such as vermiculite. The opening 34 is closed in any suitable manner, such as by welding a plug therein, after the space 36 is filled with insulation. Equally spaced angle irons 38, preferably made of mild steel, have their legs welded to the tube 30 along the length thereof. The angle irons 38 serve as reinforcement and also aid in protecting the blowpipe from damage when it is dropped. When the blowpipe 12 is in place the lowest angle iron may be slightly displaced to one side of the vertical plane through the center of the blowpipe as shown in FIGURE 1 in order to obtain greater clearance for the tuyere cooling water pipes. The tube 18 terminates short of the forward end of sleeve 22 and a metal ring 39 is welded to the end of the tube 18. A metal ring 40 is welded to sleeve 26 in spaced relationship with the end of tube 18 so as to provide a groove 41 for receiving a snap ring 42. A plurality of thin refractory sleeves 43, preferably made of fired fire clay, are received within the tube 18. The sleeves 43 are generally circular, but have a groove 44 therein for receiving the key 21. The sleeves 43 are preferably about ten or twelve inches long and have a wall thickness of about ¼ inch.

In assembly, the sleeves 43 are slid into the tube 18 with the bead or key 21 being received in the grooves 44 so as to prevent rotation thereof, this being necessary to prevent wearing away or breakage of the ends of the sleeve. After the final sleeve 43 is inserted, a snap ring 42 is preferably inserted in the groove 41 to hold the sleeves 43 in place during handling of the blowpipe. Because of its thin wall the sleeve 43 has little insulating value, but if hot slag, hot iron or coke flows through the tuyere into the blowpipe the tube 18 will be protected. A damaged sleeve or sleeves can readily be replaced when the air is off the furnace for any reason. Even though the inner tube 18 should become damaged so as to require replacement of the blowpipe the angles 38 give sufficient support in axial compression to prevent failure of the blowpipe until air is taken off the furnace during normal operation.

FIGURES 4 and 5 show a preferred embodiment of my invention which differs from that of FIGURES 1 to 3 by the provision of an expansion joint. This blowpipe 45 includes an outer tube 46, preferably of mild steel, which extends between and is fastened, as by welding, to end pieces 48 and 50. An inner tube 52, preferably of stainless steel, is welded to the exit end piece 50. A metal ring 54 is welded to the exit end of end piece 50. The end piece 50 in other respects is the same as end piece 22 of the first embodiment. The end piece 48 differs from end piece 26 in that its exit end has a concave recess 56 therein. A short second inner tube 58 is welded to the inside of end piece 48 and extends over the recess 56. A space 60 is provided between the inner tubes 52 and 58. I have found that the distance is preferably 1¼ inch for a 52 inch blowpipe which is a usual length. A tube 62 having an inside diameter just slightly greater than the outside diameter of tubes 52 and 58 has one end welded to tube 52 as shown and the other end slidably receiving tube 58. A liner 64 surrounds the outside of tubes 52 and 62 and is made of a heat resistant material which is also preferably a good heat insulator. One material found particularly suitable for this purpose is sold by the Carborundum Company under the trade name Fiber Frax Paper. This is made of 51.2% Al_2O_3; 47.1% SiO_2 and the remainder miscellaneous components. A hole 68 is provided in tube 46 to permit charging of insulation 69 into space 70 between tubes 46 and 52. The opening 68 can be closed in any suitable manner after the insulation is in place. The insulation is preferably granular Perlite. Reinforcing angles 72 are provided as in the first embodiment.

As in the first embodiment tubes 52 and 58 each has a longitudinal key 74 on its inner surface which is preferably the bead used to weld together the edges of the plate forming the tube. The metal ring 54 welded to the furnace end of tube 52 forms an abutment. Sleeves 84, similar to sleeves 43, are assembled within the tube 46 in the same manner as in the first embodiment. It will be noted that the sleeve 84 at the inlet end of the blowpipe covers the space 60. I have found that this arrangement together with the liner 64 and the welds connecting the tubes 52 and 62 forms an air tight enclosure and prevents leakage of the insulation from the blowpipe. The weld at the end of tube 52 also prevents it from curling as a result of the wind velocity.

FIGURES 6 to 9 show a blowpipe 112 which has generally the same construction as that of the first embodiment and includes an inner tube 119 which provides an air blast opening 120. The tube 119, like tubes 18 and 52, forms the main structural member for the blowpipe. A tapered sleeve 122, preferably made of mild steel, is welded to the outside of tube 119 at the furnace end thereof. The furnace end of sleeve 122 is provided with a spherical convex surface 124 which matches and is received in the concave seat 8. A sleeve 126, preferably made of mild steel, is welded to the outside of tube 119 at the end adjacent tuyere stock 14. A concave spherical surface 128, matching the convex seat 13, is provided on the end of sleeve 126. A tapered tube 130, preferably of mild steel, is welded to the outside of sleeve 122 and 126, a cut out portion 132 preferably being provided on sleeve 122 for receiving the furnace end of the tube 130. An opening 134 is provided in the tube 130 to permit charging of space 136 between tubes 119 and 130 with light weight insulation 137, such as vermiculite. The opening 134 is closed in any suitable manner, such as by welding a stainless steel plate thereover, after the space 136 is filled with insulation. Four equally spaced angle irons 138, preferably made of mild steel, have their legs welded to the tube 130 along the length thereof.

This embodiment differs from the first embodiment in that a fuel pipe 140 passes through the outer end of tube 130 adjacent the top thereof. The inner end of pipe 140 opens into a passageway 142 formed by a channel or U-shaped member 144 having its open end against the tube 119. The legs of member 144 are preferably welded to the tube 119. The member 144 may extend the full length of space 136 between tubes 119 and 130 or it may terminate a short distance from the ends thereof. In the latter case the ends of member 144 must be closed to provide a gas tight passage. An opening 148 is provided in the wall of tube 119 at the furnace end of member 144 and a bent pipe 150 is secured to tube 119 around the opening 148. The pipe 150 extends forwardly and radially to about the center of tube 119 from where it passes axially through opening 120 and tuyere 6 and terminates a few inches from the furnace end of the tuyere. As the fuel gas passes through passageway 142 it will be heated by the hot blast in tube 119.

As in the first embodiment tube 119 has a longitudinal key 152 on its inner surface which is preferably the bead used to weld together the edges of the plate forming the tube. A metal ring 154 is welded to the furnace end of tube 119 and a metal ring 155 is welded to the sleeve 126 in spaced relationship with the end of tube 119 so as to form a groove 156 for receiving a snap ring 158. A sleeve 160, similar to sleeves 43, except for a slot 161 on its inner end for receiving pipe 150 is slid into the tube 119 against the ring 154. Other sleeves 162, similar to sleeves 43, are then assembled within the tube 119 in the same manner as in the first embodiment and the snap ring 158 snapped within groove 156.

FIGURES 10 and 11 show a blowpipe 164 which is similar to that of FIGURES 6 to 9 except that an expansion joint is provided. The blowpipe 164 includes an outer tube 165 extending between and welded to sleeves 166

and 168. The sleeve 166 is the same as sleeve 122 except that it has a recess 170 therein. A short inner tube 172 is welded to sleeve 166 and a metal ring 174 is welded to the furnace end of tube 172. The sleeve 168 is the same as sleeve 126 and has a tube 176 welded thereto. A space 178 is provided between the ends of tubes 172 and 176 to allow for expansion. A tube 180 having an inside diameter only slightly greater than the outside diameter of tubes 172 and 176 has one end welded to tube 172 and the other end slidably receiving tube 176.

A fuel pipe 182 passes through the outer end of tube 165 adjacent the top thereof. The inner end of pipe 182 opens into a passageway 184 formed by a channel or U-shaped member 186 having its open end against the tube 176. The legs of member 186 are preferably welded to the tube 176. The member 186 terminates short of the tube 180 and is closed by member 188 to make a gas tight passage. An opening 190 is provided in the wall of tube 176 at the furnace end of member 186 and a bent pipe 192 is secured to tube 176 around the opening 190. The pipe 192 is otherwise the same as pipe 150. A liner 194 surrounds the outside of tubes 176 and 180 and is preferably made of the same material as liner 64. An opening 196 is provided in tube 165 to permit charging of space 198 between tubes 165 and 176 with light weight granular insulation 200. The opening 196 is closed by welding a plate thereover after the space 198 has been filled. Reinforcing angles 202 are welded to the outside of tube 165.

As in the other embodiments tubes 172 and 176 each has a longitudinal key 204. A sleeve 206, similar to sleeve 160, is slid through tube 176 into tube 172 against the ring 174. Other sleeves 208, similar to sleeves 43, are then assembled within the tube 176 as in the other embodiments. A metal ring 210 is welded to the sleeve 168 in spaced relationship with the end of tube 176 so as to form a groove 212. A snap ring 214 is snapped within groove 212 after the sleeves 208 are inserted.

It will be noted that the sleeve at the inlet end of the blowpipe covers the space 178. I have found this arrangement together with the liner 194 and the weld connecting tubes 172 and 180 form an air tight enclosure and prevents leakage of the insulation from the blowpipe.

The expansion joint of FIGURE 4 may be used with this embodiment and the expansion joint of this embodiment be used in place of the expansion joint of FIGURE 4.

While several embodiments of my invention have been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A blowpipe for insertion between the tuyere and tuyere stock of a blast furnace comprising an inner tube, outer tube surrounding said inner tube in spaced relationship therewith, an end piece at each end of said tubes, means for holding said tubes in assembled position with said end pieces, insulation in the space between said tubes, a plurality of refractory sleeves fitting snugly within said inner tube and extending substantially the full length thereof in abutting relationship, means for preventing axial movement of said sleeves toward the tuyere end of said inner tube, a third tube fastened to the end piece at the tuyere stock end of the blowpipe, said third tube having the same outside diameter as the inner tube, said inner tube being of such length as to provide a space between its tuyere stock end and said third tube, a fourth tube having an inside diameter slightly greater than the outside diameter of said inner tube, said fourth tube surrounding and overlapping said inner and third tubes, and a weld connecting the tuyere stock end of said inner tube to said fourth tube.

2. A blowpipe according to claim 1 including a heat resistant layer surrounding said inner and fourth tubes.

3. A blowpipe for insertion between the tuyere and tuyere stock of a blast furnace comprising an inner tube, an outer tube surrounding said inner tube in spaced relationship therewith, an end piece at each end of said tubes, means for holding said tubes in assembled position with said end pieces, insulation in the space between said tubes, a plurality of refractory sleeves fitting snugly within said inner tube and extending substantially the full length thereof in abutting relationship, means for preventing axial movement of said sleeves toward the tuyere end of said inner tube, a third tube fastened to the end piece at the tuyere end of the blowpipe, said third tube having the same outside diameter as the inner tube, said inner tube being of such length as to provide a space between its tuyere end and said third tube, a fourth tube having an inside diameter slightly greater than the outside diameter of said inner tube, said fourth tube surrounding and overlapping said inner and third tubes, a weld connecting said third tube to said fourth tube adjacent the tuyere end.

4. A blowpipe according to claim 3 including a heat resistant layer surrounding said inner and fourth tubes.

5. A blowpipe according to claim 1 in which said tuyere and end piece adjacent thereto have matching concave and convex end surfaces, said tuyere stock and end piece adjacent thereto have matching concave and convex end surfaces, said inner tube has a longitudinal key on the inside thereof, and each of said refractory sleeves has a longitudinal groove therein for receiving said key.

6. A blowpipe according to claim 5 including a heat resistant layer surrounding said inner and fourth tubes.

7. A blowpipe according to claim 3 in which said tuyere and end piece adjacent thereto have matching concave and convex end surfaces, said tuyere stock and end piece adjacent thereto have matching concave and convex end surfaces, said inner tube has a longitudinal key on the inside thereof, and each of said refractory sleeves has a longitudinal groove therein for receiving said key.

8. A blowpipe according to claim 7 including a heat resistant layer surrounding said inner and fourth tubes.

9. Apparatus for delivering air and fuel to a blast furnace comprising a tuyere, a blowpipe having one end bearing against the tuyere and the other end connected to a source of hot air, said blowpipe including an inner tube, an outer tube surrounding said inner tube in spaced relationship therewith, an end piece at each end of said tubes, means for holding said tubes in assembled position with said end pieces, a longitudinal passageway in the space between said tubes, insulation in the space between said tubes around said passageway, means for connecting a source of fuel to the outer end of said passageway, a tube connected to the other end of said passageway extending therefrom into said tuyere, a plurality of refractory sleeves fitting snugly within said inner tube and extending substantially the full length thereof in abutting relationship, means for preventing axial movement of said sleeves toward the tuyere end of said inner tube, a third tube fastened to the end piece at the tuyere end of the blowpipe, said third tube having the same outside diameter as the inner tube, said inner tube being of such length as to provide a space between its tuyere end and said third tube, a fourth tube having an inside diameter slightly greater than the outside diameter of said inner tube, said fourth tube surrounding and overlapping said inner and third tubes, and a weld connecting said third inner and fourth tube adjacent the tuyere end.

10. Apparatus according to claim 9 including a heat resistant layer surrounding said inner and fourth tubes.

11. A blowpipe for insertion between the tuyere and tuyere stock of a blast furnace comprising an inner tube, an outer tube surrounding said inner tube in spaced relationship therewith, an end piece at each end of said tubes, means for holding said tubes in assembled position with said end pieces, insulation in the space between said tubes, a third tube fastened to the end piece at the tuyere stock end of the blowpipe, said third tube having the same out-

side diameter as the inner tube, said inner tube being of such length as to provide a space between its tuyere stock end and said third tube, a fourth tube having an inside diameter slightly greater than the outside diameter of said inner tube, said fourth tube surrounding and overlapping said inner and third tubes, a weld connecting the tuyere stock end of said inner tube to said fourth tube, and a heat resistant layer surrounding said inner and fourth tubes.

12. A blowpipe for insertion between the tuyere and tuyere stock of a blast furnace comprising an inner tube, an outer tube surrounding said inner tube in spaced relationship, an end piece at each end of said tubes, means for holding said tubes in assembled position with said end pieces, insulation in the space between said tubes, a third tube fastened to the end piece at the tuyere end of the blowpipe, said third tube having the same outside diameter as the inner tube, said inner tube being of such length as to provide a space between its tuyere end and said third

tube, a fourth tube having an inside diameter slightly greater than the outside diameter of said inner tube, said fourth tube surrounding and overlapping said inner and third tubes, a weld connecting said third tube to said fourth tube adjacent the tuyere end, and a heat resistant layer surrounding said inner and fourth tubes.

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