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BLAST FURNACE PROBE

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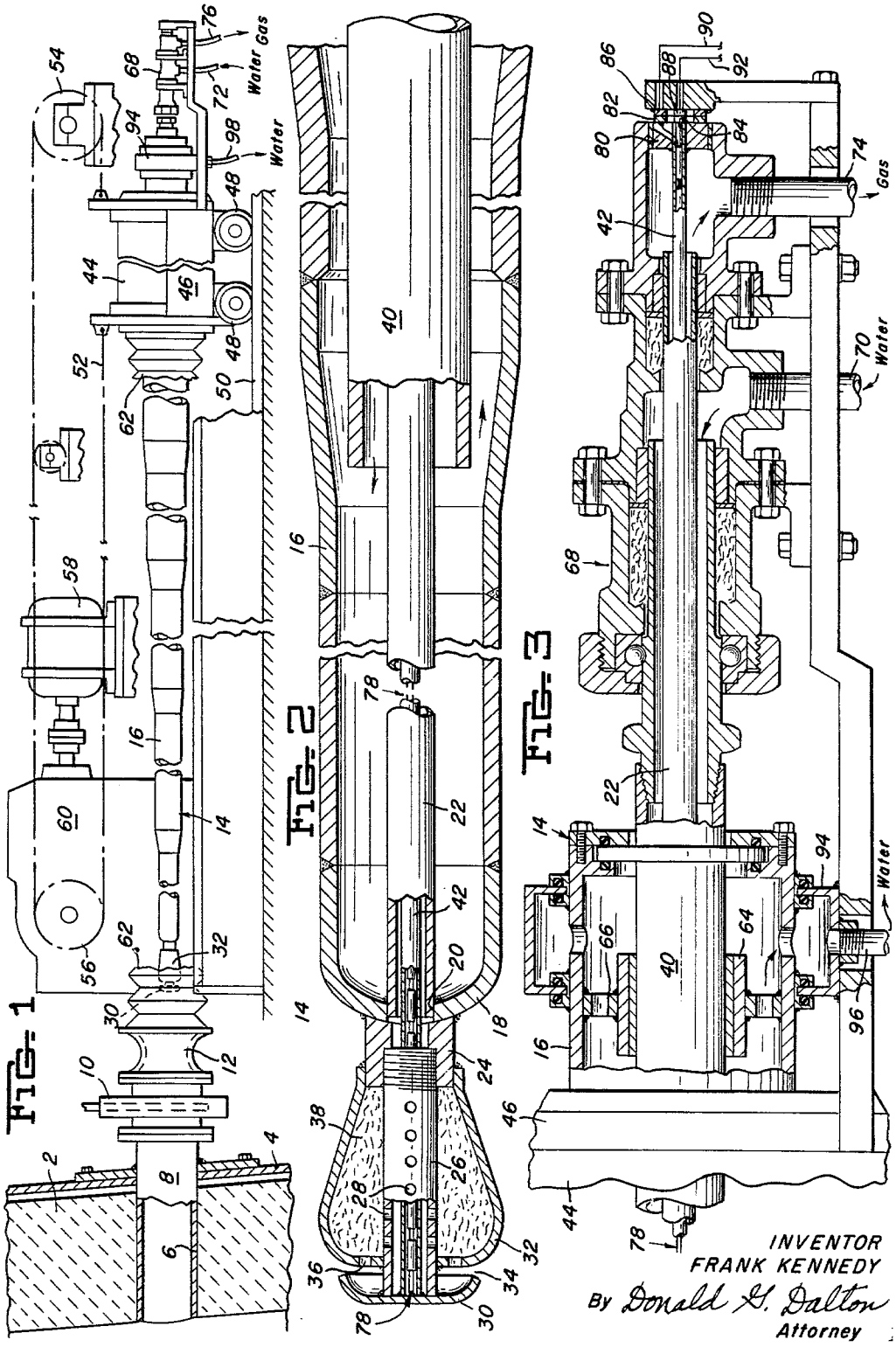


FIG. 1

FIG. 2

FIG. 3

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BLAST FURNACE PROBE

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This invention relates to a blast furnace probe and more particularly to such a probe for insertion within the stack of an iron producing blast furnace in order to provide information relating to gas and solids distribution so as to permit adjustments of the burden, hot blast temperature, wind volume and the like in order to prevent and/or correct channeling, scabbing and hanging of the burden. Probes have been used for this purpose to a limited extent, both in this country and abroad, but those in use have various disadvantages. Some require that the stockline be lowered each time the probe is inserted in or retracted from the furnace. Most of the foreign probes are stationary and must be built into the furnace. This results in very serious maintenance problems. The gas samples and temperature readings obtained by some probes are not accurate. In general the probes are expensive to fabricate and maintain. Another difficulty is that the hot gases rising through the furnace causes expansion of the lower surface of the probe when in the furnace with a resultant upward deflection of the probe. This deflection hinders withdrawal of the probe from the furnace.

It is therefore an object of my invention to provide a blast furnace probe which can obtain temperature readings and gas samples at the same time and which is easily inserted and withdrawn from the furnace while the furnace is in operation.

Another object is to provide such a probe which is relatively light in weight and which is not subject to differential temperatures while within the furnace.

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

FIGURE 1 is an elevation, partly in section, of the probe of my invention positioned at a blast furnace;

FIGURE 2 is a sectional view showing the forward end of the probe of my invention; and

FIGURE 3 is a sectional view of the rearward end of my invention.

Referring more particularly to the drawings, reference numeral 2 indicates the wall of a blast furnace having the usual steel shell 4. While only one probe is shown it is preferred to use four probes spaced 90° apart around the periphery of the furnace at a vertical location about 7 ft. below the stockline. An opening 6 is provided through the wall 2 and shell 4 and an alloy steel cylindrical liner 8 inserted therein. A gate valve 10 is secured to the steel shell 4 around the opening 6 and a flexible seal 12 secured thereto on the side away from the furnace. The flexible seal 12 is a sleeve having an initial diameter greater than the minimum diameter of the probe and capable of stretching to the maximum diameter of the probe so as to form a gas tight seal when the probe 14 is in its innermost position within the blast furnace.

The probe 14 of my invention includes an outer shell 16 made up of a plurality of double extra heavy sections of

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pipe joined together by reducers which are welded to the pipe sections as shown with the axes of the pipe sections and reducers being in alignment. Thus the shell 16 has a maximum diameter at one end and reduced to a minimum diameter at the other end in a plurality of steps, the maximum diameter being such that the shell will be snugly received within the cylindrical liner 8. A cap 18 which substantially closes the leading end of the shell 16 has an axial hole 20 therein for receiving a pipe 22 which is preferably welded to the cap 18. A coupling 24 is welded to the outside of the cap 18 around the opening 20. A tube 26 is threaded into the coupling 24 and has a plurality of holes 28 through the walls thereof. A cup shaped shield 30 is welded to the front end of tube 26 with its outer periphery extending rearwardly. A rear deflector shield 32 surrounds the tube 26 with its rear end being welded to the coupling 24 and its forward end welded to the tube 26 in spaced relationship with the shield 30 so as to provide a circumferential opening 34 therebetween. The shape of the shield 32 is generally conical with its maximum diameter being greater than the diameter of the shield 30. The maximum diameter is at the end toward the shield 30. The shield 32 is provided with openings 36 at its forward end spaced from the axis of the tube 26 a distance less than the radius of shield 30. Rock wool or other filter material 38 is provided in the space between the shield 32 and tube 26. A cooling water pipe 40 surrounds the tube 22 within the shell 16. An insulated stainless steel sheath 42 extends through tube 22 and terminates at the forward end of the tube 26.

The probe 14 may be moved into and out of the furnace by various means such as a rack and pinion or a cable arrangement actuated by an electric or hydraulic motor. In the arrangement shown, an air motor 44 surrounds the rear end of the shell 16 and is supported on a carriage 46 for movement therewith. Thus the air motor 44 serves both to rotate the probe 14 and connect it to the carriage 46. The carriage 46 has wheels 48 thereon which are supported by rails 50 for movement toward and away from the furnace. The ends of a chain 52 are attached to the top of the carriage 46. The chain 52 passes around an idler sprocket 54 arranged above and between the tracks 50 at the outer end thereof and a drive sprocket 56 arranged at the forward end of the tracks 50. The sprocket 56 is driven by a motor 58 through a gear reducer 60. Except for the air motor 44, the drive arrangement is essentially as shown in my copending application, Serial No. 89,165, filed February 14, 1961, now Patent No. 3,130,584.

A Gortite sleeve protector 62 surrounds the probe 14 and has one end attached to the seal 12 and the other end attached to the air motor 44. The rearward end of tube 40 is supported by a bushing 64 which is centered and supported in shell 16 by a web 66. A revolving joint 68 is attached to the tube 40. This may be any standard type of revolving joint such as a Barco type IBRR. The casing of the joint 68 remains stationary when the probe 14 rotates. The joint 68 includes a water inlet 70 connected by means of a flexible hose 72 to a water source, not shown, and a gas sample outlet 74 connected by means of a flexible conduit 76 to a sampling device, not shown. Thermocouple wires 78 extend from the hot junction at

the shield 30 through the sheath 42, the rearward end of which is supported by a rotatably mounted ring 80. Brushes 82 and 84 are mounted on ring 80 with one of the wires 78 attached to brush 82 and the other to brush 84. Brushes 86 and 88 are mounted on carriage 46 and are adapted to contact brushes 82 and 84, respectively. Wires 90 and 92 connected to brushes 86 and 88 lead to a temperature recorder, not shown. A stationary annular ring 94 surrounds the probe 14 at its outer end and has a water drain outlet 96 thereon connected to a flexible conduit 98.

The operation of my device is as follows:

When it is desired to obtain temperature readings and flue gas analyses the gate valve 10 is opened and the motor 58 operated to cause the carriage 46 to move inwardly into the furnace. During the inward movement, the flexible seal 12 is expanded by the probe 16 until it reaches its innermost position. In this position there is a tight sealing engagement with the maximum diameter portion of the probe 14. The sleeve protector 62 will also be compressed and any blast furnace gas that might possibly escape through the seal 12 will be confined within the sleeve protector 62. Water will pass through the tube 40 to the innermost portion of the shell 16 and then return between the tube 40 and shell 16 and out through drain 96. As the probe moves inwardly through the furnace burden the motor 44 will cause the probe 14 to rotate about its axis. Gas from the blast furnace will pass through opening 34 and holes 36 into the space between tube 26 and shield 32. It will be seen that the shapes of the shields 30 and 32 are such that the furnace burden will be deflected away from the opening 34 which is smaller than the burden aggregates. The gas then passes through the holes 28 into the tube 26 and then through tube 22 and out through outlet 74 in the joint 68. The temperature of the gases is measured by means of a temperature recorder, not shown, connected to wires 90 and 92. Rotation of the probe carries the burden downwardly away from its outer periphery and permits easy penetration of the probe into the burden. The rotation also permits uniform heating of the shell 16 so as to prevent the distortion that would occur in a fixed structure wherein the hot gases rise under the probe. It will be seen that the furnace gases contact the hot junction of the thermocouple before cooling of the gases and that the temperature readings and gas analyses can be obtained at the same time. When it is desired to retract the probe, the motor 58 is rotated in the opposite direction so as to cause the probe to move outwardly. When the shield 30 passes the valve 10, the valve 10 is closed to prevent flow of gases from the furnace.

While one embodiment of my invention has 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. Apparatus for determining conditions at spaced points within a blast furnace comprising an outer shell adapted to be inserted within said furnace, said shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the outer end to the furnace end thereof, means closing the forward end of said shell, a tube connected to the forward end of said shell and communicating with the interior of said shell, a cup shaped shield closing the forward end of said tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, a gas passageway between said circumferential opening and the interior of said tube, means for moving said shell into and out of said furnace, and means for rotating said shell when it is in said furnace.

2. Apparatus for determining conditions at spaced points within a blast furnace comprising an outer shell adapted to be inserted within said furnace, said shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the outer end to the furnace end thereof, means closing the forward end of said shell, a tube connected to the forward end of said shell and communicating with the interior of said shell, a cup shaped shield closing the forward end of said tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, the forward end of said second shield having openings therein spaced from the axis of said tube a distance less than the radius of said first shield, said tube having openings in the wall thereof beneath said second shield, filter material in the space between said second shield and tube, means for moving said shell into and out of said furnace, and means for rotating said shell when it is in said furnace.

3. Apparatus for determining conditions at spaced points within a blast furnace comprising an outer shell adapted to be inserted within said furnace, said shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the outer end to the furnace end thereof, means closing the forward end of said shell, a cooling water inlet pipe extending within said shell from the outer end thereof and terminating short of the forward end thereof, a revolving joint attached to the rearward end of said cooling water tube, means for delivering cooling water to said revolving joint and into said cooling water tube, a second tube within said cooling water tube extending from the forward end of said shell to said revolving joint, a third tube connected to the forward end of said shell and communicating with said second tube, a cup shaped shield closing the forward end of said third tube with its outer periphery extendling rearwardly, a second shield surrounding and attached to said third tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, a gas passageway between said circumferential opening and the interior of said third tube, means for moving said shell into and out of said furnace, and means for rotating said shell when it is in said furnace.

4. Apparatus for determining conditions at spaced points within a blast furnace comprising an outer shell adapted to be inserted within said furnace, said shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the outer end to the furnace end thereof, means closing the forward end of said shell, a cooling water inlet pipe extending within said shell from the outer end thereof and terminating short of the forward end thereof, a revolving joint attached to the rearward end of said cooling water tube, means for delivering cooling water to said revolving joint and into said cooling water tube, a second tube within said cooling water tube extending from the forward end of said shell to said revolving joint, a third tube connected to the forward end of said shell and communicating with said second tube, a cup shaped shield closing the forward end of said third tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said third tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first

shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, the forward end of said second shield having openings therein spaced from the axis of said third tube a distance less than the radius of said first shield, said third tube having openings in the wall thereof beneath said second shield, filter material in the space between said second shield and third tube, a gas outlet from said revolving joint communicating with said second tube, means for moving said shell into and out of said furnace, and means for rotataing said shell when it is in said furnace.

5. Apparatus for determining conditions at spaced points within a blast furnace comprising an elongated probe, a guide through the wall of said blast furnace, a valve on the exit side of said guide, a carriage supporting the outer end of said probe, means of said carriage for rotating said probe, means for moving said carriage and probe through said guide, said probe including an outer shell, means closing the forward end of said shell, a cooling water inlet pipe extending within said shell from the carriage end thereof and terminating short of the forward end thereof, a revolving joint mounted on said carriage and attached to the carriage end of said cooling water tube, means for delivering cooling water to said revolving joint and into said cooling water tube, means surrounding the carriage end of said shell for receiving and discharging the cooling water, a second tube within said cooling water tube extending from the forward end of said shell to said revolving joint, a third tube connected to the forward end of said shell and communicating with said second tube, a cup shaped shield closing the forward end of said third tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said third tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diimeter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, and a gas passageway between said circumferential opening and the interior of said third tube.

6. Apparatus for determining conditions at spaced points within a blast furnace comprising an elongated probe, a guide through the wall of said blast furnace, a valve on the exit side of said guide, a carriage supporting the outer end of said probe, means on said carriage for rotating said probe, means for moving said carriage and probe through said guide, said probe including an outer shell, means closing the forward end of said shell, a cooling water inlet pipe extending within said shell from the carriage end thereof and terminating short of the forward end thereof, a revolving joint mounted on said carriage and attached to the carriage end of said cooling water tube, means for delivering cooling water to said revolving joint and into said cooling water tube, means surrounding the carriage end of said shell for receiving and discharging the cooling water, a second tube within said cooling water tube extending from the forward end of said shell to said revolving joint, a third tube connected to the forward end of said shell and communicating with said second tube, a cup shaped shield closing the forward end of said third tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said third tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the dimeter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, the forward end of said second shield having openings therein spaced from the axis of said third tube a distance less than the radius of said shield, said third tube having openings in the wall thereof beneath said second shield, filter material in the space between said second shield and third tube, and a gas outlet from said revolving joint communicating with said second tube.

7. Apparatus for determining conditions at spaced points within a blast furnace comprising an elongated probe, a guide through the wall of said blast furnace, a valve on the exit side of said guide, a flexible seal on the exit side of said valve, a carriage supporting the outer end of said probe, means on said carriage for rotating said probe, means for moving said carriage and probe through said guide and seal into said furnace, and a sleeve protector surrounding said probe between said seal and carriage, said probe including an outer shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the carriage end thereof, means closing the forward end of said shell, a cooling water inlet pipe extending within said shell from the carriage end thereof and terminating short of the forward end thereof, a revolving joint mounted on said carriage and attached to the carriage end of said cooling water tube, means for delivering cooling water to said revolving joint and into said cooling water tube, means surrounding the carriage end of said shell for receiving and discharging the cooling water, a second tube within said cooling water tube extending from the forward end of said shell to said revolving joint, a third tube connected to the forward end of said shell and communicating with said second tube, a cup shaped shield closing the forward end of said third tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said third tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, the forward end of said second shield having openings therein spaced from the axis of said third tube a distance less than the radius of said first shield, said third tube having openings in the wall thereof beneath said second shield, filter material in the space between said second shield and third tube, a gas outlet from said revolving joint communicating with said second tube, thermocouple wires extending from the forward end of said third tube through said second tube and revolving joint, stationary brushes mounted on said carriage and means electrically connecting said thermocouple wires to said stationary brushes.

8. Apparatus for determining conditions at spaced points within a blast furnace comprising an elongated horizontal probe, a guide through the wall of said blast furnace, a valve on the exit of said guide, a carriage supporting the outer end of said probe, means on said carriage for rotating said probe, means for moving said carriage and probe horizontally through said guide into said furnace, said probe including an outer shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the carriage end thereof, means closing the forward end of said shell, a tube connected to the forward end of said shell and communicating with the interior of said shell, a cup shaped shield closing the forward end of said tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, and a gas passageway between said circumferential opening and the interior of said tube.

9. Apparatus for determining conditions at spaced points within a blast furnace comprising an elongated horizontal probe, a guide through the wall of said blast furnace, a valve on the exit side of said guide, a carriage supporting the outer end of said probe, means on said carriage for rotating said probe, means for moving

said carriage and proble horizontally through said guide into said furnace, said probe including an outer shell having a plurality of aligned hollow cylindrical portions decreasing in diameter from the carriage end thereof, means closing the forward end of said shell, a tube connected to the forward end of said shell and communicating the interior of said shell, a cup shaped shield closing the forward end of said tube with its outer periphery extending rearwardly, a second shield surrounding and attached to said tube in spaced relationship therewith, said second shield being generally conical with its maximum diameter being greater than the diameter of said first shield, the maximum diameter portion of said second shield being adjacent the first shield and spaced therefrom to provide a circumferential opening, the forward end of said second shield having openings therein spaced from the axis of said tube a distance less than the radius of said first shield, said tube having openings in the wall thereof beneath said second shield, and filter material in the space between said second shield and tube.

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