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[54] **APPARATUS FOR TAKING GAS SAMPLES IN SHAFT FURNACES**

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[52] **U.S. Cl.** ..... **73/421.5 A;** 138/113

[51] **Int. Cl.** **G01n 1/24**

[58] **Field of Search** ..... 73/421.5 R, 421.5 A, 425, 73/435.2; 138/111, 113; 175/19

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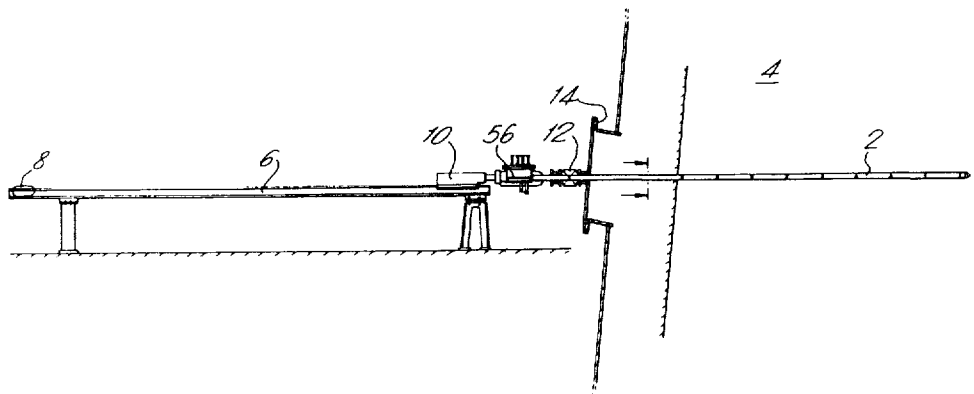
[57] **ABSTRACT**

Apparatus for taking gas samples in shaft furnaces, particularly blast furnaces, which is normally located outside the furnace and which is introduced into the furnace for sampling purposes. The apparatus comprises a probe equipped with a vibrator to facilitate its movement into the furnace charge.

9 Claims, 4 Drawing Figures



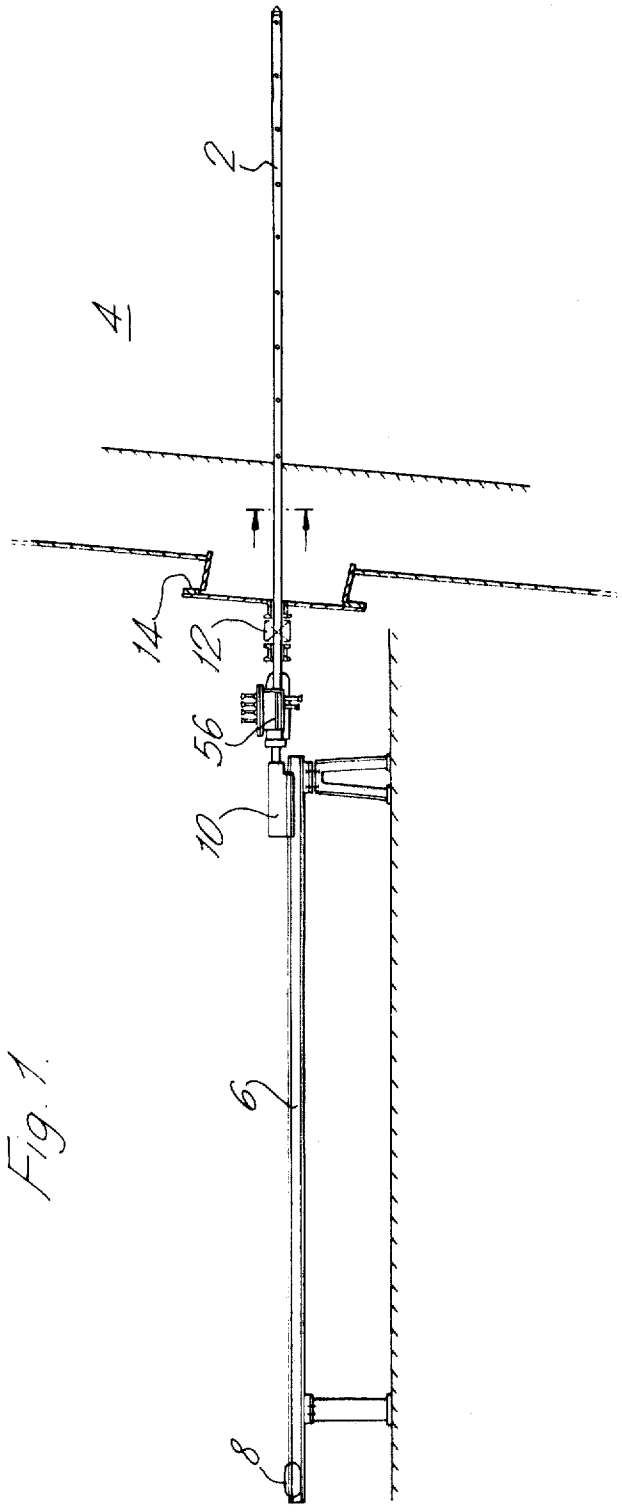


Fig. 1.

Fig. 2.

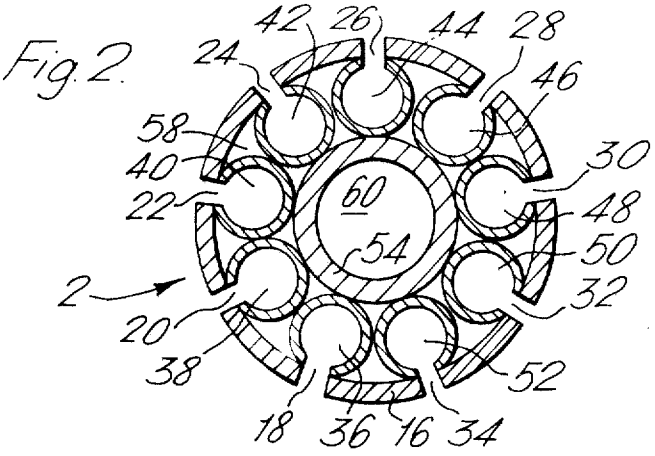

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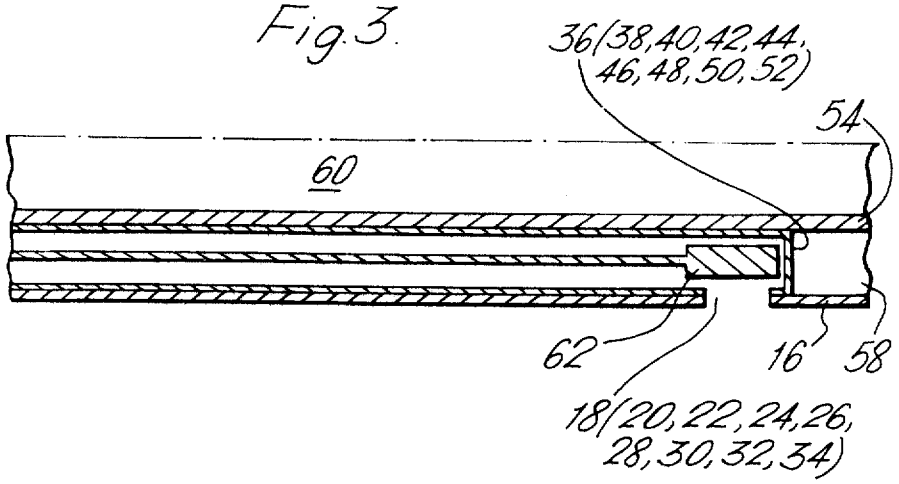
Fig. 3.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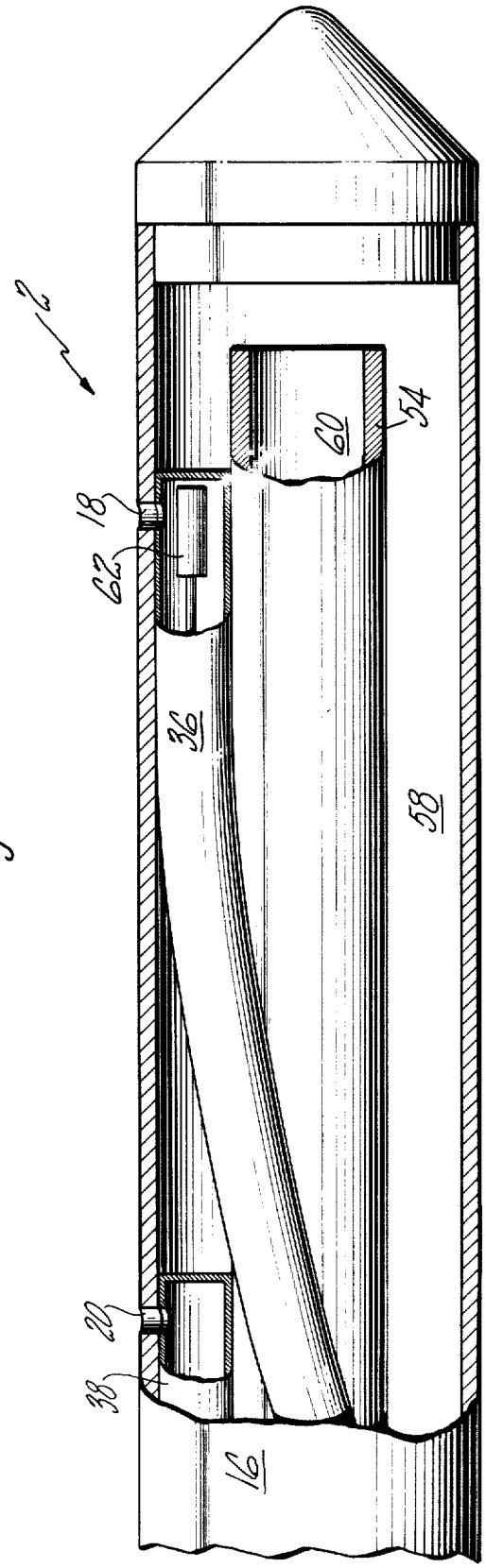

Fig. 4

APPARATUS FOR TAKING GAS SAMPLES IN SHAFT FURNACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an apparatus for taking gas samples in shaft furnaces, particularly blast furnaces, which in the inoperative position is located outside the blast furnace and which is introduced into the blast furnace charge for taking gas samples (operating position).

Taking reduction gas samples from the blast furnace and the knowledge of their chemical composition will in the future become of increasingly decisive importance for controlling the blast furnace process relative to optimum furnace working. To obtain informative reproducible measured values it is usual to take the gas samples in the blast furnace charge.

2. Description of the Prior Art

It is known to take the indicated gas samples from the blast furnace by means of probes. For this purpose either probes which are arranged fixedly in the blast furnace or movable probes introduced radially into the blast furnace are used. Furthermore, a probe installation is known which comprises a cross-beam passing from wall to wall at right angles through the blast furnace charge and which serves as a support for a displaceable probe head for taking gas samples.

However, the known probe installations have general and specific disadvantages which will be briefly explained hereinafter.

Gas probes arranged rigidly in the blast furnace, due to their cumbersome construction resulting from the harshness of the operating environment have a detrimental influence on the blast furnace material flow at the point of gas sampling. Frequently below the gas probe a space containing no material is formed which disturbs the reduction gas flow as a result of the artificially created space free of material and falsifies the measured values.

The prior art movable tubular probes comprise a probe support which is arranged with the end thereof projecting into the blast furnace. In operation, the reduction gas is sucked into the probe duct and is passed e.g. to a collecting tank arranged outside the blast furnace for subsequent chemical analysis. A drive arranged outside the blast furnace moves the probe horizontally into or out of the blast furnace. For taking gas samples at different furnace radii the probe is moved stepwise to the different points. However, as a result it is impossible to avoid a spacing in time of the individual gas sampling operations. As a result of the time lapse between the individual sampling operations no informative reproducible gas picture in the blast furnace can be obtained because a change in the gas resulting from the process can falsify the measured values during sampling. Moreover, as a result of the long dwell time of the probe in the blast furnace the possiblity of damage through overheating of the probe and slipping of the charge is increased. In some cases the probe is actually destroyed and/or lost. For these reasons the known introductible probes generally have relatively large diameters in order to increase their resistance to high temperature and buckling stresses. As a result the same disadvantages occur at least during the measurements as with fixed probes the furnace charge is disturbed and an inaccurate sampling of the reduction gases results.

As regards the probe displaceably arranged on a cross beam located in the furnace, quite apart from the extremely cumbersome constructions in the furnace which take up the space required for other important operating devices such a probe has the disadvantages of the two types of probe construction mentioned hereinbefore.

The apparently most appropriate known construction comprises a probe for taking gas samples which may be moved into and out of the charge of a shaft furnace, particularly a blast furnace, in the radial direction which is provided with a plurality of removal apertures along its longitudinal axis in each case connected with a pipe which permits the removal of gas samples at several points over the furnace diameter. Such probes are for example described in U.S. Pat. No. 3,240,069 and German DAS 1,533,829. They permit the simultaneous removal of gas samples at several points of the furnace cross-section which considerably reduces the dwell time of the probe in the furnace for measurement purposes. The present invention relates to this type of probe.

It has now been found that although the time necessary for the measurement is greatly reduced prior art multi-apertured movable probes still require a relatively long time to be moved into and out of the furnace charge so that the overall dwell time of the probe in the furnace is still too long.

It is an object of the invention to bring about the rapid introduction and withdrawal of a gas sampling probe relative to the furnace charge, whereby the gas sampling probe is introduced into and removed from the furnace radially and namely in such a way that the gas removing device introduced into the furnace charge permits the obtaining of an informative overall picture of the reduction gas in the furnace without disturbing furnace working without any major influence on the distribution of the furnace charge.

A further object of the present invention is to avoid the disadvantages of the existing installations to the greatest possible extent particularly relative to considerably reducing the total dwell time of the probe in the furnace by combining an effective cooling with a high rigidity of the probe.

These objects are generally considered to be of the greatest importance and several proposals have already been made for the solution thereof. Thus according to previously mentioned German DAS 1,533,829 the probe is given a rotary movement on introduction or the outer end of the probe is mounted on guide rollers and its displacement takes place by means of a hydraulic cylinder piston drive.

SUMMARY OF THE INVENTION

The present invention relates to a gas removal device or probe including a vibrator which acts upon the same during the displacement movement of the probe. The resultant vibration during liner motion considerably facilitates the introduction and removal of the probe relative to the furnace charge and considerably reduces the dwell time of the probe in the furnace for the purpose of taking gas samples.

A preferred embodiment of the invention further involves a special construction which has an effective cooling and, despite the limited size, a high rigidity. The reduction in size without sacrificing rigidity or cooling capacity is achieved by arranging a plurality of

furnace gas sampling pipes within an outer cylindrical protective tube around a central pipe, whereby these sampling pipe lines are connected with the apertures formed in the casing of the outer protective tube in order to permit the simultaneous sampling of gas at several points along the probe. Water circulation for cooling the probe is maintained in the central pipe and in the free space between the central pipe and the outer protective tube not occupied by the pipe lines.

The construction according to the invention, which comprises two concentrically arranged pipes whose interspace is substantially filled by a plurality of pipe lines which supply the gas samples to an analyser, ensures the rigidity of the probe with smallest possible dimensions. The movement of the probe into the furnace charge is thus further considerably facilitated.

BRIEF DESCRIPTION OF THE DRAWINGS:

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 drawings relative to a preferred embodiment, wherein:

FIG. **1** is a schematic side elevation view of a portion of a shaft furnace including a sampling probe installation in accordance with the present invention;

FIG. **2** is a cross sectional view showing a complete array of gas entry ports in a probe in accordance with a first embodiment of the invention, FIG. **2** being taken at an angle along the entire length of the probe and the gas entry ports actually being longitudinally spaced along the probe;

FIG. **3** is a cross sectional side elevation view of a single gas supply pipe of the probe of FIG. **2**: and

FIG. **4** is a cross sectional view of the free end of a second embodiment of a probe in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

According to FIG. **1**, which represents a longitudinal section through the probe installation, a probe **2** is mounted so as to be horizontally introduced into and withdrawn from the blast furnace **4**. In the inoperative position (withdrawn position) the probe **2** is arranged on a sliding or guide block **6** on a working platform. On the end of guide block **6** remote from blast furnace **4** is attached a servo motor **8** which is connected with probe **2** via, for example, an endless chain (not shown in FIG. **1**). Motor **8**, via the chain or other transmission means, delivers longitudinal force to move probe **2** in the horizontal direction.

Furthermore the probe is provided with a pneumatic or hydraulically operated vibrator **10**. The vibrations produced are superimposed on the tension or pressure exerted by servo-motor **8** on probe **2** and substantially aid the movement of probe **2** into the blast furnace charge.

A cut off valve **12** on the blast furnace wall **14** is opened to introduce the probe **2** and is closed with the probe **2** in the inoperative position. In order to seal the inside of the blast furnace relative to the outer atmosphere with the probe **2** introduced, the valve **12** is provided with a labyrinth seal device.

As according to the invention with the aid of probe **2** simultaneously several gas samples are taken at different furnace radii in the charge in order not to provide a falsified gas diagram probe **2**, as shown in FIG. **2** probe **2** is provided with a certain number of apertures or gas entry ports **18, 20, 22, 24, 26, 28, 30, 32** and **34** on its cylindrical outer casing **16**. The number of apertures **18** to **34** corresponds to the desired number of gas samples to be taken at the various blast furnace radii. To each aperture **18, 20, 22, 24, 26, 28, 30,** 32 and **34** is connected a gas distribution pipe **36, 38,** 40, 42, 44, 46, 48, 50, 52. These gas distribution pipes **36** to **52** are distributed over the inside of the outer casing **16** and are held in their particular position by means of a supporting tube **54** located centrally and concentrically to outer casing **16**. As all the gas distribution tubes **36** to **52** of the embodiment of FIG. **2** run parallel to the outer casing **16** or supporting tube **54**, apertures **18** to **32** are longitudinally and angularly displaced over outer casing **16** and are perpendicular to the appropriate gas distribution pipes **36** to **52.**

All the gas supply pipes **36** to **52** are connected to a distributor system **56** located outside blast furnace **4** (FIG. **1**), from which distributor system **56** the different gas samples are simultaneously supplied via separate pipe lines to collecting tanks.

To prevent damage through heating of the probe **2** in the blast furnace **4** probe **2** is water cooled. The cooling water flow up to the tip of the probe may take place through hollow chamber **58** (FIGS. **2** 3 and **4**) which is bounded by gas distribution pipes **36** to **52**, outer casing **16** and supporting tube **54**. The cooling water return flow takes place through the inside **60** of supporting tube **54.**

In a further development the cooling water supply takes place through the inside of supporting tube **54** and the return flow via hollow chamber **58.** This results in a particularly favourable cooling of the tip of the probe.

Whereas in the above described embodiment of FIG. **2** the gas entry apertures of gas distribution pipes **36** to **52** are angularly distributed over the complete periphery of the protective casing **16.** In accordance with a further embodiment, as depicted in FIG. **4,** the gas inlet apertures are only longitudinally displaced and not angularly displaced. To this end the gas distribution pipes **36** to **52** are twisted around the supporting tube **54.** The gas distribution pipes of the FIG. **4** embodiment will, of course, be parallel at any given point along the length of the probe and the maximum twist about the support tube **54** imparted to any distribution pipe will be less than 360°.

The FIG. **2** embodiment which comprises the straight gas distribution pipes has the advantage that it can be produced in a very simple manner. In the FIG. **4** embodiment, however, all the gas inlet apertures are in the same plane.

FIG. **3** represents a longitudinal section through one of the gas distributing pipes and through the appropriate inlet aperture **18.** In FIG. **3** a gas distribution pipe **36** terminates at a point adjacent to the outwardly disposed edge of inlet aperture **18.** Furthermore a thermocouple **62** around which the gas flows is provided in gas distribution pipe **36.** A signal commensurate with temperature as provided by the thermocouple is passed on to an indicator. Due to the relatively short dwell time of probe **2** in blast furnace **4** the thermocouple **62** must have a rapid response time thermocouples or other temperature sensors have been omitted from FIGS. **2**

and **4** in the interest of facilitating understanding of the invention.

To complete the gas diagram in the blast furnace outside the blast furnace a gas pressure indicator or recording device can be connected to each individual gas distribution pipe. Thus, on the various furnace radii the chemical composition, temperature and pressure of the reduction gas may be measured. These measured values can be used for controlling the complete blast furnace process.

Regarding the operation of the probe according to the invention it is pointed out that prior to the introduction of probe **2** into blast furnace **4** valve **12** is, for example, hydraulically opened. During the introduction of probe **2** with the aid of servo-motor **8** and vibrator **10** compressed air is introduced through distributor valve **56** into gas distribution pipes **36** to **52** for keeping free the apertures during the introduction process of the probe. The introduction of the probe **2** into its operating position takes a maximum of 15 seconds. The compressed air supply to the gas distribution pipes is now disconnected and reduction gas now flows through the gas distribution pipes to distributor valve **56.** As residual quantities of compressed air are still present in the gas distribution pipes this reduction gas — compressed air mixture is first blown out into the atmosphere before the reduction gas is passed into the available collecting tanks or analyzers. Approximately 30 seconds are necessary for carrying out this complete operation. The subsequent removal of the probe from the blast furnace takes a further 15 seconds so that the total sampling time up to removal of the probe amounts to one minute. Under normal circumstances this time is not exceeded. Besides the technical and time advantages it is also stressed that the simple construction of the probe allows for very small dimensions. Thus the external diameter of the outer casing **16** can be limited in one embodiment to 60.3 mm. The limited probe diameter does not disturb the reduction gas picture and does not falsify the measured values.

To facilitate the movement of the probe into the furnace charge it is advantageous to use a vibrator similar to those used in percussion drills or mechanical picks.

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 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 taking gas samples from a plurality of locations within the charge burden on the hearth of a shaft furnace comprising:

moveable probe means, said probe means including an elongated probe adapted to be introduced into and withdrawn from the furnace charge via a port in the furnace wall, said elongated probe including a central supporting tube and a plurality of rigid gas sampling pipes symmetrically arranged around said supporting tube, said gas sampling pipes each being provided with a gas entry aperture, said gas entry apertures being individually displaced along the longitudinal axis of the probe, said probe further comprising a tubular outer sheath surrounding said gas sampling pipes, said sheath being concentric with said central supporting tube and being provided with a plurality of gas entry ports individually displaced along the longitudinal axis of the probe, said gas entry ports being individually coupled to respective of said gas entry apertures in said gas sampling pipes, said sheath and central supporting tube defining an annular housing for said gas sampling pipes and a path for coolant flow in the free interspace between said sampling pipes;

drive means for applying longitudinal force to said probe means to urge said probe means into and to withdraw said probe means from the furnace charge; and

vibrator means coupled to said probe means for superimposing vibratory movement on to the longitudinal force during introduction of the probe into the furnace charge.

2. The apparatus of claim **1** wherein said movable probe means central supporting tube is provided with an opening adjacent the free end of said probe means whereby a coolant may be delivered to the interspace between said sheath and supporting tube adjacent the free end of said probe means, said coolant flowing along said probe in said free interspace.

3. The apparatus of claim **1** further comprising:

temperature sensing means disposed in at least some of said gas sampling pipes for indicating the temperature of the gas entering said probe means through the gas entry port coupled to the gas entry aperture in the sampling pipe in which the temperature sensing means is installed.

4. The apparatus of claim **1** wherein all of said sampling pipes are oriented parallely to one another.

5. The apparatus of claim **1** wherein an axial twist relative to said supporting tube is imparted to said probe means gas sampling pipes to thereby place all of said gas entry apertures in a single plane which passes through the axis of said probe means.

6. The apparatus of claim **2** further comprising:

temperature sensing means disposed in at least some of said gas sampling pipes for indicating the temperature of the gas entering said probe means through the gas entry port coupled to the gas entry aperture in the sampling pipe in which the temperature sensing means is installed.

7. The apparatus of claim **6** wherein all of said sampling pipes are oriented parallely to one another.

8. The apparatus of claim **7** wherein an axial twist about said supporting tube is imparted to said parallel gas sampling pipes to thereby place all of said gas entry apertures in a common plane through the axis of said probe means.

9. A method for taking gas samples in a shaft furnace which comprises the steps of:

imparting longitudinal force to an elongated sampling probe to cause said probe to extend inwardly through the wall of a furnace into the charge burden on the furnace hearth, said probe being characterized by a plurality of spacially longitudinally displaced gas entry ports, each of said ports being coupled to a separate gas sampling pipe;

superimposing vibratory motion onto said longitudinal force to minimize disruptions of the furnace charge burden during probe insertion into the burden;

delivering gas at a pressure in excess of the internal furnace pressure to the gas entry pipes in the probe during introduction of the probe into the furnace;

circulating a coolant through the probe during the time the probe is introduced into the furnace;

discontinuing the supply of pressurized gas when the probe is inserted into the furnace to the desired position to thereby permit the simultaneous taking of gas samples at several points over the furnace diameter, the furnace gases entering the probe through the entry ports and being delivered via the sampling pipes to the exterior of the furnace; and

withdrawing the probe after the gas samples have been taken.

* * * * *