Oct. 12, 1965 Y. BOUDIER 3,211,005

SAMPLING TUBE CONTROL STRUCTURE FOR SHAFT FURNACES

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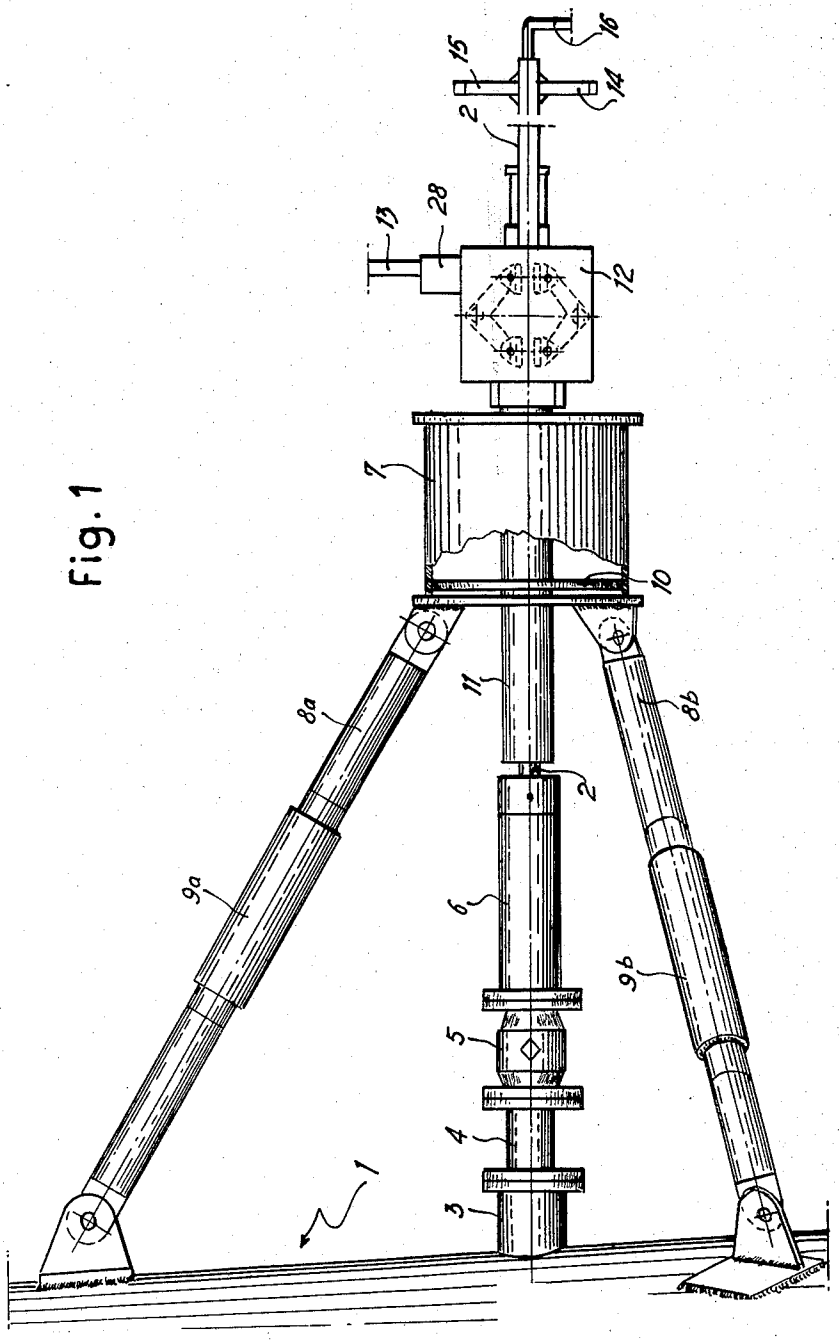
Fig. 1



Inventor:
Yves Boudier
By:
Michael S. Striker
Attorney

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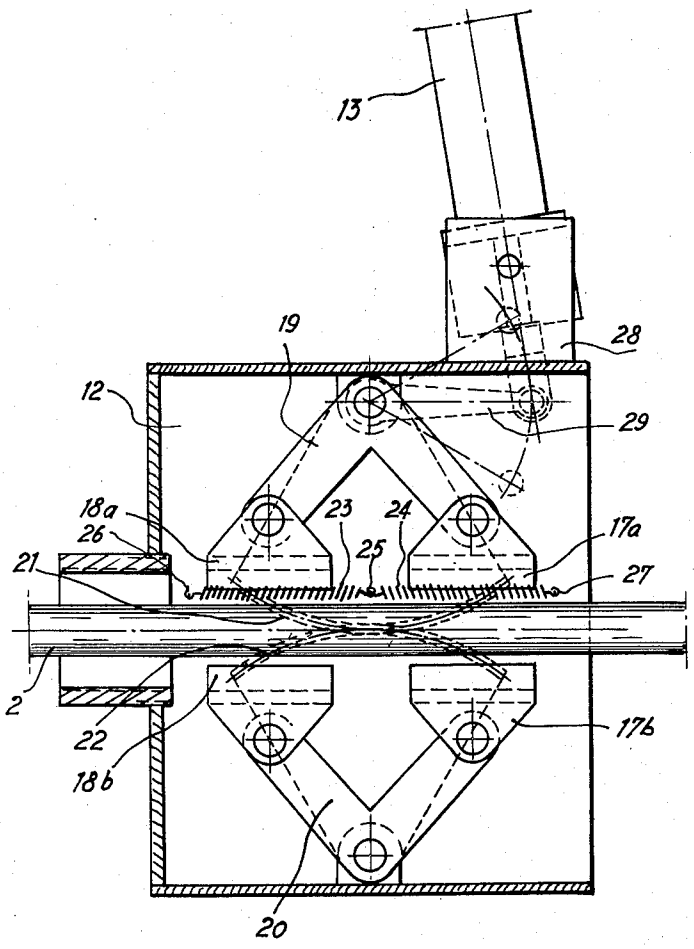
Fig. 2



Inventor:
Yves Boudier
By:
Michael S. Striker
Attorney

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SAMPLING TUBE CONTROL STRUCTURE FOR SHAFT FURNACES

Yves Boudier, Metz, France, assignor to Institut de Recherches de la Siderurgie Francaise, Saint Germain-en-Laye, France, a French professional institution

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4 Claims. (Cl. 73—421)

The present invention relates to sampling devices.

More particularly, the present invention relates to structure for taking samples of material from the interior of enclosures such as shaft furnaces.

In the operation of various types of shaft furnaces, such as blast furnaces, for example, there has been a considerable development in recent years of a system for determining the best possible operation of the furnace for a particular purpose by taking readings not only of the temperature and pressure of gases in the furnace but also by removing samples from the interior of the furnace and determining by tests on such samples the best possible way to operate the furnace.

The extent to which these sampling procedures are used is such that samples are taken not only at different elevations in the furnace but also from different distances from the axis of the furnace at the same elevation in the interior thereof.

In order to take samples from the interior of the furnace at different distances from the axis thereof at the same elevation in the furnace it is conventional to use a sampling tube which extends through an opening in the furnace wall into the interior thereof, and such a sampling tube can be positioned with respect to the axis of the furnace so as to remove samples from the interior thereof at selected distances from the axis of the furnace at the elevation at which the sampling tube is located. However, in order to obtain the necessary information it is necessary to be able to repeatedly position a given sampling tube at the same position relative to the axis of the furnace, and this problem has not been satisfactorily solved up to the present time. At the present time all of these operations are manually performed, and it is therefore necessary for the furnace to be provided with suitable structure such as scaffolding, platforms, and the like located in the region of the sampling tube so that an attendant may stand on such a platform and manually position the sampling tube. In addition to the inconvenience in providing the furnace with such structures, there is also the unavoidable inaccuracies resulting from manual positioning of the sampling tube.

It is a primary object of the present invention to provide a structure which will avoid the above drawbacks by making it possible to very precisely locate a sampling tube repeatedly at a given position relative to the axis of the furnace or other enclosure.

Another object of the present invention is to provide a structure of the above type which is fully mechanized and which is almost entirely automatic, if not fully automatic.

Also, the objects of the present invention include a structure which can be easily connected to any existing

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enclosure such as a shaft furnace without occupying a large amount of space.

Furthermore, it is an object of the present invention to provide a structure which while being considerably shorter than the sampling tube nevertheless is capable of moving the latter through a distance much greater than the distance through which the structure of the invention extends so that in this way the structure of the invention is extremely compact but at the same time can precisely position a sampling tube which extends through a distance far greater than that through which the structure of the invention itself extends.

Still another object of the present invention is to provide a structure capable of accomplishing the above objects and at the same time composed of simple rugged elements which are very reliable in operation.

With the above objects in view the invention includes, in a sampling device, an enclosure having a wall formed with an opening passing therethrough, and a sampling tube aligned with this opening so as to be capable of passing therethrough. In accordance with the present invention a fluid means is carried by the enclosure wall in the region of the sampling tube and includes a piston which is movable back and forth between predetermined end positions in the general direction of the sampling tube itself. This piston is fixedly connected with a hollow piston rod through which the sampling tube freely extends so that the piston and piston rod are freely movable relative to the sampling tube, and in accordance with the present invention a gripping means is fixed to the piston rod for movement therewith. A second fluid means cooperates with the gripping means for actuating the latter to grip the tube only when the piston moves in the direction in which it is desired to shift the sampling tube, while the gripping means releases the sampling tube when the piston moves in the direction opposite to that in which it is desired to shift the sampling tube, so that with the structure of the invention it is possible to move the sampling tube in a stepwise manner toward or away from the wall of the enclosure in order to locate the sampling tube at a preselected location.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 fragmentarily illustrates an exterior wall portion of a shaft furnace having connected thereto the structure of the invention which is illustrated in a partly diagrammatic manner in FIG. 1; and

FIG. 2 is a sectional elevation on an enlarged scale of the gripping means of the invention.

Referring to FIG. 1, there is shown therein part of a wall 1 of a blast furnace. Actually, the exterior surface of the wall is visible in FIG. 1, this exterior surface being provided with a suitable outer plating, as is well known in the art. The axis of the blast furnace is vertical and of course the wall 1 extends circumferentially around the axis of the blast furnace. The wall 1 is formed with an opening passing therethrough, and the elongated

sampling tube 2, which may be of a structure well known in the art, is capable of passing through the opening of the wall 1 into the interior of the furnace so as to have a selected location with respect to the axis of the furnace, this sampling tube 2 extending substantially radially with respect to the axis of the furnace. The wall 1 also fixedly carries a structure which guides the sampling tube 2 and which is capable of providing a fluid-tight closure when the sampling tube does not extend into the furnace. This latter structure includes a tube 3 which is welded to the exterior of the wall 1 and which is aligned with the opening passing therethrough, and the tube 3 is coaxially fixed with an intermediate tube 4 which can be used in the known way for connection with known meters in order to determine the pressure of the gas in the interior of the furnace, such readings being capable of being taken through the tube 4 when the sampling tube is in an inoperative position where it does not extend into the furnace. The tube 4 is fixed, at its end distant from the tube 3, to a valve 5 made of a suitable ceramic material, for example, and capable of being closed in a manner well known in the art so as to provide a fluid-tight closure when the sampling tube is withdrawn and is not used. The valve 5 is in turn coaxially connected with an elongated guiding tube 6 through which the tube 2 slidably extends, and this tube 6 is provided in its interior with a suitable sealing gland such as a suitable stuffing box structure for the purpose of providing a fluid-tight seal around the sampling tube 2 while supporting the latter for longitudinal shifting movement through the tube 6 into and out of the furnace, so that the sealing gland within the tube 6 provides a fluid-tight seal around the tube 2 when the latter extends into the interior of the furnace.

The wall 1 of the furnace fixedly carries a fluid means which participates in the movement of the sampling tube 2 toward and away from the axis of the furnace, and this fluid means includes a stationary cylinder 7 whose axis coincides with the axis of the sampling tube 2. This cylinder 7 is fixed to the wall of the furnace by three arms, two of which, 8*a* and 8*b*, are visible in FIG. 1. These arms are uniformly distributed about the axis of the cylinder 7 so that they are displaced from each other by an angle of 120°, and each arm is pivoted at one end to the cylinder 7 and at its opposite end to a bracket which is welded to the exterior surface of the wall 1. The length of the several arms 8*a*, 8*b*, and the third unillustrated arm are capable of being adjusted through the internally threaded sleeves 9*a*, 9*b*, and the third unillustrated sleeve, these sleeves having a structure similar to turnbuckles in that the interior of each of these sleeves is provided with oppositely directed threads respectively threaded to separate threaded portions of the arms so that by turning the sleeves the arms can be lengthened or shortened and in this way the position of the cylinder 7 relative to the furnace wall 1 can be accurately adjusted. The fluid means includes in addition to the cylinder 7 a piston 10 which is axially slidable within the cylinder 7 between opposite end positions where the piston 10 is located adjacent the end walls of the cylinder 7. This piston 10 is fixed with an elongated hollow tube 11 which forms a piston rod and which extends slidably and fluid-tightly through the end walls of the cylinder 7, the hollow piston rod 11 of course being coaxial with the piston 10 and the cylinder 7, and the sampling tube 2 extends freely through the hollow piston rod 11 so that the latter together with the piston 10 are freely movable relative to the sampling tube 2. The interior diameter of the tube 11 is greater than the exterior diameter of the tube 2 so that there is no actual contact between the tube 11 and the tube 2.

At its right end, as viewed in FIG. 1, which is always located beyond the cylinder 7, the hollow piston rod 11 fixedly carries a gripping means 12 which serves to grip the sampling tube 2 in a manner described below, and thus the gripping means 12 is compelled to move back and forth with the piston 10 and the piston rod 11. As will be apparent from the description below, the gripping means 12 includes gripping jaws which grip the tube 2, one set of gripping jaws gripping the tube 2 when it is moved toward the axis of the furnace further into the interior of the furnace and the other set of gripping jaws gripping the tube 2 when the latter moves outwardly away from the axis of the furnace, and in order to determine which set of gripping jaws engage the tube 2, these gripping jaws are actuated through a second fluid means 13 which is double-acting. At the outer end of the tube 2, this tube is connected to a pair of conduits 14 and 15 through which cooling water enters into and moves out of the tube 2 in a manner well known in the art, and in addition there is shown in communication with the tube 2 a conduit 16 through which passes the gas which forms the sample which is to be analyzed.

The details of the gripping means 12 are shown in FIG. 2 which illustrates part of the hollow piston rod 11 and the elongated sampling tube 2 passing through the latter as well as through the gripping means 12. The gripping means 12 includes one pair of jaws 17*a* and 17*b* and a second pair of jaws 18*a* and 18*b*. A bell crank lever 19 is pivotally carried by the frame which is fixed to the piston rod 11 and at its free ends pivotally carries the jaws 17*a* and 18*a*, while a second bell crank 20 is also pivotally connected at its apex to the frame of the gripping means 12, and this bell crank 20 pivotally carries the pair of jaws 17*b* and 18*b*, as is apparent from FIG. 2. In order to render the jaws 17*a* and 17*b* active, which is to say in order to grip the tube 2 with the jaws 17*a* and 17*b*, the bell crank 19 is turned in a clockwise direction and the bell crank 20 is turned in a counterclockwise direction, as viewed in FIG. 2, and these jaws 17*a* and 17*b* will automatically grip the tube 2, in a manner described below, when it is desired to shift the tube 2 to the right, as viewed in FIG. 2, away from the axis of the furnace, and it will be noted that at this time the jaws 17*a* and 17*b* will act reliably to hold the tube 2 during its movement away from the axis of the furnace in opposition to any frictional resistance encountered between the material in the furnace and the tube 2, as the latter moves outwardly of the furnace. The bell crank 19 is turned in a counterclockwise direction and the bell crank 20 is turned in a clockwise direction, as viewed in FIG. 2, in order to place the jaws 18*a* and 18*b* in gripping engagement with the tube 2, and these jaws 18*a* and 18*b* are placed in their gripping positions when the tube 2 is moved inwardly toward the axis of the furnace, and it will be noted that in this gripping position of the jaws 18*a* and 18*b* they will reliably move the tube into the furnace in opposition to any frictional resistance encountered between the material in the furnace and the tube 2. The pair of bell cranks 19 and 20 are respectively fixed coaxially to a pair of gear sectors 21 and 22 which mesh with each other so that in this way the bell crank 20 is compelled to turn simultaneously with and in a direction opposite to the bell crank 19. A spring means is operatively connected to the gripping means for automatically placing the latter in a non-gripping position when it is not acted upon to place one or the other of the pairs of jaws in their gripping position, and this spring means includes a pair of coil springs 23 and 24 fixed at one end to a pin 25 which is fixed to the gear sector 21 and fixed at their opposite ends to a pair of stationary pins 26 and 27 fixedly carried by the frame of the gripping means 12, so that when no other force acts on the gripping means the springs 23 and 24 will automatically act to return the gripping means to the illustrated rest position where the sampling tube 2 is not gripped. With this arrangement it cannot happen that the tube 2 will be moved in an undesired direction. The double-acting fluid means 13 in-

cludes a cylinder in which a piston is slidable, and the cylinder is pivotally connected to the frame of the gripping means 12 by a bracket 28, while the piston rod is pivotally connected at its lower free end, as viewed in FIG. 2, to a lever 29 which is in turn fixed to the pivot shaft of the bell crank 19, this pivot shaft also being fixed to the bell crank 19 and the gear sector 21, so that in response to movement of the piston of the fluid means 13 the bell crank 19 will turn in one direction or the other.

The operation of the device is as follows: The cylinder 13 not being pressure-fed, the gripping jaws are in the rest position owing to the springs 23 and 24 and the sampling tube is not gripped. Assuming that compressed air enters into the cylinder 13, the jaws 17 or 18 are placed in gripping engagement with the tube 2, according to the movement of the piston of the double-acting fluid means 13. Compressed air fed to the cylinder 7 to move the tube 2 is also fed to the cylinder 13 in order to obtain the gripping action of the jaws in the desired direction. For the return movement, compressed air is fed only to the cylinder 7 and the jaws do not grip. In order to move the tube 2 in the opposite direction, compressed air is fed to cylinder 13 to obtain a gripping action of the jaws in the opposite direction, during the opposite movement of piston 10.

It is to be noted that one of the features of the invention resides in making the fluid means 13 smaller and lighter than the fluid means 7, so that the fluid means 13 has less inertia and requires less force and less pressure to actuate the gripping means. As a result, when the cylinders 7 and 13 are simultaneously placed in communication with the conduit of fluid under pressure the gripping means will always be actuated to grip the tube 2 before the piston 10 is moved, so that in this way it cannot happen that the piston 10 will move in the direction in which it is desired to advance the tube 2 without advancing the latter. While such an arrangement is preferred, it is of course also possible to provide a structure which will delay the introduction of fluid under pressure into the cylinder 7 until the fluid means 13 has acted to cause the gripping means to engage the tube 2.

It is thus apparent that with the structure of the invention not only is it possible for the operator to accurately position the sampling tube 2 at a desired location relative to the axis of the furnace, in addition the operator can be located at a convenient distance from the furnace and need only make a selection as to the direction of movement of the sampling tube 2, and the structure of the invention operates automatically to produce the desired location of the sampling tube 2.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of shaft furnaces differing from the types described above.

While the invention has been illustrated and described as embodied in sampling structure for shaft furnaces, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a sampling assembly, in combination, an enclosure for material to be sampled, said enclosure having a wall formed with an opening passing therethrough; an elongated sampling tube aligned with said opening of said wall for movement through said opening into and out of the enclosure; first fluid means coaxial with said sampling tube and carried by said wall, said first fluid means including a piston movable back and forth away from and toward said wall and a hollow piston rod fixed to said piston for movement therewith and freely surrounding said sampling tube so that the latter extends freely through said piston rod and said piston and piston rod are freely movable relative to said sampling tube; gripping means connected to said piston rod for movement therewith and including one pair of gripping jaws for gripping said tube when said piston moves away from said wall and a second pair of jaws for gripping said tube when said piston moves toward said wall, said one pair of griping jaws compelling said tube to move with said piston away from said wall in opposition to frictional resistance of material in the enclosure with respect to said sampling tube and said second pair of jaws compelling said tube to move with said piston toward said wall in opposition to resistance of the material in the enclosure; and double-acting fluid means operatively connected to said jaws for actuating said one pair of jaws only to grip said tube for stepwise movement of the same into the interior of said enclosure, or for actuating said second pair of jaws only to grip said tube for stepwise movement of the same out of said enclosure.

2. In a sampling assembly, in combination, an enclosure for material to be sampled, said enclosure having a wall formed with an opening passing therethrough; an elongated sampling tube aligned with said opening of said wall for movement through said opening into and out of said enclosure; a cylinder carried by said wall and coaxially surrounding said sampling tube; a piston slidable in said cylinder; an elongated hollow piston rod fixed coaxially to said piston for movement therewith and also surrounding said sampling tube so that said piston and piston rod are movable with respect to said tube; a frame fixed to said piston rod for movement therewith; a pair of identical substantially V-shaped bell cranks pivotally carried by said frame at equal distances from and on opposite sides of said sampling tube for respective rotation relative thereto about axes perpendicular to said sampling tube, said bell cranks each having free ends respectively pivotally carrying gripping jaws, and the gripping jaws carried by one bell crank on one side of said sampling tube being respectively aligned with the gripping jaws carried by the other bell chank on the other side of the gripping tube, said bell cranks respectively having a near pair of arms respectively located closer to said wall than a far pair of arms of said bell cranks both of which are situated more distant from said wall than said near pair of arms, and the gripping jaws carried by said near pair of arms forming a near pair of gripping jaws while the remaining gripping jaws form a far pair of gripping jaws more distant from said wall than said near pair of gripping jaws; and means operatively connected to said bell cranks for simultaneously turning said near pair of arms thereof toward said sampling tube and said near pair of jaws into engagement with said sampling tube each time said piston moves along a stroke directed away from said wall, so that at each of said strokes said near pair of jaws will grip said tube to advance the latter away from said wall, and for turning said far pair of arms toward said sampling tube while placing said far pair of gripping jaws in engagement therewith each time said piston moves along the stroke directed toward said wall, for advancing said tube toward said wall at each stroke of said piston directed toward said wall, whereby said sampling tube can be moved in a stepwise manner either toward or away from said wall.

3. In a sampling assembly as recited in claim 2, spring means cooperating with said bell cranks for maintaining the latter in a neutral position where all of said jaws are

spaced from said sampling tube when neither said near arms or said far arms of said bell cranks are displaced toward said sampling tube.

4. In an assembly as recited in claim 2, a pair of gear sectors meshing with each other and respectively fixed to said bell cranks for turning movement therewith, so that when one of said gear sectors is turned in one direction one of said pair of arms of said bell cranks will be turned toward said tube while when said one gear sector is turned in an opposite direction the other of said pair of arms of said bell cranks will be turned toward said tube.

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RICHARD C. QUEISSER, *Primary Examiner.*

JOSEPH P. STRIZAK, *Examiner.*