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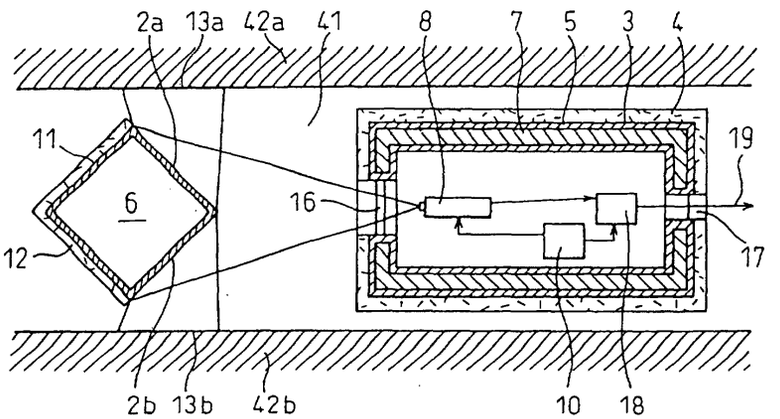
(54) **FURNACE WALL OBSERVATION DEVICE AND FURNACE WALL SHAPE MEASURING DEVICE**

(57) An oven wall viewing apparatus for viewing the surface of facing surface walls in a coke oven coking chamber etc. and an oven wall shape measurement apparatus for measuring the surface of the oven walls, wherein a light beam emitter and camera apparatus are housed in a heat insulated container, a mirror surface is arranged at the outside of the heat insulated container, and the image of the oven wall surface reflected at the mirror surface is captured by the camera apparatus.

Fig.1



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Description

[TECHNICAL FIELD]

[0001] The present invention relates to an oven wall viewing apparatus for viewing a high temperature oven wall such as an oven wall of a coking chamber of a coke oven and an oven wall shape measurement apparatus for measuring the surface shape of a high temperature oven wall.

[BACKGROUND ART]

[0002] In a high temperature oven section such as a coking chamber of a coke oven, the oven walls making up the oven section are made of refractories. It is necessary to maintain an accurate grasp over the state of deterioration of the refractories. In particular, a coking chamber of a coke oven is continuously operated under harsh conditions over a long period of usually over 20 years. The refractory brick making up the coking chamber gradually deteriorate due to thermal, chemical, and mechanical factors.

[0003] Therefore, clogging of the coke due to deterioration of the refractory brick will arise and pieces of the refractory brick will fall off. If pieces of the refractory brick fall off or other such trouble occurs, repair will be difficult and will have a notable effect on operations. Accordingly, maintaining a constant grasp over the state of the refractory brick making up the inside of the coking chamber, in particular the oven walls, is extremely important in managing the operation of a coke oven.

[0004] With the method of viewing the walls inside an oven by the naked eye from the oven jamb of the coke oven using the short time between operations, since the inside of the oven is high in temperature, it is necessary to view the inside from the outside of the oven jamb. Further, since the coking chamber is narrow in width while the oven is deep in depth, the refractories at the inside wall deep in the oven are viewed from a great distance at a shallow angle and therefore viewing of the surface is extremely difficult.

[0005] As a means for more accurately maintaining a grasp over the state of the oven wall refractories, there is the method of capturing an image of the oven walls and the method of measuring the relief shape of the oven walls.

[0006] If capturing an image of the oven walls, it is possible to visually determine two-dimensionally the state of cracks in the brick or gaps in the joint. Further, carbon deposits are high in luminance compared with the exposed parts of the surrounding brick, so their locations can be confirmed from an image of the oven walls. By measuring the relief shape of the oven walls, it is possible to obtain a quantitative grasp over the state of damage of the brick.

[0007] The relatively small damaged parts of the oven walls of a coking chamber are repaired by filling them by melt spraying a refractory, while missing parts of brick are fit with refractory brick and refractory is melt sprayed for the joint. Therefore, it is important to view the surface by the necessary resolution and discover and obtain a grasp of the positions of damage in a state where the inside of the coking chamber is red hot.

[0008] As methods for capturing an image of the oven walls, there are the following. Japanese Unexamined Patent Publication (Kokai) No. 3-105195 discloses a method of inserting a camera conveyance boom mounting a camera (ordinary two-dimensional ITV camera) into a coke oven from the oven jamb of the oven coking chamber and capturing an image of the oven inside wall surfaces while moving the camera in the oven length direction. A coking chamber is extremely narrow in width, so if the camera is oriented to directly face an inside wall of the coking chamber, a sufficient distance cannot be obtained between the camera and the inside wall, the capture range becomes narrower, and the necessary range of the image cannot be obtained, so the camera is mounted at a slant with respect to the wall surface and the wall surface is captured in the field of vision at a shallow angle.

[0009] In the method disclosed in Japanese Unexamined Patent Publication (Kokai) No. 2001-3058 as well, the image is captured by a camera from a direction slanted with respect to the oven walls. In the method described in Japanese Unexamined Patent Publication (Kokai) No. 2001-11465, a video camera housed in a heat insulated container is oriented vertical to the wall surface to capture an image.

[0010] In the methods described in Japanese Unexamined Patent Publication (Kokai) No. 2001-3058 and Japanese Unexamined Patent Publication (Kokai) No. 2001-11465, a camera or data recorder is housed inside a heat insulated container. No cooling water is supplied from outside of the oven, therefore cooling water pipes are not required. Measurement and recording of the obtained image data or measurement data are completed inside an inspection unit inside a heat insulated container, signal wires and power lines etc. do not have to be laid inside the high temperature coking chamber, and a water cooling structure for these wires is not required, thereby realizing inspection of the wall surface by a simple structure.

[0011] Japanese Unexamined Patent Publication (Kokai) No. 61-114085 discloses a method of housing a prism and television camera inside a water-cooled box and reflecting onto a television camera the situation inside the oven reflected at the prism through a viewing window of the water-cooled box.

[0012] In the method described in Japanese Unexamined Patent Publication (Kokai) No. 3-105196, a refractory mirror surface is arranged at a pusher ram head of a coke pusher and an image of the wall surface inside the coking chamber reflected at the mirror surface is captured by a telescopic television camera provided with a zoom lens. The telescopic television camera is

arranged outside of the coking chamber and an image reflected on the mirror surface inside the oven is captured through the oven jamb. By moving the pusher ram head from the oven jamb of the coking chamber to the opposite side oven jamb, the state of the entire wall surface inside the coking chamber can be recorded as image information along with position information. It is possible to adjust the magnification rate and focus of the zoom lens in accordance with the distance between the mirror surface and the camera.

[0013] In the method described in Japanese Unexamined Patent Publication (Kokai) No. 3-105195 or Japanese Unexamined Patent Publication (Kokai) No. 2001-3058, the camera is mounted at a slant with respect to the wall surface to capture an image of the wall surface inside the field of vision by a shallow angle, so the image at the side closer to the camera becomes narrower in the capture range, while the image of the side far from the camera conversely has a broad capture range, but only covers a small area and therefore the necessary resolution cannot be obtained. Further, with such a capture method, it is difficult to focus over the entire field of vision.

[0014] In the method described in the above publication, the obtained perspective image is processed to convert it to a front image as if captured directly facing the oven wall, but even with such image processing, the facts remain that a sufficient resolution cannot be obtained for the parts captured from a far distance and that it is difficult to focus the image over the entire field of vision. Further, with viewing from such a slanted direction, fine cracks in the vertical direction in the oven wall surface and gaps in the joint between the bricks are difficult to see.

[0015] With the method of orienting the video camera vertical to the oven wall to capture an image described in Japanese Unexamined Patent Publication (Kokai) No. 2001-11465, since the distance between the left and right oven walls of the coking chamber is extremely narrow, it is not possible to obtain a sufficient distance between the lens of the video camera and the oven wall and therefore the range of the surface of the oven wall which can be captured by a single field of vision of the video camera becomes extremely narrow.

[0016] In the method of housing a camera or data recorder inside a heat insulated container described in Japanese Unexamined Patent Publication (Kokai) No. 2001-3058 and Japanese Unexamined Patent Publication (Kokai) No. 2001-11465, there is the advantage that the apparatus can be made lighter in weight and can be simply attached to and detached from a pusher or other moving apparatus. On the other hand, since an apparatus inside a heat insulated container cannot send and receive signals with an apparatus outside the oven, the obtained image information cannot be directly combined with position information of the camera and it is difficult to obtain an accurate grasp of the position in the oven of damaged locations from the image information.

[0017] Further, the recorded data has to be taken out from the heat insulated container and played back, so the data cannot be played back until the heat insulated container taken out from the oven sufficiently cools. Therefore, the work efficiency is poor when viewing a plurality of coking chambers.

[0018] Further, while a "heat insulated container", it merely blocks the heat by a heat insulating material, so the time which it can reside in an oven in a high temperature state like a coke oven is at most about 3 minutes. Even if inserting the pusher of a coke oven in the oven and moving it in the oven by one stroke, normally about 3 minutes of time is required. Therefore, with a time which the container can reside in the oven of at most 3 minutes, there is little margin of time. If time is required for pushing, the camera apparatus or other electronic equipment would probably be damaged.

[0019] In the method of housing a prism and television camera inside a box described in Japanese Unexamined Patent Publication (Kokai) No. 61-114085, if trying to capture a sufficiently broad region of the oven wall surface, it would be necessary to increase the size of the viewing window of the box. If using a heat insulated container without using a water-cooled box, the temperature of the inside of the heat insulated container would remarkably rise due to the heat penetrating from this large viewing window and the container cannot remain for the time required for viewing in the high temperature oven.

[0020] In the method of arranging a refractory mirror surface at the pusher ram head and capturing an image of the oven wall reflected on the mirror surface by a telescopic television camera provided outside of the oven described in Japanese Unexamined Patent Publication (Kokai) No. 3-105196, in particular when capturing an image of the vicinity of the oven jamb at the side far from the television camera, the distance between the mirror surface and the television camera becomes larger. Since the inside of the coking chamber has a large amount of dust, it is difficult to capture an image of the oven wall reflected at the mirror surface by a camera outside of the oven.

[0021] Further, a refractory mirror surface deforms along with the sharp rise in temperature when inserted from the ordinary temperature outside of the oven to the high temperature inside of the oven, so it is necessary to preheat the container by a preheater before insertion. Further, by exposure to the high temperature oven atmosphere, the surface of the mirror surface clouds and it is difficult to maintain the optical performance over a long period of time.

[0022] In the method of measuring the relief shape of the oven wall, in the past an oven width meter was used for the coking chamber of the coke oven. When the left and right oven walls face each other in parallel in a narrow oven section like with the oven walls of the coking chamber, if the oven wall refractories are damaged or the oven wall deforms due to the side pressure received

at the time of pushing the coke, the distance between the two oven walls increases. Therefore, by measuring the distance between the two oven walls, it is possible to estimate the soundness of the refractories forming the oven walls.

[0023] When placing a range finder inside the oven and measuring the distance between the range finder and an oven wall, it is necessary to accurately position the range finger at a certain position in the oven. On the other hand, in the method of measuring the distance between oven walls as explained above, even if there is lateral movement of the oven wall measuring apparatus, no large error is given to the measured value of the distance between oven walls. Therefore, in the method of measuring the distance between oven walls, it is not necessary to strictly position the measurement apparatus. For example, it is possible to measure the oven width by mounting an oven width measurement apparatus to a pusher ram of a coke pusher.

[0024] As such an oven width measurement apparatus, for example, Japanese Unexamined Patent Publication (Kokai) No. 62-293112 discloses to provide a ram of a coke pusher etc. with a pair or a plurality of pairs of noncontact type range finders oriented to the oven walls, simultaneously measure the left and right walls from the mounting position, and continuously measure the width of the coking chamber from the total distances. By moving the pusher horizontally, it is possible to continuously measure the width between the oven walls in the coking chamber.

[0025] However, in the above method of measuring the oven width, it is not possible to independently evaluate the relief of the left and right oven walls. In the method of measurement of damaged parts of partitions of a coke oven described in Japanese Unexamined Patent Publication (Kokai) No. 8-73860, a probe is prepared for insertion from a coal charging port or peephole at the top of the coke oven, a line of light of projected from a light projector arranged in the probe to the partition by a projection angle θ, the partition is captured by a camera, and the displacement of the partition and the width of the damaged parts and amount of relief of the damaged parts are measured from the amount of displacement of the line of light in the image.

[0026] The probe is cooled by circulation of cooling water. The image of the partition is bent at a right angle by a prism arranged inside the probe and captured by the camera. The side surface of the probe is formed with a window provided with heat resistant glass for projection of light from the projector and capturing an image by the camera.

[0027] This method enables independent evaluation of the amount of damage of the oven walls, but since the probe is inserted from the coal charging port etc. at the top of the coke oven, it is only possible to measure the part below the single coal charging port by one measurement and difficult to evaluate the state of the oven wall over a broad range in the longitudinal direction of the coking chamber in a short time.

[0028] In the method of evaluating the state of a high temperature oven wall such as the oven wall of a coking chamber of a coke oven, while it is possible to evaluate the amount of brick damage quantitatively for linear parts of the oven wall with measurement of the oven width or measurement of the relief by a line of light, it is not possible to obtain a grasp of the two-dimensional state of the oven wall as a whole. Conversely, with the method of capturing an image of an oven wall, while it is possible to obtain a grasp of the overall two-dimensional state of an oven wall, it is not possible to obtain a quantitative grasp of the amount of damage.

[0029] As reasons of reduction of the oven width, there are deformation of the brick oven surface itself and carbon deposition, but in measurement of the oven width or measurement of relief by a line of light, even if it is known that the oven width has become narrower, it is not possible to identify the reason for the oven width becoming narrower. With carbon deposition, it is sufficient to blow in air to burn away the carbon, but with deformation of the wall surface itself, sometimes large-scale repair work becomes necessary.

[0030] In the method of housing a camera and prism in a probe described in Japanese Unexamined Patent Publication (Kokai) No. 8-73860, in the same way as the method described in Japanese Unexamined Patent Publication (Kokai) No. 61-114085, it is necessary to increase the size of the viewing window formed in the box or probe if trying to capture an image of a sufficiently broad oven wall surface region.

[0031] When using a heat insulated container without using a water-cooled box, due to the heat penetrating from the large viewing window, the temperature inside the heat insulated container remarkably rises and it is no longer possible for the viewing apparatus to remain inside the high temperature oven for the time required for viewing.

[SUMMARY OF THE INVENTION]

[0032] The present invention has as its first object the provision of an oven wall viewing apparatus for viewing the surface of facing oven walls of a coking chamber of a coke oven which is compact in size and light in weight, does not require coolant water piping etc., is able to be easily attached to and detached from a pusher or other moving apparatus, is able to view the necessary viewing range at a wall surface, and has sufficient durability.

[0033] The present invention has as its second object the provision of such an oven wall viewing apparatus which is able to combine the captured oven wall image information and capture position information while maintaining the advantages of being compact in size, light in weight, and simple in structure and is able to propose an oven wall repair plan quickly utilizing the capture results.

[0034] The present invention has as its third object the

provision of such an oven wall viewing apparatus which is able to sufficiently secure residence time in the high temperature oven while maintaining the advantages of being compact in size, light in weight, and simple in structure.

[0035] The present invention has as its fourth object the provision of an oven wall shape measurement apparatus for measuring the surface shape of facing oven walls such as high temperature oven walls of a coking chamber of a coke oven which is able to evaluate the state of a broad two-dimensional range of an oven wall by an image and is able to quantitatively evaluate the state of damage of a specific location and further which is compact in size and light in weight, does not require coolant water piping etc., is able to be easily attached to and detached from a pusher or other moving apparatus, is able to view the necessary viewing range at a wall surface, and has sufficient durability.

[0036] The present invention has as its fifth object the provision of such an oven wall shape measurement apparatus which is able to combine the captured oven wall image information and capture position information while maintaining the advantages of being compact in size, light in weight, and simple in structure and is able to propose an oven wall repair plan quickly utilizing the capture results.

[0037] The present invention further has as its sixth object the provision of an oven wall shape measurement apparatus able to sufficiently secure a high temperature oven residence time while maintaining the advantage of the compact size, light weight, and simplicity of the above oven wall shape measurement apparatus.

[0038] The present invention was made to achieve the above objects. The gist of the oven wall viewing apparatus of the present invention is as follows:

(1) An oven wall viewing apparatus for viewing surfaces of facing oven walls, said oven wall viewing apparatus characterized by housing a camera apparatus in a heat insulated container, arranging a mirror surface at the outside of said heat insulated container, and capturing an image of an oven wall surface reflected at said mirror surface by said camera apparatus.

(2) An oven wall viewing apparatus as set forth in (1), characterized in that said mirror surface is comprised of two mirror surfaces of different angles and in that said mirror surfaces reflect surfaces of the facing oven walls.

(3) An oven wall viewing apparatus as set forth in (1) or (2), characterized in that said mirror surface is comprised of the surface of the container containing cooling water inside it.

(4) An oven wall viewing apparatus as set forth in any one of (1) to (3), characterized in that said heat insulated container houses a wireless transmitter, a wireless receiver and data recorder are arranged outside the oven, and information captured by said camera apparatus is transmitted from said wireless transmitter to said wireless receiver and is recorded at said data recorder.

(5) An oven wall viewing apparatus as set forth in any one of (1) to (3), characterized in that said heat insulated container houses a data recorder and information captured by said camera apparatus is recorded in the data recorder.

(6) An oven wall viewing apparatus as set forth in (4) or (5), characterized in that said data recorder also records position information of the camera apparatus inside the oven.

(7) An oven wall viewing apparatus as set forth in any one of (1) to (6), characterized in that said heat insulated container has a jacket filled with a liquid having a heat absorbing ability and further a heat insulating material covering it at the outside.

(8) An oven wall viewing apparatus as set forth in any one of (1) to (7), characterized by capturing an image while moving said camera apparatus in a depth direction of the oven and recording the captured data in said data recorder.

(9) An oven wall viewing apparatus as set forth in (8), characterized in that said data recorder combines a plurality of captured data obtained by capturing an image to obtain an image of a broad region in a depth direction of the oven.

(10) An oven wall viewing apparatus as set forth in any one of (1) to (9), characterized in that said oven walls are oven walls of a coking chamber of a coke oven and in that said heat insulated container and mirror surface are arranged at a pusher of the coke oven.

(11) An oven wall shape measurement apparatus for measuring a surface shape of facing oven walls, said oven wall shape measurement apparatus characterized by housing a light beam emitter and camera apparatus in a heat insulated container, arranging a mirror surface at the outside of said heat insulated container, emitting a light beam from said light beam emitter to the oven walls from a slanted direction, capturing an image of the surfaces of the oven walls reflected at said mirror surface including light beam reflected light by said camera apparatus, and measuring the oven wall shape based on the position of the light beam reflected light.

(12) An oven wall shape measurement apparatus as set forth in (11), characterized in that the light beam emitted to said oven walls is emitted in a line to the oven walls.

(13) An oven wall shape measurement apparatus as set forth in (12), characterized by emitting the light beam directly from said light beam emitter and in that a direction of the line of light emitted to the oven walls is substantially parallel to the intersecting line of the wall surface and the mirror surface.

(14) An oven wall shape measurement apparatus as set forth in (12), characterized by emitting the

light beam from said light beam emitter and reflecting it at said mirror surface and in that a direction of the line of light emitted to the oven walls is substantially perpendicular to the intersecting line of the wall surface and the mirror surface.

(15) An oven wall shape measurement apparatus as set forth in any one of (11) to (14), characterized in that said light beam emitter is a laser light emitter for emitting light of not more than a wavelength of 550 nm and in that said camera apparatus is a color camera apparatus.

(16) An oven wall shape measurement apparatus as set forth in (15), characterized by processing the image captured at said camera apparatus and, when measuring the oven wall shape from the position of the light beam reflected light, processing the image while emphasizing the light range of a wavelength of less than 550 nm.

(17) An oven wall shape measurement apparatus as set forth in any one of (11) to (16), characterized by having a means for measuring the intensity of the thermal radiation light of the oven wall surface to which said light beam is emitted and adjusting the intensity of the light beam emitted from said light beam emitter in accordance with the measured intensity of the thermal radiation light.

(18) An oven wall shape measurement apparatus as set forth in any one of (11) to (17), characterized in that said heat insulated container is provided inside it with a plurality of light beam emitters, the light beam emitters emit light beams to the surfaces of the facing oven walls, said mirror surface is comprised of two mirror surfaces of different angles, and said mirror surfaces reflect surfaces of the facing oven walls including light beam reflected lights.

(19) An oven wall shape measurement apparatus as set forth in any one of (11) to (18), characterized in that said mirror surface is comprised of the surface of the container containing cooling water inside it.

(20) An oven wall shape measurement apparatus as set forth in any one of (11) to (19), characterized in that said heat insulated container houses a wireless transmitter, a wireless receiver and data recorder are arranged outside the oven, and information captured by said camera apparatus is transmitted from said wireless transmitter to said wireless receiver and is recorded at said data recorder.

(21) An oven wall shape measurement apparatus as set forth in any one of (11) to (20), characterized in that said heat insulated container houses a data recorder and information captured by said camera apparatus is recorded in the data recorder.

(22) An oven wall shape measurement apparatus as set forth in (20) or (21), characterized in that said data recorder also records position information of the camera apparatus inside the oven.

(23) An oven wall shape measurement apparatus as set forth in any one of (11) to (22), characterized in that said heat insulated container has a jacket filled with a liquid having a heat absorbing ability and further a heat insulating material covering it at the outside.

(24) An oven wall shape measurement apparatus as set forth in any one of (11) to (23), characterized in that said oven walls are oven walls of a coking chamber of a coke oven and in that said heat insulated container and mirror surface are arranged at a pusher of the coke oven.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0039]

FIG. 1 is a plan view of an oven wall viewing apparatus of the present invention having a jacket filled with a liquid.

FIG. 2 is a perspective view of an oven wall viewing apparatus of the present invention.

FIG. 3 is a side view of an oven wall viewing apparatus or oven wall shape measurement apparatus of the present invention installed in a coke pusher.

FIG. 4 is a plan view of an oven wall viewing apparatus of the present invention having one mirror surface.

FIG. 5 is a plan view of an oven wall viewing apparatus of the present invention having two mirror surfaces.

FIG. 6 is a plan view of an oven wall viewing apparatus of the present invention having a wireless transmitter.

FIG. 7 is a side view of a heat insulated container of the present invention having a jacket filled with a liquid.

FIG. 8 is a conceptual view of the state of connection of equipment of the present invention having a wireless transmitter and receiver.

FIG. 9 gives views of examples of results of viewing by an oven wall viewing apparatus of the present invention. (a) is a view of an image of the two oven walls reflected at the two mirror surfaces, (b) is a view of an image of a location where the oven wall has been damaged, and (c) is a view of an image showing the state of carbon deposition on the oven walls.

FIG. 10 is a view of another example of the results of viewing by an oven wall viewing apparatus of the present invention.

FIG. 11 is a plan view of an oven wall shape measurement apparatus of the present invention.

FIG. 12 gives perspective views schematically showing an oven wall shape measurement apparatus of the present invention having two mirrors. (a) is a view schematically showing the apparatus as a whole, while (b) is a view schematically showing the case focusing on one light beam emitter.

FIG. 13 is a conceptual view of the state of a light beam emitted to oven walls from a slanted direction.
FIG. 14 gives conceptual views of the state of a light beam emitted to oven walls from a slanted direction in a line. (a) is a view of the oven walls seen from the side, (b) is a perspective view along the line A-A, and (c) is a perspective view along the line B-B.
FIG. 15 gives conceptual views of the state of emission of light beams to the oven walls from a slanted direction in a line by reflection at a mirror surface. (a) is an overall conceptual view, while (b) is a perspective view along the line B-B focusing on the light beam system.
FIG. 16 is a plan view of an oven wall shape measurement apparatus of the present invention having one mirror surface.
FIG. 17 is a plan view of an oven wall shape measurement apparatus of the present invention having two mirror surfaces.
FIG. 18 is a plan view of an oven wall shape measurement apparatus of the present invention having a wireless transmitter.
FIG. 19 is a side view of a heat insulated container of the present invention having a jacket filled with a liquid.
FIG. 20 shows an example of the results of viewing by an oven wall shape measurement apparatus of the present invention. (a) is a view of an image of two oven walls reflected at two mirror surfaces, while (b) is a view of a location where the oven wall has been damaged,
FIG. 21 shows another example of the results of viewing by an oven wall shape measurement apparatus of the present invention. (a) is a view of an image of two oven walls reflected at the two mirror surfaces, (b) is a view of an image of a location where the oven wall has been damaged, and (c) is a view of an image showing the state of carbon deposition on the oven walls.
FIG. 22 is a view of another example of the results of viewing by an oven wall viewing apparatus of the present invention.
FIG. 23 is a view of the present invention for adjusting the intensities of the light beams emitted from light beam emitters in accordance with an intensity of thermal radiation light.

[THE MOST PREFERRED EMBODIMENT]

[0040] (1) First, an oven wall viewing apparatus of the present invention will be explained based on FIG. 1 to FIG. 8.

[0041] The oven wall viewing apparatus of the present invention (hereinafter sometimes referred to as the "viewing apparatus of the present invention") covers an oven wall viewing apparatus used inside a coking chamber 41 of an oven having high temperature oven walls 42a and 42b facing each other across a narrow gap, for example, a coke oven.

[0042] As a camera apparatus 8, it is possible to use a CCD camera, a camera controller for controlling the same, etc.. The direction of the field of vision of the camera apparatus 8 should be made parallel to the oven walls 42a and 42b as shown in FIG. 4 and FIG. 5. Further, the mirror surface 2 or 2a and 2b is arranged in the direction of the field of vision of the camera apparatus 8 and the angle of the mirror surface is adjusted so that the image of the oven wall surface is reflected at the mirror surface 2 or 2a and 2b when viewed from the position of the camera apparatus 8.

[0043] Normally, as shown in FIG. 4 and FIG. 5, if the angle between the mirror surface 2 or 2a and 2b and the oven walls 42a and 42b is made 45°, it is possible to obtain an image of the oven wall surface seen from a direction vertical to the surface. Therefore, this is preferable.

[0044] In the method of viewing the oven wall from a slanted direction as in the past, there was the problem the fine cracks in the vertical direction of the oven wall surface or gaps in the joint between the bricks were difficult to see. In the viewing apparatus of the present invention, it is possible to capture an image of the wall surface in a state close to viewing the front surface, so it is possible to clearly obtain a grasp of the fine cracks in the vertical direction or the gaps in the joint between the bricks.

[0045] Of course, when it is possible to clearly view the relief of the surface of an oven wall by viewing the wall surface from a slanted direction, it is possible to make the angle between the mirror surface and oven wall an angle other than 45°.

[0046] During viewing of the inside of an oven, normally the distance between the camera apparatus 8 and the mirror surface 2 or 2a and 2b is made constant. If the distance between the camera apparatus 8 and the mirror surface 2 or 2a and 2b is increased, it is possible to increase the effective length of the mirror surface in a direction parallel to the oven wall and possible to enlarge the range of the field of vision 13 or 13a and 13b (length in long side) of the camera apparatus for viewing the mirror surface.

[0047] On the other hand, the effective mirror surface width in the direction vertical to the oven wall, that is, the width direction, cannot be increased since the distance between the oven walls is narrow. Therefore, the range (short side length) of the field of vision 13 or 13a and 13b of the camera apparatus cannot be increased.

[0048] In viewing of the coking chamber of a coke oven, if the long side length of the field of vision 13 or 13a and 13b of the camera apparatus at the oven wall surface is made about 500 to 600 mm, it is possible to view the surface by a spatial resolution of about 1 mm - sufficient for detection of damage - by a general CCD camera. The short side length of the field of vision 13 or 13a and 13b of the camera apparatus at the oven wall surface becomes about 150 to 200 mm when viewing the

oven wall from the vertical direction.

[0049] As the direction of orientation of the mirror surface 2 or 2a and 2b, as shown in FIGS. 1 to 5, the longitudinal direction of the mirror surface should be made the height direction of the oven, that is, the direction orthogonal to the depth direction of the oven. The depth direction of the oven is the direction of movement of the oven wall viewing apparatus 1 when viewing the oven wall 42a and/or 42b. By viewing the surface while moving the apparatus, it is possible to store the results of viewing of the oven wall in the depth direction of the oven.

[0050] Therefore, by making the longitudinal direction of the mirror surface a direction orthogonal to the depth direction of the oven (direction of movement), it is possible to obtain the maximum capture information of the oven wall surface.

[0051] In the present invention, as shown in FIG. 1 and FIGS. 4 to 6, electronic equipment such as the camera apparatus 8 is housed in a heat insulated container 3, and the mirror surface 2 or 2a and 2b is arranged at the outside of the heat insulated container 3. The heat insulated container 3 is not supplied with cooling water from outside of the oven and does not have power lines or signal wires connected to it.

[0052] Therefore, the oven wall viewing apparatus placed in the oven can be made light in weight and compact in size and can be easily mounted to and detached from a structure inserted into and moving in the oven, for example, a coke pusher 43 of a coke oven coking chamber 41 (see FIG. 3).

[0053] As shown in FIG. 4 and FIG. 5, the heat insulated container 3 is covered on its surface by a heat insulating material 4. If the time is short, it can remain in the high temperature oven and operate the electronic equipment inside it normally. If inside the coking chamber 41 of the coke oven, since the container can reside inside the oven for 3 minutes, it is possible to secure the minimum amount of time for insertion of the coke pusher 43 mounting the oven wall viewing apparatus 1 into the oven, viewing of the entire length in the depth direction of the oven, and extraction to the outside.

[0054] As the heat insulating material 4 covering the heat insulated container 3, it is possible for example to use a ceramic fiber board, calcium silicate board, etc..

[0055] In the viewing apparatus of the present invention, the mirror surface 2 or 2a and 2b is arranged at the outside of the heat insulated container 3, so it is possible to keep the viewing window 16 of the heat insulated container 3 for securing the field of vision of the viewing apparatus down to the minimum size.

[0056] In the prior art housing a prism in a box, it is necessary to increase the size of the viewing window provided in the box. When using a heat insulated container 3, there was the problem of the temperature inside the container rapidly rising due to the radiation heat penetrating the container from the viewing window, but by arranging the mirror surface 2 or 2a and 2b at the outside of the heat insulated container 3 like in the viewing apparatus of the present invention, the viewing window 15 can be made small, so the radiation heat entering from there can be kept down to the minimum and a rise in temperature inside the heat insulated container can be prevented.

[0057] The viewing window 16 is provided with quartz glass or other heat resistant glass. The heat resistant glass preferably has the function of passing visible light from the outside and reflecting the radiation heat by a means such as metal-evaporation.

[0058] In the viewing apparatus of the present invention, as shown in FIG. 4, it is possible to use a single mirror surface 2 to view one oven wall 42a. On the other hand, it is also preferable to configure the mirror surface by two mirror surfaces (2a and 2b) different in angle as with the viewing apparatus of the present invention of the above (2) and use the mirror surfaces to reflect the surfaces of the facing oven walls (42a and 42b).

[0059] In the viewing apparatus of the present invention shown in FIG. 2 and FIG. 5, the first mirror surface 2a reflects the surface of the first wall surface 42a, the second mirror surface 2b reflects the surface of the second wall surface 42b, and the two are simultaneously captured by a single camera apparatus 8.

[0060] Due to this, by moving the oven wall viewing apparatus housing the single camera apparatus 8 once in the depth direction of the oven, it is possible to obtain the results of viewing of the oven wall surface at the left and right sides. Further, it becomes possible to simultaneously compare the left and right oven walls.

[0061] Further, it is possible to view the left and right oven walls by a single camera apparatus 8, so it is possible to reduce the open area of the viewing window 16 of the heat insulated container compared with when housing two camera apparatuses inside a heat insulated container. The ratio of the radiation heat penetrating the inside of the heat insulated container and raising the temperature becomes smaller.

[0062] Since the mirror surface of the viewing apparatus of the present invention is arranged at the outside of the heat insulated container 3, the mirror surface is directly exposed to the high temperature atmosphere inside the oven. In the viewing apparatus of the present invention of the above (3), as shown in FIG. 5 and FIG. 6, the mirror surface of the container 11 containing cooling water 6 inside is made the mirror surface (2a and 2b).

[0063] The time when the viewing apparatus of the present invention resides in the high temperature oven is short. If within this time, the cooling water 6 inside the container 11 rises in temperature and boils to cool the container 11 by boiling and maintains the temperature of the container 11 at the boiling point of the cooling water (100°C). The optical performance of the mirror surfaces 2 and 2b formed at the container surface can be maintained over a long time and the flatness of the mirror surfaces 2 and 2b can similarly be maintained over a long time.

[0064] The viewing apparatus of the present invention does not require the supply of cooling water from the outside of the oven for cooling the mirror surfaces 2a and 2b. Further, there is no need for use of a preheater of the mirror surfaces. Therefore, it is possible to easily mount the apparatus on a coke pusher or other moving apparatus.

[0065] The container 11 containing cooling water 6 inside it, as shown in FIG. 2, FIG. 5, and FIG. 6, may be made a long rectangular cross-section shape with two of its four outer surfaces made mirror surfaces (2a and 2b) and the remaining two surfaces made heat insulating by a heat insulating material 12 in accordance with need. It is simple to make the container 11 itself out of stainless steel and polish the surface to a mirror finish.

[0066] The image captured by the camera apparatus 8 in the heat insulated container has to be recorded in a data recorder and the finally recorded data used to prepare image information of the oven walls. The data recorder 22 may be housed inside the heat insulated container as with the viewing apparatus of the present invention of the above (5) (see FIG. 5).

[0067] Further, it is more preferable to house a wireless transmitter 18 inside the heat insulated container and arrange the wireless receiver 21 and data recorder 22 outside of the oven as with the viewing apparatus of the present invention of the above (4) (see FIG. 3 and FIG. 6).

[0068] The information captured by the camera apparatus 8 is transmitted from the wireless transmitter 18 to the wireless receiver 21 and recorded in the data recorder 22. If designing the data recorder 22 so as to record the information in a recording computer or other processor 30 and simultaneously display the captured image at an image display 31, it is possible to confirm the results of the viewing at the same time as inserting the oven wall viewing apparatus inside the oven for viewing.

[0069] The heat insulated container returned from the 1000°C oven is high in temperature at the outside, so the inside data cannot be taken out until after the elapse of a certain time. As opposed to this, in the viewing apparatus of the present invention of the above (4), the trouble of taking out the oven wall viewing apparatus from the oven, then waiting until the apparatus cools before taking out the image data is not required, so it is possible to quickly confirm the state of the oven walls.

[0070] Further, it is possible to immediately use the oven wall viewing apparatus taken out from the coking chamber of the coke oven for viewing of the next coking chamber.

[0071] For the wireless communication from the heat insulated container inside of the oven to outside of the oven, it is possible to use wireless transmission using electromagnetic waves or wireless communication using visible light, infrared light, or other light. For wireless communication, the wall of the heat insulated container 3 facing the outside of the oven is provided with a communication window 17 as shown in FIG. 6.

[0072] When the window 17 is fit with heat resistant glass and electromagnetic waves are used as the communication medium, a metal-evaporation coating is not used for the coating for preventing penetration of radiation heat from the outside. A dielectric substance such as a silica coating is coated.

[0073] As shown in FIG. 8, it is possible to use a digital wireless transmitter and receiver (27 and 28) for transmitting a digital signal by electromagnetic waves for the wireless communication. Since an analog image signal is output from the camera apparatus 8, the signal is converted to a digital signal by an A/D converter 26, the digital signal is transmitted by a digital wireless transmitter 27, and that signal is received by a digital wireless receiver 28 outside of the oven.

[0074] The received digital signal can be converted to an analog signal by a D/A converter 29 and output to an image display 31 or can be input as a digital signal to a processor 30 etc..

[0075] When arranging a wireless transmitter 18 inside the heat insulated container, the capture information is transmitted from the heat insulated container to an outside wireless receiver 21 and the data recorded in an outside data recorder 22.

[0076] At that time, it is possible to simultaneously record the oven position information of the camera apparatus (capture current position data 35 in horizontal direction in oven) together with the capture information in the data recorder 22 such as with the viewing apparatus of the present invention of the above (6).

[0077] The outside data recorder 22 is arranged outside of the oven, so it is possible to calculate and fetch the capture current position data 35 of the camera apparatus 8 from the current position data of the pusher 43 mounting the camera apparatus 8.

[0078] As a result, in the outside data recorder 22, it becomes possible to establish correspondence with the capture position in the horizontal direction and the capture data in real time. During viewing, it is possible to identify the damaged locations in the oven and locations requiring repair.

[0079] Conversely to the above, it is possible to provide a data recorder 22 and a wireless receiver 21 inside the heat insulated container, wirelessly transmit the time of oven insertion of the heat insulated container and the capture current position data 35 in the horizontal direction in the oven from the outside to the heat insulated container, and simultaneously record the capture data and the capture current position data 35 in the horizontal direction of the oven to the data recorder 22 in the heat insulated container.

[0080] For the wireless transmitter 18 and the wireless receiver 21, it is also possible to use a transceiver provided with the functions of both transmission and reception.

[0081] The heat insulated container 3 preferably has a jacket 5 filled with a liquid 7 having a heat absorbing ability and further a heat insulating material 4 covering

the outside such as the viewing apparatus of the present invention of the above (7) (see FIG. 1).

[0082] In general, the liquid selected may be one having a large heat capacity per mass and volume. As a liquid able to be most easily obtained industrially and optimal as a heat absorbing material, it is preferable to use water.

[0083] When inserting the heat insulated container 3 in the high temperature oven, since the outside of the heat insulated container is covered by the heat insulating material 4, it is possible to reduce the amount of heat penetrating the inside through the heat insulating material 4.

[0084] Further, since there is a jacket 5 filled with a liquid 7 having a heat absorbing ability inside the heat insulating material 4, the heat penetrating the inside first is used up to raise the temperature of the liquid 7, for example, water.

[0085] Water has a large heat capacity, so it is possible to delay the rise in temperature inside the heat insulated container. Further, when the temperature of the water reaches 100°C, a large amount of the heat of vaporization is robbed by the boiling, so the temperature inside the heat insulated container will never exceed 100°C.

[0086] To discharge the water vapor when the water reaches 100°C in temperature and starts boiling, the top of the heat insulated container 3 is provided with an opening or a safety valve is provided. The viewing apparatus of the present invention is characterized in that pipes are not connected for supplying or discharging liquid during viewing of the oven walls in the oven.

[0087] The width of the coke oven is usually about 400 mm. The viewing apparatus of the present invention has to be made dimensions enabling insertion into this space with some leeway. When using water as the heat absorbing liquid, the jacket holding the water has a width of the water at the left and right of about 40 mm in the oven width direction.

[0088] As the heat insulating material 4 at the outer circumference of the heat insulated container 3, for example, it is possible to use a ceramic fiber board and make the thickness of the heat insulating material 4 about 30 mm.

[0089] When the external dimensions of the oven wall viewing apparatus are made 500 mm length × 300 mm width × 500 mm height, the internal space holding the oven wall viewing apparatus becomes 380 mm length × 160 mm width × 300 mm height.

[0090] When inserting an oven wall viewing apparatus having such a shape into the coking chamber 41 of a coke oven of an oven temperature of 1000°C, the temperature of the internal space housing the oven wall viewing apparatus becomes, along with the elapsed time after insertion, 25°C after 3 minutes, 40°C after 5 minutes, and 55°C after 7 minutes. The usual upper limit of the temperature used of the different electronic equipment housed in the heat insulated container is about 50°C, so the container can reside in the high temperature oven for at least 5 minutes.

[0091] In viewing of the oven wall of a coking chamber of a coke oven according to the viewing apparatus of the present invention, when mounting the oven wall viewing apparatus 1 of the present invention on the coke pusher 43 for measurement, the car 40 of the coke pusher 43 continuously successively repeats the work of pushing out the coke of the coking chamber finished being carbonized while moving on rails at 5 to 10 minute intervals. During that work, the apparatus views the oven walls of a large number of coking chambers.

[0092] Due to one insertion into a coking chamber, the liquid in the heat insulated container rises in temperature, so if the container were inserted into the next coking chamber for measurement as it were without any time interval, the temperature of the liquid 7 in the heat insulated container 3 would successively rise and the possible time of residence in the oven would become shorter.

[0093] As shown in FIG. 7, the bottom of the heat insulated container 3 is provided with a discharge port 23 for discharging the inside liquid. By discharging the inside liquid raised in temperature and inserting new liquid of a low temperature each time the oven walls finish being viewed, it is possible to prevent a rise in temperature of the liquid. If continuing to discharge the liquid from the discharge port 23 while supplying cooled liquid from the filling port 24 at the time of filling the new liquid, it is also possible to reduce the temperature of the heat insulated container itself. As a result, it is possible to secure a sufficient residence time in the oven for each measurement.

[0094] When arranging a wireless transmitter 18 in the heat insulated container, further, as shown in FIG. 8, it is possible to install a thermometer 36 for measuring the temperature of the heat insulated container or the temperature of the liquid in the jacket inside the heat insulated container and to transmit the measured temperature to outside of the oven by the wireless transmitter 18.

[0095] Due to this, it is possible to obtain a grasp of the temperature of the oven wall viewing apparatus at the present point of time outside of the furnace. When the temperature approaches the upper limit of management, it is possible to suspend the measurement and take the oven wall viewing apparatus outside of the oven so as to prevent in advance damage to the oven wall viewing apparatus due to the abnormally high temperatures.

[0096] The viewing apparatus of the present invention may set viewing positions in the oven in advance and capture images of the oven wall at those positions as still images. Due to this, it is possible to obtain images of the states of oven wall positions where damage is predicted as occurring in advance.

[0097] On the other hand, it is more preferable to capture images while moving the camera apparatus 8 in the

depth direction of the oven and record the capture data in a data recorder 22 as with the viewing apparatus of the present invention of the above (8).

[0098] The camera apparatus 8 is moved in the depth direction of the oven by for example as shown in FIG. 3 mounting the oven wall viewing apparatus 1 housing the camera apparatus 8 on the coke pusher 43 of the coking chamber 41 of the coke oven and inserting the coke pusher 43 into the oven or extracting it from the oven at a constant speed by operation of a ram driver 46.

[0099] It is possible to move the camera apparatus 8 while continuously capturing images and view the capture results as a moving image.

[0100] More preferably, as in the viewing apparatus of the present invention of (9), it is possible to capture images while moving the camera apparatus 8 in the depth direction of the oven and process and join the capture data recorded in the data recorder 22 so as to obtain a single still image of a broad range in the depth direction of the oven.

[0101] For example, when the speed of movement of the coke pusher is 300 mm/sec. and the still image capture interval of the camera apparatus is 1/30 second, the camera apparatus moves 10 mm from the capture of one still image to the capture of the next still image.

[0102] Therefore, by making the capture range of one still image in the width direction (depth direction of oven) 10 mm and stitching successively captured still images, it is possible to obtain a single still image of the connected images of the oven wall surface over the entire length of movement of the coke pusher.

[0103] Alternatively, it is possible to make the capture range in the width direction 100 mm and capture images at a still image capture interval of 1/3 second. FIG. 10 shows an oven wall picture obtained by joining eight adjoining still images at the image joining positions 15 to prepare an image 14 of a broad region. This data processing can be performed at the data recorder 22.

[0104] In a viewing apparatus of the present invention arranging a wireless transmitter 18 in the heat insulated container, transmitting the capture information from the heat insulated container to a wireless receiver 21 outside, recording this data in an outside data recorder 22, and simultaneously recording the oven position information of the camera apparatus (capture current position data 35 in the horizontal direction in the oven) in a data recorder 22, it is possible to capture images while moving the camera apparatus 8 in the depth direction of the oven and select still images based on oven position information.

[0105] The case of taking still images at a pitch of 100 mm in the width direction and stitching these still images to prepare an oven wall image of a broad range in the depth direction of the oven will be explained as an example.

[0106] The captured still images are successively transmitted to an outside data recorder at a pitch of 1/30 second. The data recorder 22 outside of the oven selects the still images received at the time each time the camera apparatus reaches a 100 mm pitch still image taking position based on the oven position information.

[0107] Due to this, as a result, by taking still images at a pitch of 100 mm in the width direction and stitching together these still images, it is possible to prepare an oven wall image extending over a broad range in the depth direction of the oven. With this method, even if the running speed of the coke pusher mounting the heat insulated container fluctuates, it is possible to acquire still images at equal intervals.

[0108] When arranging a wireless receiver in the heat insulated container and transmitting oven position information from outside the oven to the heat insulated container, it is sufficient to process the data in the same way as above in the heat insulated container.

[0109] Further, if arranging a wireless receiver enabling communication with the inside of the heat insulated container and the outside of the oven, it is also possible to transmit oven position information from outside the furnace to the heat insulated container, select still images every constant interval in the heat insulated container, and wirelessly transmit only the selected still images outside of the oven.

[0110] In a viewing apparatus of the present invention capturing images while moving the camera apparatus 8 in the depth direction of the oven to take still images and stitching together these still images to prepare an oven wall image extending over a broad range in the depth direction of the oven, it is also possible to capture images so that overlapping parts occur between adjoining still images.

[0111] For example, by capturing images at a pitch of about 100 mm in the width direction and making the size of the still images in the width direction 150 mm, 50 mm overlapping parts will occur. The overlapping parts capture the same parts of the oven wall, so it is possible to accurately position and align two images by pattern matching based on the images of the oven walls.

[0112] If using this technique, even if there is some deviation in the oven position information of the still images, it is possible to automatically correct this deviation and prepare an accurate oven wall image of a broad range in the depth direction of the oven.

[0113] Further, even when it is not possible to use oven position information, it is possible to determine the overlap of the images by pattern matching for a group of images taken in time series with overlapping portions between adjacent images and successively connect them to prepare an accurate oven wall image.

[0114] For example, when viewing the coking chamber of the coke oven, since the oven walls are high in temperature, they emit light. It is possible to view the oven walls by capturing this thermal radiation light by a camera apparatus.

[0115] Further, when using an ordinary CCD camera as a camera apparatus, it is possible to capture images at a shutter speed of about 1/1000 second. With this fast

a shutter speed, even with a speed of movement of the coke pusher of 300 mm/sec., it is possible to obtain a sharp image free from blurring.

[0116] By moving the camera apparatus together with the moving apparatus in the depth direction of the oven in this way, it is possible to fit the entire length of the oven wall surface in a single still image.

[0117] On the other hand, in the height direction of the oven, while depending on the distance between the mirror surface and camera apparatus, ordinarily the capture range is a range of about 500 to 600 mm. Therefore, in the height direction of the oven, the range which can be captured at one time is limited.

[0118] On the other hand, for example, in the coking chamber of the coke oven, the parts of the oven wall refractories where damage is particularly severe are for example limited to the vicinity of the coal charging line in the oven height direction etc..

[0119] Therefore, by setting the viewing apparatus of the present invention at a position enabling the vicinity of the coal charging line to be viewed, even if the range of viewing in the oven height direction is limited, it is possible to obtain sufficiently useful data. Of course, by providing a plurality of oven wall viewing apparatuses in the height direction at the coke pusher, it becomes possible to view the oven wall over a broad range in the oven height direction.

[0120] The viewing apparatus of the present invention is compact in shape, light in weight, and does not require the provision of cooling pipes etc., so is easily changed to any height of mounting to the pusher. Further, it is possible to make measurements while changing the mounting position for each predetermined height to obtain oven wall viewing data for the oven height as a whole.

[0121] In the viewing apparatus of the present invention, operating power cannot be supplied from the outside during measurement, so a power supply 10 is provided inside the heat insulated container. The camera apparatus 8, data recorder 22, and wireless transmitter 18 operate by power supplied from this power supply 10. As the power supply 10, it is possible to use a dry cell, rechargeable storage cell, etc..

[0122] If using a cell which cannot be recharged as the power supply 10, it is necessary to open up the heat insulated container each time the cell is replaced. Further, even if using a rechargeable power supply as a power supply 10, it becomes necessary to open up the heat insulated container for each recharging if positioning the recharging cable connection plug inside the heat insulated container.

[0123] As the power supply, a rechargeable power supply may be used. Further, as shown in FIG. 7, by providing a recharging cable connection plug 25 at the outside of the heat insulated container 25, it becomes possible to recharge without opening the heat insulated container and therefore improve the work efficiency.

[0124] The recharging cable connection plug 25 may be covered at its outside by a heat insulating cap 34 when inserted into the oven. Only the heat insulating cap 34 need be removed at the time of recharging and the recharging cable connected.

[0125] Here, examples of the viewing apparatus of the present invention will be shown.

(EXAMPLES)

[0126] The oven wall viewing apparatus shown in FIG. 1 was used for the purpose of viewing the surface of the oven walls of the coking chamber of the coke oven. The external dimensions of the oven wall viewing apparatus 1 are a height of 500 mm, width of 300 mm, and length of 500 mm and the total weight about 50 kg.

[0127] As the heat insulated container 3 of the oven wall viewing apparatus, one covered over its outer circumference with ceramic fiber board as a heat insulating material 4 was used. The thickness of the heat insulating material was made 30 mm. At the inside of the heat insulating material, a jacket made of stainless steel was arranged. The jacket was filled with a total of 30 liters of water 7. At the portion of the heat insulating container 3 facing the oven wall, the thickness of the layer of water was 40 mm.

[0128] Inside of the heat insulated container was arranged a CCD camera as the camera apparatus 8. The image signal captured by the camera apparatus was transmitted outside of the oven by the wireless transmitter 18. The heat insulated container and the heat insulating material were provided with a viewing window 16 and a communication window 17. The viewing window was fit with metal-evaporated quartz glass. Further, a rechargeable storage cell was provided as a power supply 10 and used to supply power to the camera apparatus, wireless transmitter, and controller for controlling the same.

[0129] In front of the heat insulated container, as shown in FIG. 1, mirror surfaces 2a and 2b were arranged. The longitudinal direction of the mirror surfaces was made the height direction of the oven. The two mirror surfaces 2a and 2b were set to angles with the oven wall 42 of 45°. The left and right oven walls 42a and 42b can be simultaneously captured in the field of vision of the camera apparatus 8. By arranging the mirror surfaces, the fields of vision 13a and 13b of the camera apparatus have lengths on the long sides of 600 mm and lengths of the short sides of 200 mm for each of the left and right oven walls.

[0130] For the mirror surfaces, use was made of the surface of the stainless steel container 11 containing cooling water 6 inside polished to a mirror finish. The container 11, as shown in FIG. 2, has a long rectangular cross-sectional shape with two of its four outer surfaces made mirror surfaces and the remaining two surfaces made heat insulating by a heat insulating material 12.

[0131] The oven wall viewing apparatus and mirror surfaces were attached to the pusher 43. The total

weight of the oven wall viewing apparatus is a comparatively light one of approximately 50 kg. Further, since there is no need for arranging cooling water pipes or signal cables, it is possible to easily attach the components to any positions in the height direction of the pusher ram 44.

[0132] In the present example, as shown in FIG. 3, these components are either attached to positions of the oven wall viewing apparatus 1 behind the pusher ram 44 using a support 45 or attached to positions of the oven wall viewing apparatus 1' on a ram beam 47. By successively viewing the oven wall at different heights in this way, it was possible to obtain oven wall viewing data over a broad range.

[0133] For the wireless communication, wireless communication using the electromagnetic waves of a digital signal was adopted. The output of the camera apparatus and the output of the thermometer 36 for measuring the temperature inside the measurement unit are converted to a digital signal by the A/D converter 26 and sent to the digital signal wireless transmitter 27. The digital signal wireless transmitter 27 functions as a wireless transmitter 18 and sends a wireless signal 19 to a wireless receiver 21 outside of the oven.

[0134] In the heat insulated container, the part through which the electromagnetic wave passes is provided with a communication window 17 equipped with quartz glass coated with silica. This silica coating blocks the radiation heat from the oven and does not obstruct the propagation of the electromagnetic waves since it is not a metal coating.

[0135] Outside of the furnace, a digital signal wireless receiver 28 is arranged as a wireless receiver 21, while a processor 30 and image display 31 are arranged as a data recorder 22. The digital signal received by the digital signal wireless receiver 28 is transmitted to the D/A converter 29 and processor 30.

[0136] The data sent to the processor 30 is recorded in the computer. The capture signal is processed to easily analyzable image information. The analog signal output from the D/A converter 29 is sent to the image display 31.

[0137] The data recorder 22 is sent the capture current position data 35 found based on the current position data of the pusher ram 44, so this data is also sent to the processor 30 and image display 31.

[0138] In the image display 31, the capture information captured at different times can be arranged based on the capture current position data 35 to produce a single still image extending over the entire length in the depth direction of the coking chamber and to identify locations of oven wall damage.

[0139] Specifically, along with movement of the pusher 43, each time the capture current position data 35 is increased by 150 mm, the transmitted still image is fetched into the processor 30. Since the length of the still image in the oven width direction (short side) is 200 mm, adjoining images have 50 mm overlapping parts.

[0140] It is possible to use the overlapping parts for pattern matching and finely adjust the overlap of the images. In this way, it is possible to produce a single still image extending over the entire length in the depth direction of the coking chamber.

[0141] One example of the results of viewing of the oven walls is shown in FIG. 9. FIG. 9(a) shows an image of the oven wall 42a reflected in the mirror surface 2a and an image of the oven wall 42b reflected in the mirror surface 2b in the overall field of vision 9 of the camera apparatus. In both images, the joint 49 of the bricks 48 is clearly discriminated.

[0142] FIG. 9(b) shows the image of a location of the oven wall where damage occurred. A joint gap 50 is viewed other than the normal joint 49. Further, a vertical crack 51 was viewed in the oven wall. In the image shown in (c) in FIG. 9, a carbon deposit 52 of the oven wall can also be viewed.

[0143] By combining still images obtained continuously along with movement of the pusher 43, it is possible to obtain an oven wall image over a broad region in the depth direction of the oven.

[0144] FIG. 10 shows an oven wall picture obtained by combining eight adjoining still images at the image joining positions 15 to obtain an image 14 of a broad region. In an image of a broad region, identification of damaged locations is easy. Further, it is possible to obtain a grasp of the overall state of damage at a single glance. Therefore, this is useful in diagnosis and management of ovens.

[0145] During measurement, the data recorder 22 was successively sent data, so there was no need to open the heat insulated container after measurement was completed and the work efficiency of the measurement could be greatly improved. Further, it was possible to catch oven wall damage during measurement in real time and accurately identify even locations of occurrence of that damage, so it was possible to propose repair plans of the coking chamber without delay.

[0146] After the oven wall of one coking chamber finishes being viewed, before viewing the oven wall of the next coking chamber, the discharge port 23 at the bottom of the heat insulated container was opened and the raised temperature cooling water 7 discharged and, simultaneously, ordinary temperature water was filled from the top filling port 24. 15 liters of water was filled to lower the temperature of the heat insulated container 3, then the discharge port 23 at the bottom of the heat insulated container was closed and water filled in the heat insulated container.

[0147] In this way, the next measurement was performed after sufficiently lowering the temperature of the heat insulated container and the water in the heat insulated container, so it was possible to secure a measurement time of more than 5 minutes at a time even when continuously viewing oven walls of coking chambers.

[0148] The rechargeable storage cell used as the power supply 10 in the measurement unit has a capacity

enabling continuous measurement of the oven width of 10 coking chambers. At the time of recharging, it is possible to recharge by connecting a recharging cable to the recharging cable connection plug 25 arranged at the outside of the heat insulated container, so the heat insulated container does not have to be opened for recharging and recharging was possible with a good work efficiency.

[0149] (2) Next, an oven wall shape measurement apparatus of the present invention (hereinafter sometimes referred to as the "measurement apparatus of the present invention") will be explained based on FIG. 3, FIG. 8, and FIG. 11 to FIG. 23.

[0150] As shown in FIG. 11, the oven wall shape measurement apparatus 61 of the present invention houses inside it light beam emitters 62a and 62b and a camera apparatus 8. The oven wall shape measurement apparatus 61 is arranged close to the oven walls 42a and 42b. When inserting the oven wall shape measurement apparatus 61 inside the coking chamber of a coke oven, the distance between the facing oven walls (42a and 42b) is narrow, so the apparatus is inserted at the center of the width of the coking chamber and arranged in proximity to the two oven walls.

[0151] The light beam emitters 62a and 62b emit light beams 63a and 63b to the oven walls 42a and 42b from a slanted direction. In FIG. 11, they emit the light beams at an angle θ. The parts of the oven wall surface at which the light beams are emitted reflect the light beams and emit light forming the beam spots 64a and 64b.

[0152] The camera apparatus 8 is arranged for the purpose of capturing the oven wall surface including the light beam reflected light from a direction vertical to the oven wall as much as possible. As the camera apparatus 8, it is possible to use a CCD camera, a camera controller for controlling the same, etc.. The direction of the field of vision of the camera apparatus 8 may be made parallel to the oven walls 42a and 42b as shown in FIG. 11 and FIG. 12.

[0153] Further, the mirror surface is arranged in the direction of the field of vision of the camera apparatus 8. The angle of the mirror surface is adjusted so that the image of the oven wall surface is reflected at the mirror surface when viewed from the position of the camera apparatus 8.

[0154] Normally, as shown in FIG. 11, if making the angle of the mirror surfaces 2a and 2b and the oven walls 42a and 42b 45°, it is possible to obtain an image as seen from a direction vertical to the oven wall surface. Of course, when the view of the oven wall from a slanted direction enables clear viewing of the relief of the oven wall surface, it is also possible to make the angle between the mirror surface and oven wall an angle other than 45°.

[0155] During measurement of the shape in the oven, normally the distance between the camera apparatus and the mirror surface is made constant. The longer the distance between the camera apparatus and the mirror surface, the longer the effective mirror surface length in the direction parallel to the oven wall can be made and the broader the range of the field of vision 13 of the camera apparatus (length of long side) viewing the mirror surface can be made.

[0156] On the other hand, since the distance between oven walls is narrow, the effective mirror surface width in the direction vertical to the oven walls, that is, the width direction, cannot be enlarged and the range of the field of vision 13 of the camera apparatus (length of short side) cannot be broadened.

[0157] In viewing of the coking chamber of a coke oven, if the length of the long side of the field of vision 13 of the camera apparatus at the oven wall surface is made 500 to 600 mm or so, viewing at a spatial resolution of about 1 mm sufficient for detection of damage is possible by a general CCD camera. The length of the short side of the field of vision 13 of the camera apparatus at the oven wall surface becomes 150 to 200 mm when viewing the oven wall from a vertical direction.

[0158] As shown in FIG. 13, the light beam 63 is emitted from the light beam emitter 62 to the oven wall surface 66b from a slanted direction. In FIG. 13, it is emitted at an angle θ. Therefore, if the distance between the oven wall shape measurement apparatus 61 (light beam emitter 62) and the oven wall changes by exactly Δx, the position of the point where the light beam 63 and the oven wall surface 66b intersect (light beam spot) changes from 64a to 64b and the position of the light beam reflected light changes by exactly Δy.

[0159] The camera apparatus 8 captures an image of the oven wall surface 66 including the light beam reflected light, so a change in the distance between the oven wall shape measurement apparatus 61 and the oven wall 42, that is, deformation of the oven wall, can be deemed as a change of the position of the light beam reflected light in the captured image.

[0160] Therefore, it is possible to evaluate the state of a broad two-dimensional range of the oven wall by an image obtained by the camera apparatus 8 and possible to quantitatively evaluate the state of damage at a specific location, that is, the light beam emitted position.

[0161] The light beam 63 emitted from the light beam emitter 62 can be made a spot-like light beam. Due to this, it is possible to evaluate the distance from the oven wall shape measurement apparatus 61 for one spot of the oven wall.

[0162] On the other hand, the light beam 63 emitted from the light beam emitter 62, as shown in FIG. 14(a) and (b), may be emitted so that the reflected light becomes a line of light 65 when emitted to the oven wall. When using a spot light source such as laser light as the light beam source, it is possible to arrange a cylindrical lens able to enlarge the light spot in only a single axial direction and thereby form a light beam generating such a line of light 65.

[0163] For example, when there is a groove-shaped damaged location 67 in the oven wall surface 66 as

shown in FIG. 14(c), if emitting the light beam 63 to the oven wall surface 66 to generate the line of light 65, it is possible to view the drift 68 in the line of light 65 as shown in FIG. 14(b) corresponding to the damaged location 67.

[0164] If the depth of the damaged location 67 is Δx, the magnitude Δy of the drift 68 becomes $\Delta y = \Delta x/\tan\theta$. Due to this, it becomes possible to obtain a quantitative grasp of the relief of the surface at the straight line part where the line of reflected light is generated.

[0165] When inserting the oven wall shape measurement apparatus 61 into the coking chamber 41 of the deep coke oven from one end, it is difficult to maintain the distance between the oven wall shape measurement apparatus 61 and oven wall surface (oven wall reference surface) 66 constant at all times. Here, the "oven wall reference surface" means the reference surface when the oven wall surface 66 is not damaged and may be considered the oven wall surface with zero oven wall damage.

Therefore, when making the light beam 63 a spot beam, the distance between the oven wall surface 66 at the light beam spot 64 reflected and the oven wall shape measurement apparatus 61 can be identified, but the absolute value of the oven wall damage is difficult to identify.

[0166] On the other hand, which parts of the oven wall surface 66 are sound and which parts are damaged can be generally determined by viewing the images captured by the camera apparatus 8.

[0167] The measurement apparatus of the present invention can simultaneously evaluate the state of a broad two-dimensional range of the oven wall by the images and quantitatively evaluate the state of damage at a specific location, so when generating a line of reflected light by emission of a light beam, sound parts and damaged parts of the oven wall can both be included in the straight line part.

[0168] If conducting measurement in this way, it is possible to identify the relative relief at the oven wall surface in the range of the line of light 65. Therefore, in the measurement apparatus of the present invention, even if it is not possible to identify the distance between the oven wall shape measurement apparatus 61 and the oven wall reference surface, it is possible to identify the difference in relative depth between the sound parts and the damaged parts and identify the damage at the damaged parts.

[0169] The plane including the light beam 63 striking the oven wall and generating the line of light 65 will be referred to as the "light beam plane" here. The position of the line of light 65 naturally matches with the line where the light beam plane and oven wall surface 66 intersect.

[0170] Further, as shown in FIG. 14(b) and (c), when making the spot beam at the center of the width direction of the beam in the light beam 63 generating the line of light 65 the center beam 69, the plane including the center beam 69 vertical to the oven wall surface 66 will be referred to here as the "center beam vertical plane".

[0171] When the light beam plane and the center beam vertical plane are parallel, that is, match, even if there is relief at the oven wall surface 66, the reflected light will remain straight and even if viewing the reflected light, the damage of the oven wall cannot be evaluated.

[0172] When the light beam plane and the center beam vertical plane are orthogonal to each other, it is possible to detect the change in position of the line of light 65, that is, the drift 68, most efficiently. In the example shown in FIG. 14(b) and (c), the light beam plane and the center beam vertical plane are orthogonal to each other.

[0173] The line where the plane formed by the oven wall and the plane formed by the mirror surface intersect will be referred to here as the "intersecting line 70". In the example shown in FIG. 12(b), the intersecting line 70 becomes a line in the vertical direction.

[0174] Consider the case, as shown in FIG. 12(a), where the light beam emitters 62a and 62b are arranged in proximity to the camera apparatus 8 and the light beams 63a and 63b are not reflected at the mirror surfaces 2a and 2b, but are emitted directly to the oven wall surface 66.

[0175] In this case, if the direction of the line of light 65 ends up perpendicularly intersecting the intersecting line 70, this will correspond to the case where the light beam plane and center beam vertical plane become parallel and evaluation of the damage of the oven wall will become impossible.

[0176] To enable the relief to be efficiently detected, that is, to enable the light beam plane and center beam vertical plane to become orthogonal to each other, similarly, as shown in FIG. 12(a), it is possible to make the direction of the line of light 65 emitted to the oven wall substantially parallel to the intersecting line 70 of the oven wall and mirror surface.

[0177] Next, consider the case, as shown in FIG. 15 (a) and (b), of reflecting the light beam 63 from the light beam emitter 62 at the mirror surface 2b and emitting it to the oven wall surface 66. To emit the light beam to the oven wall surface 66 from in a slanted direction by reflecting it at the mirror surface 2b, as shown in FIG. 15(a), the light beam emitter 62 and the camera apparatus 8 have to be arranged separate from each other.

[0178] The direction of separation is the direction parallel to the intersecting line of the wall surface and the mirror surface. At this time, if viewing the light beam emitter 62 reflected at the mirror surface 2b from the position of the oven wall surface 66, the light beam emitter 62 appears at the position of 62a at FIG. 15(a). If the direction of the line of light 65 ends up becoming parallel to the intersecting line 70 by such an arrangement, this corresponds to the case where the light beam plane and center beam vertical plane become parallel and evaluation of the damage of the oven wall becomes impossible.

[0179] To enable the relief to be efficiently detected, that is, to enable the light beam plane and center beam vertical plane to become orthogonal to each other, as shown in FIG. 15(a), it is possible to make the direction of the line of light 65 emitted to the oven wall substantially perpendicularly intersect the intersecting line 70 of the oven wall and mirror surface.

[0180] As the light beam emitter 62, it is preferable to use a laser light emitter (laser light source). This is because if a laser light source, it is possible to generate a fine spot of light and powerful light beam. To emit light to the oven wall and make a light beam giving a line of reflected light, it is possible to use a cylindrical lens etc. and enlarge the light spot in only one axial direction. The angle of spread, that is, the length of the line of reflected light at the oven wall surface, is determined by the focal distance of the cylindrical lens.

[0181] Inside the high temperature coking chamber, the oven wall surface 66 emits thermal radiation light in the red region. In particular, the carbon deposits 52 burn and become high in temperature so feature a strong intensity of emission of red light. If the wavelength of the laser light is in the red region, the light is overcome by the thermal radiation light of the oven wall surface and detection of the light beam reflected light becomes difficult.

[0182] As a small-sized laser light source able to be mounted in the heat insulated container, a red laser diode of a wavelength of 633 nm or 670 nm has conventionally been used. This is a wavelength region common with the thermal radiation light of the oven wall surface 66. In a high temperature region such as a carbon deposit 52, sometimes the light beam reflected light cannot be sufficiently detected.

[0183] In the measurement apparatus of the present invention, the light beam emitter 62 is preferably made a laser light beam apparatus emitting light of a wavelength of not more than 550 nm and the camera apparatus 8 is made a color camera apparatus. If the wavelength is made not more than 550 nm, since it is different from the strong wavelength region of the thermal radiation light of the oven wall surface 66, the line of light is displayed emphasized at the captured color image.

[0184] Further, by emphasizing and taking out the component of a wavelength of not more than 550 nm from the captured image by image processing, it is possible to make the line of light 65 clearer.

[0185] In the measurement apparatus of the present invention, when capturing an image due to thermal radiation light of the high temperature oven wall, the intensity of the thermal radiation light fluctuates depending on the temperature of the oven wall. If the temperature of the oven wall is high, the luminance of the oven wall due to the thermal radiation light is high, while if the temperature of the oven wall is low, the luminance of the oven wall becomes low. In particular, parts of carbon deposits become high in temperature due to the burning of the carbon, so the luminance of those parts becomes high.

[0186] In the camera apparatus 8, it is possible to adjust the aperture of the optical system or adjust the exposure time in accordance with the luminance of the oven wall surface and thereby obtain an optimal image of the oven wall surface. Normally, it is possible to automatically obtain the optimal image by the exposure control function of the camera apparatus 8.

[0187] On the other hand, if the intensity of the light beam 63 emitted by the light beam emitter 62 is constant, if the temperature of the oven wall is remarkably high, the thermal radiation light of the oven wall surface becomes higher in luminance than the light beam reflected light. The exposure of the camera apparatus 8 is determined by the luminance of the oven wall surface 66. Therefore, the light beam reflected light becomes relatively dark. It is not possible to obtain a sufficient grasp of this or not possible to identify the position of the light beam reflected light.

[0188] Conversely, if the temperature of the oven wall is low, the exposure of the camera apparatus is adjusted in accordance with the low luminance of the thermal radiation light of the oven wall surface, so the light beam reflected light becomes too strong, halation occurs, and the position of the light beam reflected light cannot be accurately identified.

[0189] The measurement apparatus of the present invention has a means for measuring the intensity of the thermal radiation light of the oven wall surface emitting the light beam, so it is possible to adjust the intensity of the light beam 63 emitted from the light beam emitter 62 in accordance with the intensity of the thermal radiation light measured and thereby solve this problem.

[0190] When the intensity of the thermal radiation light of the oven wall surface is high, the intensity of the light beam 63 is strong and it becomes possible to obtain an accurate grasp of the position of the light beam reflected light. Further, when the intensity of the thermal radiation light of the oven wall surface is low, it is possible to weaken the intensity of the light beam 63 to prevent halation of the light beam reflected light.

[0191] Power is supplied to the light beam emitter 62 from the power supply 10 housed in the heat insulated container. To increase the period of use from one recharging of the power supply 10 to the next, it is preferable that the power consumption of the light beam emitter 62 be as small as possible.

[0192] If adjusting the intensity of the light beam in accordance with the intensity of the thermal radiation light of the oven wall as in the measurement apparatus of the present invention, it is possible to reduce the power consumption of the light beam emitter 62.

[0193] In measurement of the intensity of the thermal radiation light of the oven wall surface, it is possible to use the results of evaluation of the exposure control function of the camera apparatus 8 as they are. Alternatively, as shown in FIG. 23, it is also possible to provide a photometer 71 as a means for measuring the

amount of light separate from the camera apparatus 8. Further, it is also possible to measure the temperature of the oven wall surface 66 and estimate the intensity of the thermal radiation light from the temperature based on Plank's blackbody radiation law.

[0194] Since the measurement apparatus of the present invention moves inside the oven, it is preferable to use a radiation thermometer as a temperature measuring means. Further, in measuring the intensity of the thermal radiation light, it is also possible to measure the average intensity of light of the total wavelength of the visible light, but it is also possible to take out and measure only the light intensity of the wavelength region centered on the wavelength of the light beam emitted.

[0195] When measuring the intensity of the thermal radiation light, it is also possible to measure the average light intensity at the field of vision 13 of the camera apparatus captured at the camera apparatus 8. Further, it is also possible to measure the intensity of light limited to the region emitting the light beam in the field of vision 13 of the camera apparatus.

[0196] In the measurement apparatus of the present invention, it is possible to evaluate the relief of the oven wall surface quantitatively for a straight line part of the oven wall and possible to obtain a grasp of the two-dimensional state of the oven wall as a whole including the straight line part as an image. As a result, when data arising due to a bulge occurring at the oven wall surface is obtained, it is possible to clearly differentiate whether that bulge is due to deformation of the brick wall surface itself or due to carbon deposition based on the image.

[0197] Therefore, it becomes possible to propose an accurate repair plan based on the results of shape measurement. Specifically, with carbon deposition, air is blown in to burn away the carbon, while with deformation of the wall surface itself, a large-scale repair plan is proposed.

[0198] As the direction of arrangement of the mirror surface, as shown in FIG. 12(b), it is sufficient to make the intersecting line 70 of the oven wall and the mirror surface the height direction of the furnace, that is, a direction orthogonal to the depth direction of the oven. The depth direction of the oven is the direction of movement of the oven wall shape measurement apparatus 61 while viewing the oven walls 42a and 42b. By viewing the surface while moving, it is possible to store the results of measurement of the oven wall shape in the depth direction of the oven.

[0199] Therefore, by making the intersecting line of the oven wall and the mirror surface a direction orthogonal to the depth direction of the oven (movement direction), it is possible to obtain the maximum capture information of the oven wall surface.

[0200] In the measurement apparatus of the present invention, as shown in FIG. 11 and FIG. 16 to FIG. 18, the electronic equipment such as the light beam emitter 62 and camera apparatus 8 is housed in the heat insulated container 3 and the mirror surface 2 or 2a and 2b are arranged at the outside of the heat insulated container 3. The heat insulated container 3 is not supplied with cooling water from outside of the furnace and does not have any power lines or signal wires connected to it.

[0201] Therefore, it is possible to make the oven wall shape measurement apparatus 61 set in the oven light in weight and compact in size and possible to easily attach it to and detach it from a structure inserted and moving in the oven, for example, the coke pusher 43 of the coking chamber 41 of the coke oven (see FIG. 3).

[0202] As shown in FIG. 16 and FIG. 17, the heat insulated container 3 is covered on its surface by the heat insulating material 4, so if a short time, it is possible to operate the electronic equipment inside the container normally while residing in the high temperature furnace.

[0203] The heat insulated container 3 can remain inside the coking chamber 41 of the coke oven for 3 minutes, so it is possible to secure the minimum amount of time for insertion of the coke pusher 43 mounted with the oven wall shape measurement apparatus 61 into the oven, viewing of the oven wall over the entire length in the depth direction of the oven, and extraction to the outside.

[0204] As the heat insulating material 4 covering the heat insulated container 3, it is possible for example to use a ceramic fiber board, calcium silicate board, etc..

[0205] In the measurement apparatus of the present invention, the mirror surface 2 or 2a and 2b are arranged at the outside of the heat insulated container 3, so it is possible to keep the viewing window 16 of the heat insulated container 3 for securing the field of vision of the camera apparatus down to the minimum size.

[0206] In the prior art housing a prism in a box to try to secure a broad field of vision, it is necessary to increase the size of the viewing window placed in the box. When using a heat insulated container, there was the problem of the temperature inside the container rapidly rising due to the radiation heat penetrating the container from the viewing window, but by arranging the mirror surface at the outside of the heat insulated container like in the measurement apparatus of the present invention, the viewing window 16 can be made small, so the radiation heat entering from there can be kept down to the minimum and a rise in temperature inside the heat insulated container can be prevented.

[0207] The viewing window 16 is fit with quartz glass or other heat resistant glass. The heat resistant glass preferably has the function of reflecting radiation heat from the outside by a means such as vapor deposition of a metal.

[0208] In the measurement apparatus of the present invention, as shown in FIG. 16(a), it is possible to use a single mirror surface and view one oven wall 42a. In this case, the light beam emitter 62 also emits a light beam 63 to only one viewed oven wall 42a.

[0209] Further, as shown in FIG. 17, the heat insulated container is preferably provided with a plurality of light beam emitters 62a and 62b, the light beams 63a

and 63b are emitted to the facing oven wall surfaces 66a and 66b, and the two mirror surfaces 2a and 2b with the different angles reflect surfaces including the light beam reflected light of the facing oven walls 42a and 42b.

[0210] In the example shown in FIG. 12 and FIG. 17, the first mirror surface 2a reflects the surface of the first wall surface 42a, the second mirror surface 2b reflects the surface of the second wall surface 42b, and the two are simultaneously captured by a single camera apparatus 8.

[0211] Due to this, by using the oven wall shape measurement apparatus 61 housing the single camera apparatus 8 and the two light beam emitters 62a and 62b and moving it once in the depth direction of the oven, it is possible to measure the shape of the oven wall surface at the left and right sides.

[0212] Further, by this movement, it becomes possible to simultaneously compare the left and right oven walls. Further, since it is possible to view the left and right oven walls by a single camera apparatus 8, it is possible to reduce the open area of the viewing window 16 of the heat insulated container compared with when housing two camera apparatuses inside a heat insulated container. The ratio of the radiation heat penetrating the inside of the heat insulated container and raising the temperature becomes smaller.

[0213] when mounting the oven wall shape measurement apparatus on a pusher of the coke oven etc. and inserting it into the coking chamber of the coke oven from one end for measurement of the inside of the coking chamber, it is difficult to accurately arrange the oven wall shape measurement apparatus at the center of the oven wall reference surfaces of the two sides. Deviation from the center occurs.

[0214] Therefore, when emitting a light beam to only one oven wall, it is difficult to obtain an absolute value showing how much the actual oven wall surface is damaged from the oven wall reference surface.

[0215] In the measurement apparatus of the present invention for simultaneously measuring the oven wall surface shapes at the left and right by two light beam emitters and two mirror surfaces, it is possible to simultaneously measure the distance between the oven wall shape measurement apparatus and the measurement portions of the oven wall surface at the left and right sides. It is possible to calculate the distance between the measurement portions of the oven wall surface at the left and right sides from these measured values.

[0216] Since the distance between the oven walls at the initial stage where no damage has occurred is known, the total damage of the left and right sides can be calculated based on this measured value. At the very least, if the viewed portions at the left and right are sound portions where no local damage is viewed, since it may be considered that the damage will proceed evenly at the left and right, half of the total damage measured can be evaluated as the damage of the oven wall at each sound portion.

[0217] By viewing the line of light 65, it is possible to detect the difference in the relative damage between sound parts and local damaged parts in the range of generation of the line of light and, as explained above, possible to evaluate the oven wall damage at the sound portions, so it becomes possible to estimate even the absolute value of the damage of local damaged parts.

[0218] In the measurement apparatus of the present invention, the mirror surface is arranged at the outside of the heat insulated container 3, so the mirror surface is directly exposed to the high temperature atmosphere inside the oven. In the measurement apparatus of the present invention, as shown in FIG. 17, the surface of the container 11 containing cooling water 6 inside is made the mirror surfaces 2a and 2b.

[0219] The time when the measurement apparatus 61 of the present invention resides in the high temperature oven is short. If within this time, the cooling water 6 inside the container 11 rises in temperature and boils to cool the container 11 by boiling and maintains the temperature of the container 11 at the boiling point of the cooling water (100°C). The optical performance of the mirror surfaces 2 and 2b formed at the container surface can be maintained over a long time and the flatness of the mirror surfaces 2 and 2b can similarly be maintained over a long time.

[0220] In the measurement apparatus of the present invention, it is not necessary to supply cooling water from outside of the furnace to cool the mirror surfaces 2a and 2b. Further, it is also not necessary to use a preheater for preheating the mirror surface. Therefore, it is possible to easily attach the apparatus to the coke pusher or other moving apparatus.

[0221] The container 11 containing cooling water 6 inside it, as shown in FIG. 12 and FIG. 17, may be made a long rectangular cross-section shape with two of its four outer surfaces made mirror surfaces and the remaining two surfaces made heat insulating by a heat insulating material 12 in accordance with need.

[0222] It is possible to make the container 11 itself out of stainless steel and polish the two surfaces to be made mirror surfaces to a mirror finish. Further, it is possible to make the container 11 itself out of stainless steel and polish its surface to a mirror finish.

[0223] The image captured by the camera apparatus 8 in the heat insulated container has to be recorded in a data recorder 22 and the finally recorded data used to prepare image information of the oven walls. The data recorder 22 may be housed inside the heat insulated container (see FIGS. 16 and 17).

[0224] On the other hand, it is more preferable to house a wireless transmitter 18 inside the heat insulated container and arrange the wireless receiver 21 and data recorder 22 outside of the oven (see FIGS. 3 and 18).

[0225] The information captured by the camera apparatus 8 is transmitted from the wireless transmitter 18 to the wireless receiver 21 arranged outside of the oven and recorded in the data recorder 22. If designing the

data recorder 22 so as to input the information in a recording computer or other processor 30 and simultaneously display the capture image at an image display 31, it is possible to confirm the viewing results at the same time as inserting the oven wall shape measurement apparatus inside the oven for viewing.

[0226] The heat insulated container returned from the 1000°C oven is high in temperature at the outside, so the inside data cannot be taken out until after the elapse of a certain time. As opposed to this, if employing the above transmission and reception system, the trouble of taking out the oven wall shape measurement apparatus 61 from the oven, then waiting until the apparatus cools before taking out the image data is not required, so it is possible to quickly confirm the state of the oven walls. Further, it is possible to immediately use the oven wall shape measurement apparatus 61 taken out from the coking chamber for viewing of the next coking chamber.

[0227] For the wireless communication from the heat insulated container inside of the oven to outside of the oven, it is possible to use wireless transmission using electromagnetic waves or wireless transmission using visible light, infrared light, or other light.

[0228] For wireless communication, the wall of the heat insulated container facing the outside of the oven is provided with a transfer use window 17. When the window 17 is fit with heat resistant glass and electromagnetic waves are used as the communication medium, a metal-evaporation coating is not used for the coating for preventing penetration of radiation heat from the outside. A dielectric substance such as a silica coating is coated.

[0229] As shown in FIG. 8, it is possible to use a digital wireless transmitter and receiver (27 and 28) for transferring digital signals by electromagnetic waves for the wireless communication. Since analog image signals are output from the camera apparatus 8, the signal is converted to a digital signal by an A/D converter 26, the digital signal is transmitted by a digital wireless transmitter 27, and that signal is received by a digital wireless receiver 28 outside of the oven.

[0230] The received digital signal can be converted to an analog signal by a D/A converter 29 and output to an image display 31 or can be input as a digital signal to a processor 30 etc..

[0231] When arranging a wireless transmitter 18 inside the heat insulated container, the capture information is transmitted from the heat insulated container to an outside wireless receiver 21 and the data recorded in the outside data recorder 22. At that time, it is possible to simultaneously record the oven position information of the camera apparatus (capture current position data 35 in horizontal direction in oven) together with the capture information in the data recorder 22.

[0232] The outside data recorder 22 is arranged outside of the oven, so it is possible to calculate and fetch the capture current position data 35 of the camera apparatus 8 from the current position data of the pusher 43 mounting the camera apparatus 8.

[0233] As a result, in the outside data recorder 22, it becomes possible to establish correspondence with the capture position in the horizontal direction and the capture data in real time. During viewing, it is possible to identify the damaged locations in the oven and locations requiring repair.

[0234] Conversely to the above, it is possible to provide a data recorder 22 and a wireless receiver 21 inside the heat insulated container, wirelessly transmit the time of oven insertion of the heat insulated container and the capture current position data 35 in the horizontal direction in the oven from the outside to the heat insulated container, and simultaneously record the capture data and the capture current position data 35 in the horizontal direction of the oven to the data recorder 22 in the heat insulated container.

[0235] For the wireless transmitter 18 and the wireless receiver 21, it is also possible to use a transceiver provided with the functions of both transmission and reception.

[0236] The heat insulated container 3 preferably has a jacket 5 filled with a liquid 7 having a heat absorbing ability and further a heat insulating material 4 covering the outside as shown in FIG. 11 and FIG. 19.

[0237] In general, the liquid selected may be one having a large heat capacity per mass and volume. As a liquid able to be most easily obtained industrially and optimal as a heat absorbing material, it is preferable to use water.

[0238] When inserting the heat insulated container 3 in the high temperature oven, since the outside of the heat insulated container is covered by the heat insulating material 4, it is possible to reduce the amount of heat penetrating the inside through the heat insulating material 4.

[0239] Further, since there is a jacket 5 filled with a liquid 7 having a heat absorbing ability inside the heat insulating material 4, the heat penetrating the inside first is used up to raise the temperature of the liquid 7, for example, water. Water has a large heat capacity, so it is possible to delay the rise in temperature inside the heat insulated container.

[0240] Further, when the temperature of the water reaches 100°C, a large amount of the heat of vaporization is robbed by the boiling, so the temperature inside the heat insulated container will never exceed 100°C. To discharge the water vapor when the water reaches 100°C in temperature and starts boiling, an opening or a safety valve is provided at the top of the heat insulated container 3.

[0241] The measurement apparatus of the present invention is characterized in that pipes are not connected for supplying or discharging liquid during viewing of the oven walls in the oven.

[0242] The width of the coking chamber 41 of the coke oven is usually about 400 mm. The measurement ap-

paratus of the present invention has to be made dimensions enabling insertion into this space with some leeway. When using water as the heat absorbing liquid, the jacket holding the water has a width of the water at the left and right of about 40 mm in the oven width direction.

[0243] As the heat insulating material 4 at the outer circumference of the heat insulated container, for example, it is possible to use a ceramic fiber board and make the thickness of the heat insulating material 4 about 30 mm. When the external dimensions of the oven wall viewing apparatus are made 500 mm length × 300 mm width × 500 mm height, the internal space holding the oven wall viewing apparatus becomes 380 mm length × 160 mm width × 300 mm height.

[0244] When inserting a measurement apparatus of the present invention having such a shape into the coking chamber 41 of a coke oven of an oven temperature of 1000°C, the temperature of the internal space housing the oven wall shape measurement apparatus becomes, along with the elapsed time after insertion, 25°C after 3 minutes, 40°C after 5 minutes, and 55°C after 7 minutes. The usual upper limit of the temperature used of the different electronic equipment housed in the heat insulated container is about 50°C, so the container can reside in the high temperature oven for at least 5 minutes.

[0245] In measurement of the shape of the oven wall of a coking chamber of a coke oven according to the measurement apparatus of the present invention, when mounting the oven wall shape measurement apparatus 61 of the present invention on the coke pusher 43 for measurement, the car 40 of the pusher 43 continuously successively repeats the work of pushing out the coke of the coking chamber finished being carbonized while moving on rails at 5 to 10 minute intervals and simultaneously measures the shapes of the oven walls of a large number of coking chambers.

[0246] Due to one insertion into a coking chamber, the liquid in the heat insulated container rises in temperature, so if the container were inserted into the next coking chamber for measurement as it were without any time interval, the temperature of the liquid 7 in the heat insulated container 3 would successively rise and the possible time of residence in the oven would become shorter.

[0247] As shown in FIG. 19, the bottom of the heat insulated container 3 is provided with a discharge port 23 for discharging the inside liquid. By discharging the inside liquid raised in temperature and inserting new liquid of a low temperature each time the shape of the oven wall finishes being measured, it is possible to prevent a rise in temperature of the liquid.

[0248] If continuing to discharge the liquid from the discharge port 23 while supplying cooled liquid from the filling port 24 at the time of filling the new liquid, it is also possible to reduce the temperature of the heat insulated container itself. As a result, it is possible to secure a sufficient residence time in the oven for each measurement.

[0249] when arranging a wireless transmitter 18 in the heat insulated container, further, as shown in FIG. 8, it is possible to install a thermometer 36 for measuring the temperature of the heat insulated container or the temperature of the liquid in the jacket inside the heat insulated container and to transmit the measured temperature to outside of the oven by the wireless transmitter 18.

[0250] Due to this, it is possible to obtain a grasp of the internal temperature of the oven wall shape measurement apparatus at the present point of time outside of the oven. When the temperature approaches the upper limit of management, it is possible to suspend the measurement and take the oven wall shape measurement apparatus outside of the oven so as to prevent in advance damage to the oven wall shape measurement apparatus due to the abnormally high temperatures.

[0251] The measurement apparatus of the present invention may set viewing positions in the oven in advance and capture images of the oven wall at those positions as still images. Due to this, it is possible to obtain images of the states of oven wall positions where damage is predicted as occurring in advance.

[0252] Further, it is more preferable to capture images while moving the camera apparatus 8 in the depth direction of the oven and record the capture data in a data recorder 22. The camera apparatus 8 is moved in the depth direction of the oven by for example as shown in FIG. 3 mounting the heat insulated container 3 housing the camera apparatus 8 etc. on the coke pusher 43 and inserting the coke pusher 43 into the oven or extracting it from the oven at a constant speed by operation of a ram driver 46. It is possible to move the camera apparatus 8 while continuously capturing images and view the results of capture as a moving image.

[0253] More preferably, it is possible to capture images while moving the camera apparatus 8 in the depth direction of the oven and process and join the capture data recorded in the data recorder 22 so as to obtain a single still image of a broad range in the depth direction of the oven. For example, it is possible to capture images with a speed of movement of the coke pusher of 300 mm/sec., a capture range in the width direction of 100 mm, and a still image capture interval of the camera apparatus of 1/3 second.

[0254] FIG. 22 shows an oven wall picture obtained by stitching eight adjoining still images at the image joining positions 73 to obtain an image 72 of a broad region. In this broad region image, the light beam reflected light emitted by the light beam emitter 62 is reflected for each 100 mm pitch still image.

[0255] As shown in FIG. 22, if the light beam reflected light is the line of light 65 and the direction of the line of light 65 is parallel to the depth direction of the oven, the light is continuously reflected as a single long line of light overall. If the light beam reflected light is a line of light and the direction of the line of light is parallel to the height direction of the oven, the line of light facing the

height direction is reflected at 100 mm pitches. This data processing can be performed at the data recorder 22.

[0256] In the measurement apparatus of the present invention arranging a wireless transmitter 18 in the heat insulated container, transmitting the capture information from the heat insulated container to a wireless receiver 21 outside, recording this data in an outside data recorder 22, and simultaneously recording the oven position information of the camera apparatus (capture current position data 35 in the horizontal direction in the oven) in a data recorder 22, it is possible to capture images while moving the camera apparatus 8 in the depth direction of the oven and select still images based on oven position information.

[0257] The case of taking still images at a pitch of 100 mm in the width direction and stitching these still images to prepare an oven wall image of a broad range in the depth direction of the oven will be explained as an example. The captured still images are successively transmitted to an outside data recorder at for example a 1/30 second pitch.

[0258] The data recorder 22 outside of the oven selects the still images received at the time each time the camera apparatus reaches the 100 mm pitch still image taking positions based on the oven position information.

[0259] Due to this, as a result, by taking still images at 100 mm pitches in the width direction and stitching together these still images, it is possible to prepare an oven wall image extending over a broad range in the depth direction of the oven. With this method, even if the running speed of the coke pusher mounting the heat insulated container fluctuates, it is possible to acquire still images at equal intervals.

[0260] When arranging a wireless receiver in the heat insulated container and transmitting oven position information from outside the oven to the heat insulated container, it is sufficient to process the data in the same way as above in the heat insulated container.

[0261] Further, if arranging a wireless receiver enabling communication with the inside of the heat insulated container and the outside of the oven, it is also possible to transmit oven position information from outside the furnace to the heat insulated container, select still images every constant interval in the heat insulated container, and wirelessly transmit only the selected still images outside of the furnace.

[0262] In a measurement apparatus of the present invention capturing images while moving the camera apparatus 8 in the depth direction of the oven to take still images and stitching together these still images to prepare an oven wall image extending over a broad range in the depth direction of the oven, it is also possible to capture images so that overlapping parts occur between adjoining still images.

[0263] For example, by capturing images at a pitch of about 100 mm in the width direction and making the size of the still images in the width direction 150 mm, 50 mm overlapping parts will occur. The overlapping parts capture the same parts of the oven wall, so it is possible to accurately position and align two images by pattern matching based on the images of the oven walls.

[0264] If using this technique, even if there is some deviation in the oven position information of the still images, it is possible to automatically correct this deviation and prepare an accurate oven wall image of a broad range in the depth direction of the oven.

[0265] Further, even when it is not possible to use oven position information, it is possible to determine the overlap of the images by pattern matching for a group of images taken in time series with overlapping portions between adjacent images and successively connect them to prepare an accurate oven wall image.

[0266] For example, when viewing the coking chamber of the coke oven, since the oven walls are high in temperature, they emit red hot thermal radiation light. It is possible to view the oven walls by capturing this thermal radiation light by a camera apparatus. Further, when using an ordinary CCD camera as a camera apparatus, it is possible to capture images at a shutter speed of about 1/1000 second.

[0267] With this fast a shutter speed, even with a speed of movement of the coke pusher of 300 mm/sec., it is possible to obtain a sharp image free from blurring.

[0268] Next, a specific method for analyzing the captured light beam image and quantitatively measuring the shape will be explained. A green laser is used as the beam light source. The color components of the color CCD camera, that is, the R (red), G (green), and B (blue) components, are analyzed and introduced into the recorder 30.

[0269] The image analysis of the shape measurement is performed for the G component image corresponding to the laser wavelength. In the G component image, the thermal radiation light of the oven wall is extremely weak and the light beam reflected light is viewed bright. Therefore, by digital processing, it is possible to extract the line segment of the light beam reflected light.

[0270] If the oven wall bricks were free from all damage and smooth, the line segment would be straight, but as shown in FIG. 14(a), (b), and (c), if the oven wall has a depression of Δx, deformation of Δy occurs at the line segment of the light beam reflected light. Therefore, the number of pixels of the deformation Δy on the image are counted.

[0271] If the camera were to capture images from a direction perpendicular to the oven wall, it would be possible to find Δx from the relationship $\Delta x = \tan\theta \times \Delta y$. Note that the relationship between the number of pixels on the image and the actual distance is found in advance.

[0272] By moving the camera apparatus together with the moving apparatus in the depth direction of the oven in this way, it is possible to fit the entire length of the oven wall surface in a single still image. For the height direction of the oven, while depending on the distance between the mirror surface and camera apparatus, ordinarily the capture range is a range of about 500 to 600

mm. Therefore, in the height direction of the oven, the range which can be captured at one time is limited.

[0273] In the coking chamber of the coke oven, the parts of the oven wall refractories where damage is particularly severe are for example limited to the vicinity of the coal charging line in the oven height direction etc..

[0274] Therefore, by setting the measurement apparatus of the present invention at a position enabling the vicinity of the coal charging line to be viewed, even if the range of viewing in the oven height direction is limited, it is possible to obtain sufficiently useful data.

[0275] Of course, by providing a plurality of oven wall shape measurement apparatuses in the height direction at the coke pusher, it becomes possible to view the oven wall over a broad range in the oven height direction.

[0276] The measurement apparatus of the present invention is compact in shape, light in weight, and does not require the provision of cooling pipes etc., so is easily changed to any height of attachment to the pusher. Further, it is possible to make measurements while changing the mounting position for each predetermined height to obtain oven wall shape measurement data for the oven height as a whole.

[0277] In the measurement apparatus of the present invention, operating power cannot be supplied from the outside during measurement, so a power supply 10 is provided inside the heat insulated container. The light beam emitter 62, camera apparatus 8, data recorder 22, and wireless transmitter 18 operate by power supplied from this power supply 10. As the power supply 10, it is possible to use a dry cell, rechargeable storage cell, etc..

[0278] If using a cell which cannot be recharged as the power supply 10, it is necessary to open up the heat insulated container each time the cell is replaced. Further, even if using a rechargeable power supply as a power supply 10, it becomes necessary to open up the heat insulated container for each recharging if positioning the recharging cable connection plug inside the heat insulated container.

[0279] As the power supply, a rechargeable power supply may be used. Further, as shown in FIG. 19, by providing a recharging cable connection plug 25 at the outside of the heat insulated container 3, it becomes possible to recharge without opening the heat insulated container and therefore improve the work efficiency.

[0280] The recharging cable connection plug 25 may be covered at its outside by a heat insulating cap 34 when inserted into the oven. Only the heat insulating cap 34 need be removed at the time of recharging and the recharging cable connected.

[0281] Here, examples of the measurement apparatus of the present invention will be shown.

(EXAMPLES)

[0282] The oven wall shape measurement apparatus shown in FIG. 11 was used for the purpose of viewing the surface of the oven walls of the coking chamber of the coke oven. The external dimensions of the oven wall shape measurement apparatus 61 are a height of 500 mm, width of 300 mm, and length of 500 mm and the total weight about 50 kg.

[0283] As the heat insulated container 3 of the oven wall shape measurement apparatus, one covered over its outer circumference with ceramic fiber board as a heat insulating material 4 was used.

[0284] The thickness of the heat insulating material was made 30 mm. At the inside of the heat insulating material, a jacket made of stainless steel was arranged. The jacket was filled with a total of 30 liters of water 7. At the portion of the heat insulating container 3 facing the oven wall, the thickness of the layer of water was 40 mm.

[0285] Inside of the heat insulated container were arranged two small sized laser light emitters of a wavelength of 532 nm as light beam emitters and a color CCD camera as the camera apparatus 8. The image signal captured by the camera apparatus was transmitted outside of the oven by the wireless transmitter 18.

[0286] The heat insulated container and the heat insulating material were provided with a viewing window 16 and a communication window 17. The viewing window was fit with quartz glass on which metal-evaporation coating was coated.

[0287] Further, a rechargeable storage cell was provided as a power supply 10 and used to supply power to the camera apparatus, light beam emitters, wireless transmitter, and controller for controlling the same. As the light beam emitters, blue laser diodes of a wavelength of 405 nm may be used.

[0288] As shown in FIG. 23, a photometer 71 is arranged in the vicinity of the camera apparatus 8 inside the heat insulated container 3. The photometer 71 uses a photo diode as a light sensor and measures the average amount of light (thermal radiation light intensity) in an oven wall surface of substantially the same field of vision as the camera apparatus 8. The signal from the photometer is sent to a voltage controller 75 of the light beam emitters.

[0289] The voltage controller 74 adjusts the voltage of the power supplied to the lasers of the light beam emitters based on the signal of the photometer. The relationship between the output of the photometer 71 and the voltage applied to the lasers is investigated in advanced by experiments to enable the lasers to be fired at the optimal intensities in accordance with the intensity of the thermal radiation light of the oven wall.

[0290] In front of the heat insulated container, as shown in FIG. 11, mirror surfaces 2a and 2b are arranged. The direction of the intersecting line 70 of the oven wall surface 66 and the mirror surfaces can be made the height direction of the oven, the two mirror surfaces 2a and 2b can be set to angles with the oven walls 42a and 42b of 45°, and the left and right oven walls 42a and 42b can be simultaneously captured in the field of

vision of the camera apparatus 8.

[0291] By arranging the mirror surfaces, the fields of vision 13a and 13b of the camera apparatus have lengths on the long sides of 600 mm and lengths of the short sides of 200 mm for each of the left and right oven walls. For the mirror surfaces, use was made of the surface of the stainless steel container 11 containing cooling water 6 inside polished to a mirror finish. The container 11, as shown in FIG. 2(a), has a long rectangular cross-sectional shape with two of its four outer surfaces made mirror surfaces and the remaining two surfaces made heat insulating by a heat insulating material 12.

[0292] The light beam emitters 62a and 62b were arranged at positions of the same height as the camera apparatus 8 in the first embodiment as shown in FIG. 12(a) and emitted light beams 63 generating lines of light 65. The direction of emission of the center beam 69 was the horizontal direction. The beam was emitted in a slanted direction at an angle θ with the oven wall surface 66 of 30°.

[0293] The line of light 65 was oriented in the height direction in the oven wall surface 66. The length of the line of light 65 at the oven wall surface 66 was 200 mm.

[0294] In the second embodiment, as shown in FIG. 15(a) and (b), the light beam emitter 62 was arranged above the camera apparatus 8 and emitted the light beam 63 to the oven wall surface 66 by reflecting it at the mirror surface.

[0295] The direction of emission of the center beam 69 was the horizontal direction. The beam was emitted from a slanted direction at an angle θ with the oven wall surface 66 of 60°. The line of light 65 was oriented in the depth direction of the oven at the oven wall surface 66. The length of the line of light 65 at the oven wall surface 66 was 200 mm.

[0296] The oven wall shape measurement apparatus and mirror surfaces were attached to the pusher 43. The total weight of the oven wall shape measurement apparatus is a comparatively light one of approximately 50 kg. Further, since there is no need for arranging cooling water pipes or signal cables, it is possible to easily attach the components to any positions in the height direction of the pusher ram 44.

[0297] In the present example, as shown in FIG. 3, these components are either attached to positions of the oven wall shape measurement apparatus 61 behind the pusher ram 44 using a support 45 or attached to positions of the oven wall shape measurement apparatus 61' on a ram beam 47. By successively measuring the oven wall shape at different heights in this way, it was possible to obtain oven wall shape measurement over a broad range.

[0298] For the wireless communication, wireless communication using the electric waves of a digital signal was adopted. The output of the camera apparatus and the output of the thermometer 36 for measuring the temperature inside the measurement unit are converted to a digital signal by the A/D converter 26 and sent to the digital signal wireless transmitter 27. The digital signal wireless transmitter 27 functions as a wireless transmitter 18 and sends a wireless signal 19 to a wireless receiver 21 outside of the oven.

[0299] In the heat insulated container, the part through which the electromagnetic wave passes is provided with a communication window 17 fit with quartz glass coated with silica. This silica coating blocks the radiation heat from the oven and does not obstruct the propagation of the electromagnetic waves since it is not a metal coating.

[0300] Outside of the coke oven, a digital signal wireless receiver 28 is arranged as a wireless receiver 21, while a processor 30 and image display 31 are arranged as a data recorder 22. The digital signal received by the digital signal wireless receiver 28 is transmitted to the D/A converter 29 and processor 30.

[0301] The data sent to the processor 30 is recorded in the computer. The analog signal output from the D/A converter 29 is sent to the image display 31. The capture signal measured in real time is processed to easily analyzable image information.

[0302] The data recorder 22 is also sent the capture current position data 35 found based on the current position data of the pusher ram 44, so this data is also sent to the processor 30 and image display 31.

[0303] In the processor 30, the capture information captured at different times can be arranged based on the capture current position data 35 to produce a single still image extending over the entire length in the depth direction of the coking chamber and to identify locations of oven wall damage.

[0304] Specifically, along with movement of the pusher 43, each time the capture current position data 35 is increased by 150 mm, the transmitted still image is fetched into the processor 30. Since the length of the still image in the oven width direction (short side) is 200 mm, adjoining images have 50 mm overlapping parts. It is possible to use the overlapping parts for pattern matching and finely adjust the overlap of the images. In this way, it is possible to produce a single still image extending over the entire length in the depth direction of the coking chamber.

[0305] Each still image taken at a pitch of 150 mm in the depth direction of the oven shows a line of light 65 caused by light emitted by a light emitter. The processor 30 can digitally process the image of the color component emphasized in light near the wavelength 532 nm to take out only information of the line of light 65 and incorporate the information of the line of light 65 into the original image again.

[0306] Due to this, as the image as a whole, it is possible to clearly reflect the image of the oven wall and simultaneously clearly reflect the line of light 65 caused by the emission of the light beam in it. It is possible to evaluate the state of drift of the reflected line of light for each still image and calculate the depth of damage of a local damaged part in the range of the line of light.

[0307] The results of viewing of the oven wall in the first example are shown in FIG. 20(a) and (b). In this example, the direction of the line of light is parallel to the intersecting line 70 of the oven wall surface and mirror surfaces, that is, the height direction of the furnace. FIG. 20(a) shows an image of the oven wall 42a reflected in the mirror surface 2a and an image of the oven wall 42b reflected in the mirror surface 2b in the overall field of vision 9 of the camera apparatus.

[0308] In both images, the joint 49 of the bricks 48 are clearly discriminated and the lines of light 65a and 65b due to the emission of the light beam are reflected.

[0309] FIG. 20(b) shows the image of a location of the oven wall where damage occurred. A missing brick part 76 is viewed other than the normal joint 49. A line of light 65 is reflected across the missing brick part 76. From the drift 68 of the line of light 65, it is possible to quantitatively evaluate the shape including the amount of damage of the missing brick part 76.

[0310] The results of viewing of the oven wall in the second example are shown in FIGS. 21(a), (b), and (c). In this example, the direction of the line of light perpendicularly intersects the intersecting line 70 of the oven wall surface and mirror surface, that is, is arranged in the depth direction of the oven. FIG. 21(a) shows an image of the oven wall 42a reflected in the mirror surface 2a and an image of the oven wall 42b reflected in the mirror surface 2b in the overall field of vision 9 of the camera apparatus.

[0311] In both images, the joint 49 of the bricks 48 is clearly discriminated and the lines of light 65a and 65b due to the emission of the light beam are reflected.

[0312] FIG. 21(b) shows an image of a location of the oven wall where damage occurs. In addition to the normal joint 49, a joint gap 50 and vertical crack 51 in the oven wall are viewed. The line of light 65 is reflected across the joint gap 50 and the vertical crack 51 in the oven wall. From the drifts 68c and 68d of the line of light 65, it is possible to quantitatively evaluate the shape including the amounts of damage of a joint gap 50 and vertical crack 51 in the oven wall.

[0313] In the image shown in FIG. 21(c), a carbon deposit 52 is viewed. The line of light 65 is reflected across the carbon deposit 52. From the drift 68e of the line of light 65, it is possible to quantitatively evaluate the amount of the carbon deposit 52.

[0314] By combining still images obtained continuously along with movement of the pusher 43, it is possible to obtain an oven wall image over a broad region in the depth direction of the oven.

[0315] FIG. 22 shows an oven wall picture obtained by combining eight adjoining still images at the image joining positions 73 to obtain an image 72 of a broad region. The line of light 65 due to the emission of light beams is arranged parallel to the depth direction of the oven and is viewed as a substantially continuous straight line in the depth direction.

[0316] It is possible to quantitatively evaluate the amounts of damage of the damaged parts and deposition of the carbon deposits from the drifts 68a, 68b, and 68c in the line of light 65. In an image of a broad region, identification of damaged locations is easy. Further, it is possible to obtain a grasp of the overall state of damage at a single glance. Therefore, this is useful in diagnosis and management of ovens.

[0317] During measurement, the data recorder 22 was successively sent data, so there was no need to open the heat insulated container after measurement was completed and the work efficiency of the measurement could be greatly improved. Further, it was possible to catch oven wall damage during measurement in real time and accurately identify even locations of occurrence of that damage, so it was possible to propose a repair plan of the coking chamber without delay.

[0318] After the oven wall of one coking chamber finishes being viewed, before viewing the oven wall of the next coking chamber, the discharge port 23 at the bottom of the heat insulated container was opened and the raised temperature cooling water 7 discharged and, simultaneously, ordinary temperature water was filled from the top filling port 24.

[0319] 15 liters of water was filled to lower the temperature of the heat insulated container 3, then the discharge port 23 at the bottom of the heat insulated container was closed and water filled in the heat insulated container. In this way, the next measurement was performed after sufficiently lowering the temperature of the heat insulated container and the water in the heat insulated container, so it was possible to secure a measurement time of more than 5 minutes at a time even when continuously viewing oven walls of coking chambers.

[0320] The rechargeable storage cell used as the power supply 10 in the measurement unit has a capacity enabling continuous measurement of the oven width of 10 coking chambers. At the time of recharging, it is possible to recharge by connecting a recharging cable to the recharging cable connection plug 25 arranged at the outside of the heat insulated container, so the heat insulated container does not have to be opened for recharging and recharging was possible with a good work efficiency.

[INDUSTRIAL APPLICABILITY]

[0321] In the oven wall viewing apparatus and the oven wall shape measurement apparatus of the present invention, by housing a camera apparatus in the heat insulated container, arranging a mirror surface at the outside of the heat insulated container, and capturing an image of the oven wall surface reflected at the mirror surface by the camera apparatus, the apparatus is compact in size and light in weight, does not require coolant water piping etc., is able to be easily attached to and detached from a pusher or other moving apparatus, and is able to view the necessary viewing range at a wall surface.

[0322] In the oven wall shape measurement apparatus of the present invention, by emitting a light beam from a light beam emitter to the oven wall from a slanted direction, capturing an image of an oven wall surface reflected at a mirror surface and including light beam reflected light by a camera apparatus, and measuring the shape of the oven wall based on the position of the light beam reflected light, it is possible to evaluate the state of a broad two-dimensional range of the oven wall by the image and possible to quantitatively evaluate the state of damage of a specific location.

[0323] Further, according to the two apparatuses of the present invention, by using a wireless transmitter and receiver to record data outside of the oven, it is possible to combine the captured oven wall image information and capture position information while maintaining the advantages of being compact in size, light in weight, and simple in structure and possible to propose an oven wall repair plan quickly utilizing the capture results.

[0324] Further, according to the two apparatuses of the present invention, by stitching together the continuously taken still images, it is possible to obtain an oven wall image of a broad region in the depth direction of the oven. In the broad region image, identification of damaged portions is easy and the overall state of damage can be grasped by a single glance. This is useful in diagnosing and managing ovens.

[0325] Further, according to the two apparatuses of the present invention, by using a heat insulated container having a jacket filled with a liquid having a heat absorbing ability and further having a heat insulating material covering it at the outside, it is possible to secure a sufficient residence time in the high temperature oven while maintaining the advantages of being compact in size, light in weight, and simple in structure.

Claims

1. An oven wall viewing apparatus for viewing surfaces of facing oven walls, said oven wall viewing apparatus **characterized by** housing a camera apparatus in a heat insulated container, arranging a mirror surface at the outside of said heat insulated container, and capturing an image of an oven wall surface reflected at said mirror surface by said camera apparatus.

2. An oven wall viewing apparatus as set forth in claim 1, **characterized in that** said mirror surface is comprised of two mirror surfaces of different angles and **in that** said mirror surfaces reflect surfaces of the facing oven walls.

3. An oven wall viewing apparatus as set forth in claim 1 or 2, **characterized in that** said mirror surface is comprised of the surface of the container containing cooling water inside it.

4. An oven wall viewing apparatus as set forth in any one of claims 1 to 3, **characterized in that** said heat insulated container houses a wireless transmitter, a wireless receiver and data recorder are arranged outside the oven, and information captured by said camera apparatus is transmitted from said wireless transmitter to said wireless receiver and is recorded at said data recorder.

5. An oven wall viewing apparatus as set forth in any one of claims 1 to 3, **characterized in that** said heat insulated container houses a data recorder and information captured by said camera apparatus is recorded in the data recorder.

6. An oven wall viewing apparatus as set forth in claim 4 or 5, **characterized in that** said data recorder also records position information of the camera apparatus inside the oven.

7. An oven wall viewing apparatus as set forth in any one of claims 1 to 6, **characterized in that** said heat insulated container has a jacket filled with a liquid having a heat absorbing ability and further a heat insulating material covering it at the outside.

8. An oven wall viewing apparatus as set forth in any one of claims 1 to 7, **characterized by** capturing an image while moving said camera apparatus in a depth direction of the oven and recording the captured data in said data recorder.

9. An oven wall viewing apparatus as set forth in claim 8, **characterized in that** said data recorder combines a plurality of captured data obtained by capturing an image to obtain an image of a broad region in a depth direction of the oven.

10. An oven wall viewing apparatus as set forth in any one of claims 1 to 9, **characterized in that** said oven walls are oven walls of a coking chamber of a coke oven and **in that** said heat insulated container and mirror surface are arranged at a pusher of the coke oven.

11. An oven wall shape measurement apparatus for measuring a surface shape of facing oven walls, said oven wall shape measurement apparatus **characterized by** housing a light beam emitter and camera apparatus in a heat insulated container, arranging a mirror surface at the outside of said heat insulated container, emitting a light beam from said light beam emitter to the oven walls from a slanted direction, capturing images of the surfaces of the oven walls reflected at said mirror surface including light beam reflected light by said camera apparatus, and measuring the oven wall shape based on the position of the light beam reflected light.

12. An oven wall shape measurement apparatus as set forth in claim 11, **characterized in that** the light beam emitted to said oven walls is emitted in a line to the oven walls.

13. An oven wall shape measurement apparatus as set forth in claim 12, **characterized by** emitting the light beam directly from said light beam emitter and in that a direction of the line of light emitted to the oven walls is substantially parallel to the intersecting line of the wall surface and the mirror surface.

14. An oven wall shape measurement apparatus as set forth in claim 12, **characterized by** emitting the light beam from said light beam emitter and reflecting it at said mirror surface and in that a direction of the line of light emitted to the oven walls is substantially perpendicular to the intersecting line of the wall surface and the mirror surface.

15. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 14, **characterized in that** said light beam emitter is a laser light emitter for emitting light of not more than a wavelength of 550 nm and **in that** said camera apparatus is a color camera apparatus.

16. An oven wall shape measurement apparatus as set forth in claim 15, **characterized by** processing the image captured at said camera apparatus and, when measuring the oven wall shape from the position of the light beam reflected light, processing the image while emphasizing the light range of a wavelength of less than 550 nm.

17. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 16, **characterized by** having a means for measuring the intensity of thermal radiation light of the oven wall surface to which said light beam is emitted and adjusting the intensity of the light beam emitted from said light beam emitter in accordance with the measured intensity of the thermal radiation light.

18. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 17, **characterized in that** said heat insulated container is provided inside it with a plurality of light beam emitters, the light beam emitters emit light beams to the surfaces of the facing oven walls, said mirror surface is comprised of two mirror surfaces of different angles, and said mirror surfaces reflect surfaces of the facing oven walls including light beam reflected light.

19. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 18, **characterized in that** said mirror surface is comprised of the surface of the container containing cooling water inside it.

20. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 19, **characterized in that** said heat insulated container houses a wireless transmitter, a wireless receiver and data recorder are arranged outside the oven, and information captured by said camera apparatus is transmitted from said wireless transmitter to said wireless receiver and is recorded at said data recorder.

21. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 20, **characterized in that** said heat insulated container houses a data recorder and information captured by said camera apparatus is recorded in the data recorder.

22. An oven wall shape measurement apparatus as set forth in claim 20 or 21, **characterized in that** said data recorder also records position information of the camera apparatus inside the oven.

23. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 22, **characterized in that** said heat insulated container has a jacket filled with a liquid having a heat absorbing ability and further a heat insulating material covering it at the outside.

24. An oven wall shape measurement apparatus as set forth in any one of claims 11 to 23, **characterized in that** said oven walls are oven walls of a coking chamber of a coke oven and **in that** said heat insulated container and mirror surface is arranged at a pusher of the coke oven.

Fig.1

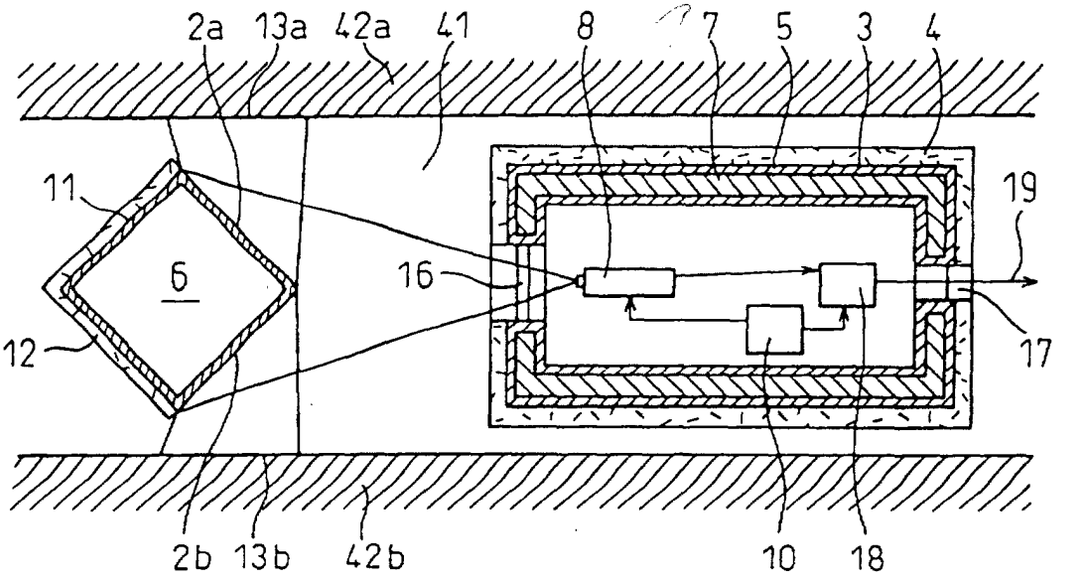

2a
13a
42a
41
8
7
5
3
4
11
6
12
16
19
17
2b
13b
42b
10
18

Fig.2

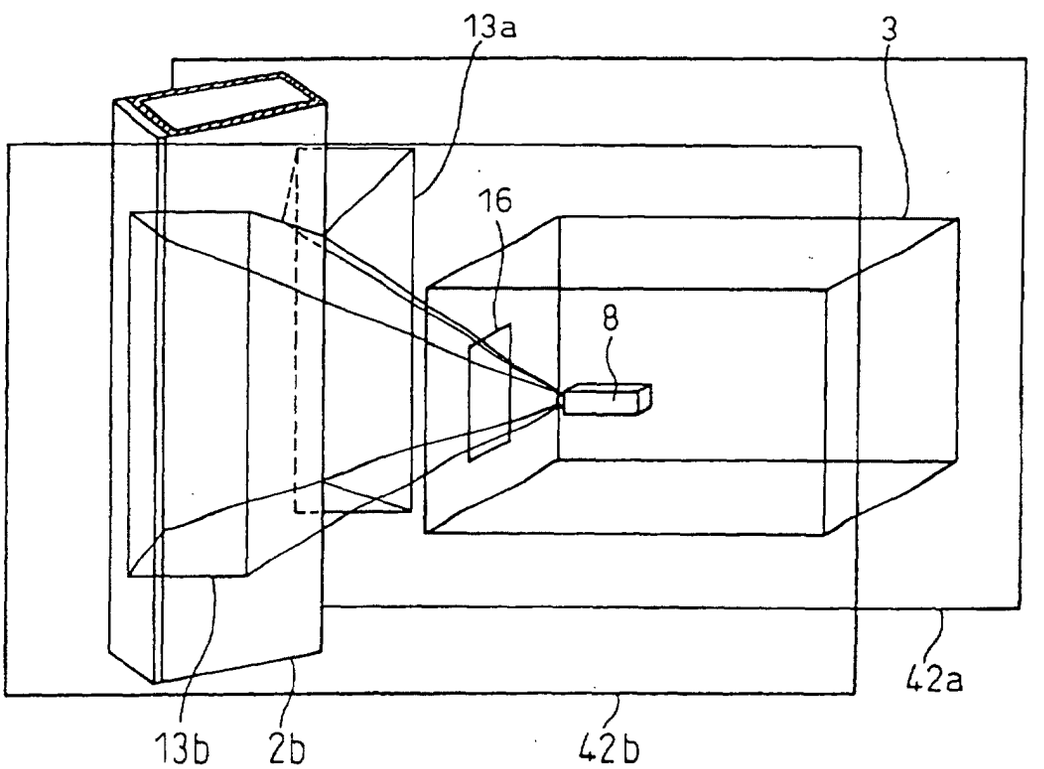

13a
3
16
8
42a
13b
2b
42b

Fig.3

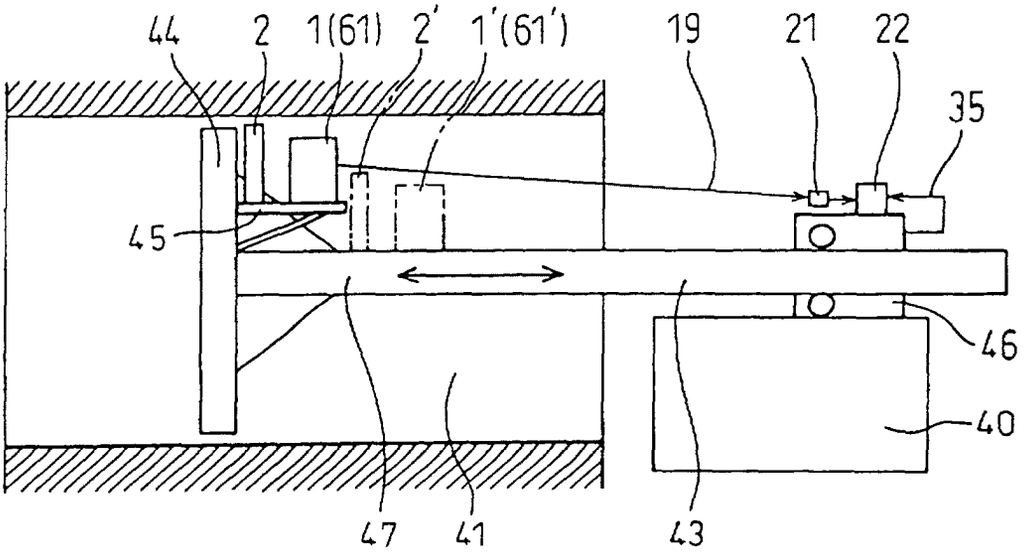

44
2
1(61)
2'
1'(61')
19
21
22
35
45
46
40
47
41
43

Fig.4

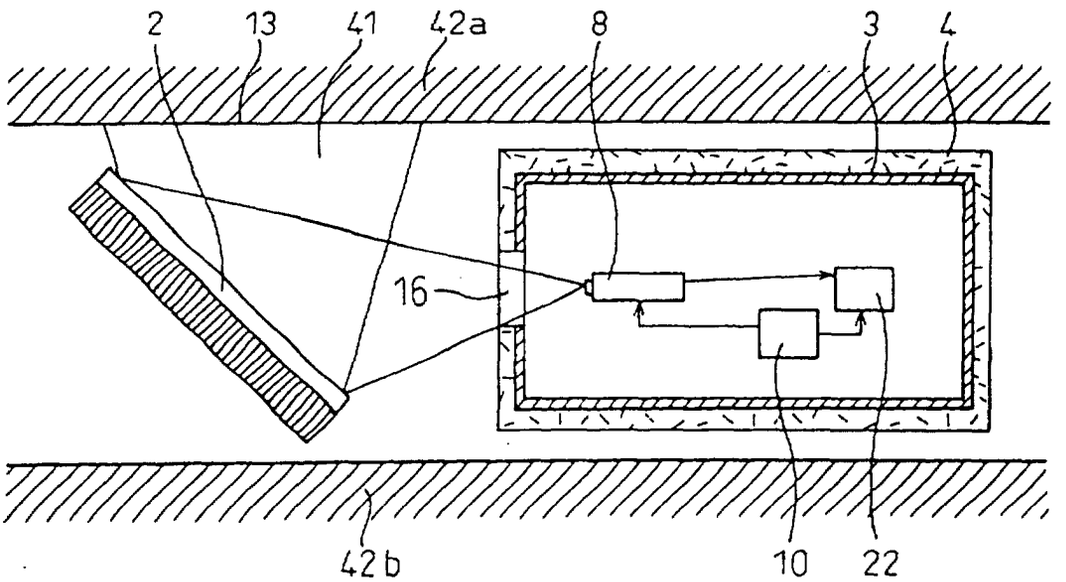

2
13
41
42a
8
3
4
16
42b
10
22

Fig.5

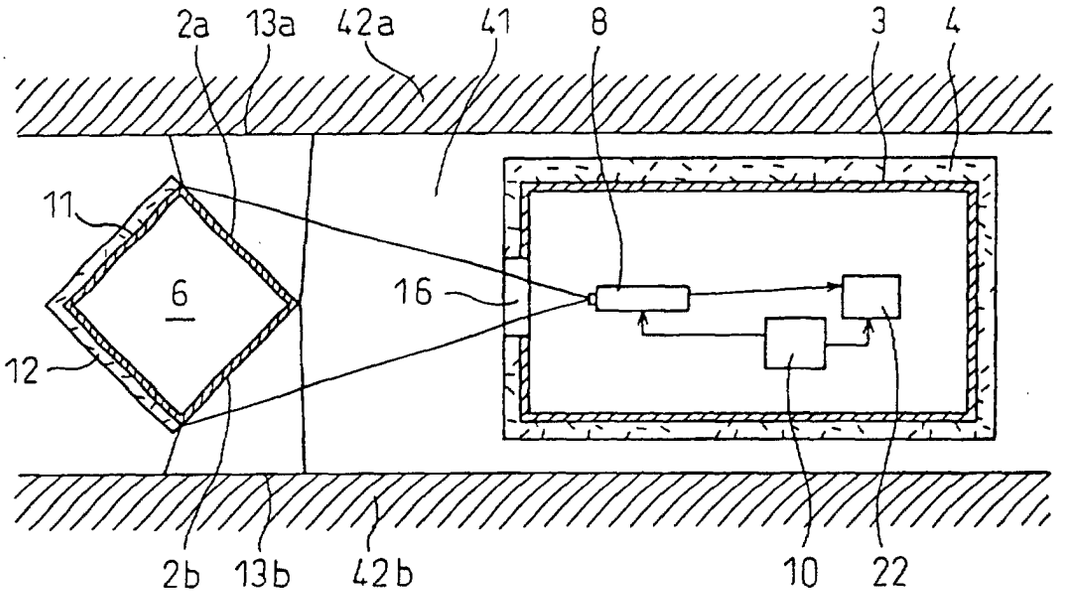

2a
13a
42a
41
8
3
4
11
6
16
12
2b
13b
42b
10
22

Fig.6

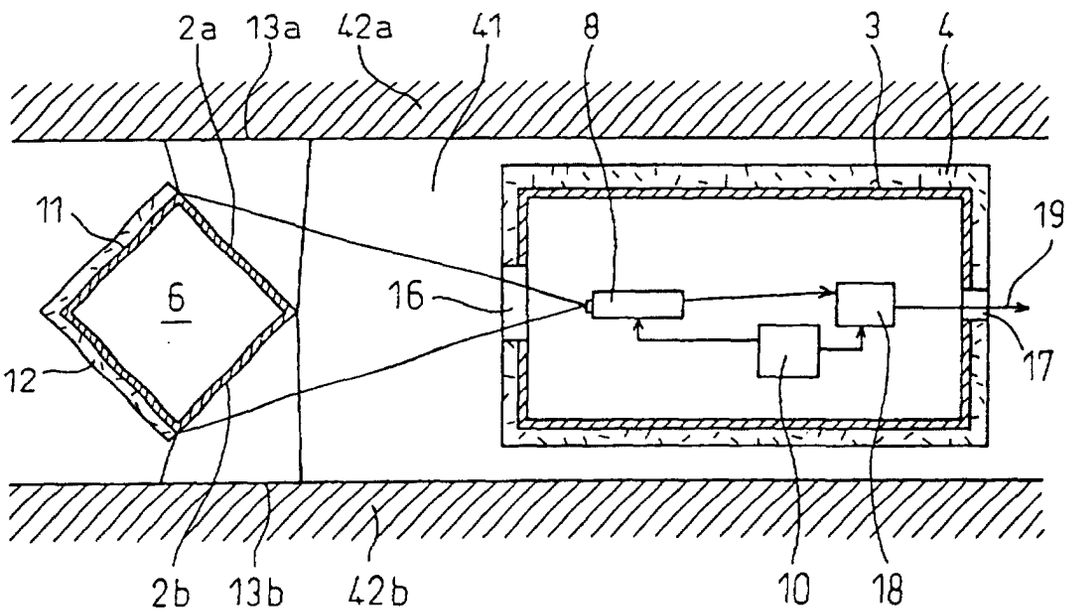

2a
13a
42a
41
8
3
4
11
6
16
19
12
17
2b
13b
42b
10
18

Fig.7

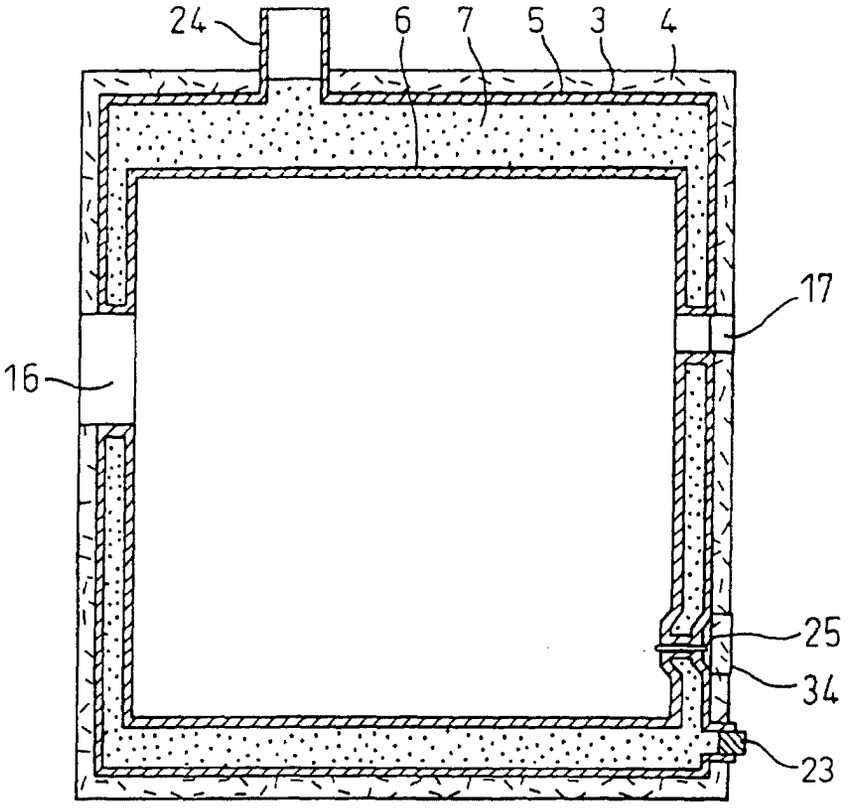


Fig.8

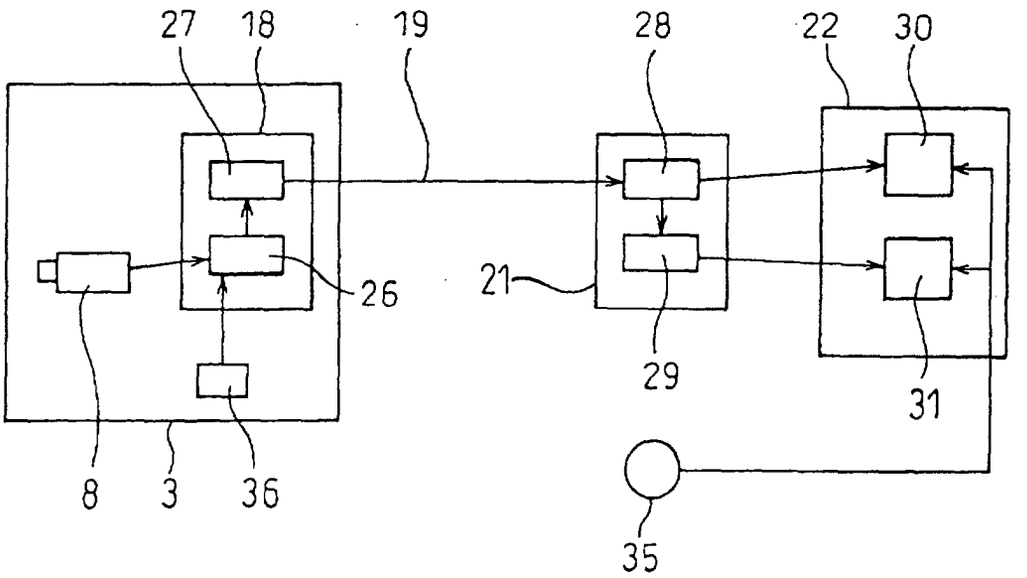
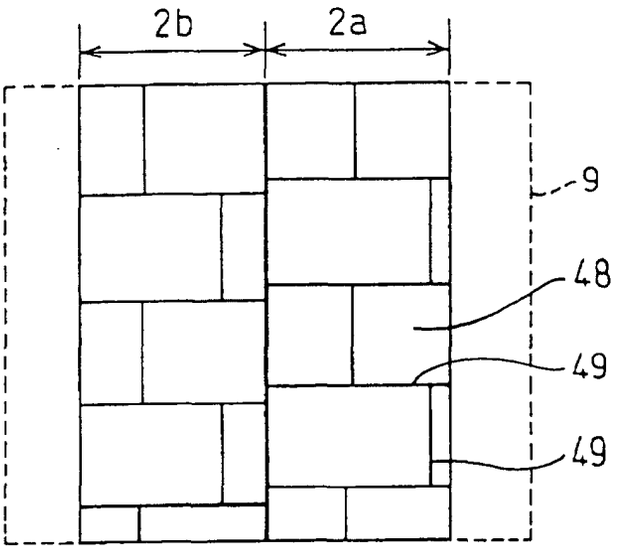
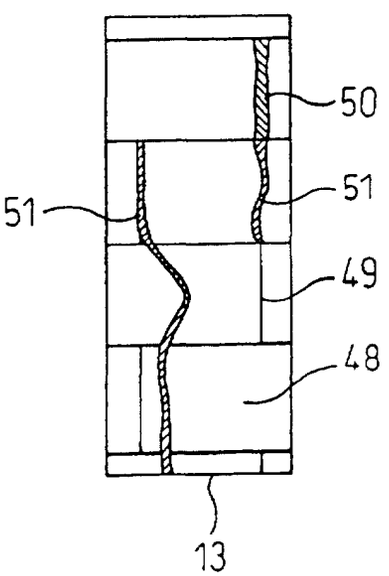


Fig.9

(a)



(b)



(c)

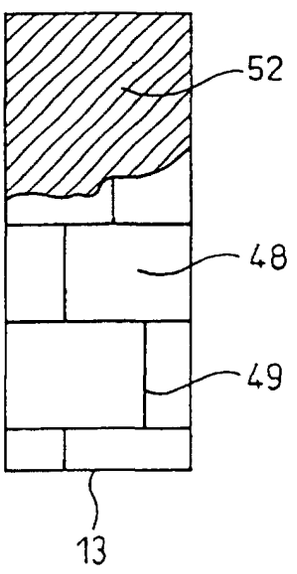
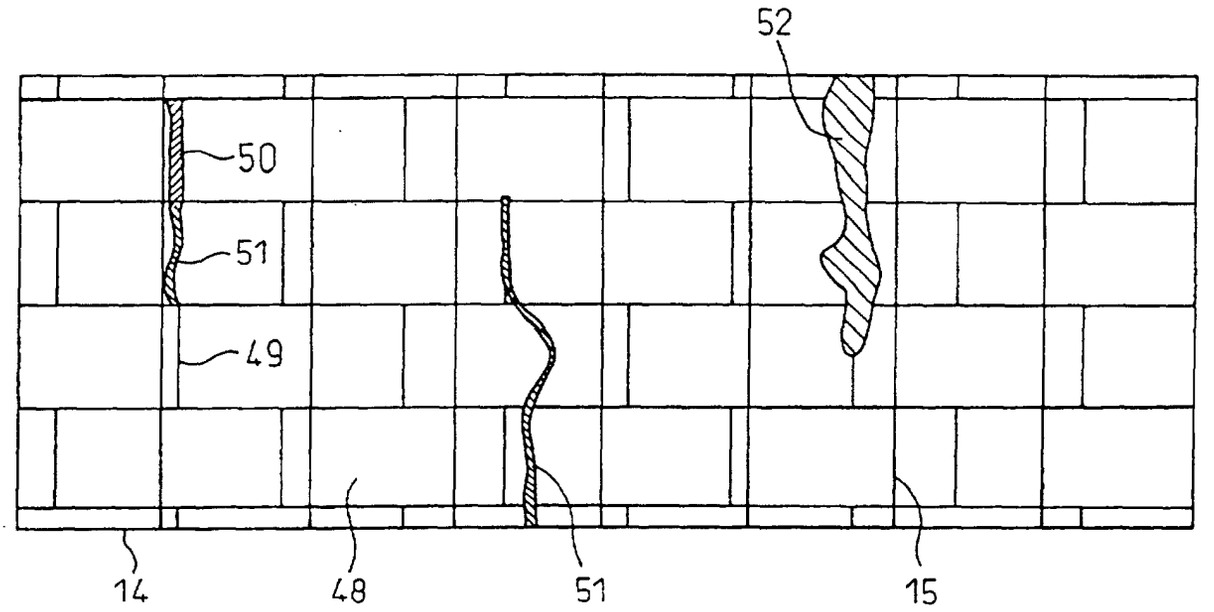


Fig.10


52
50
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49
14
48
51
15

Fig.11

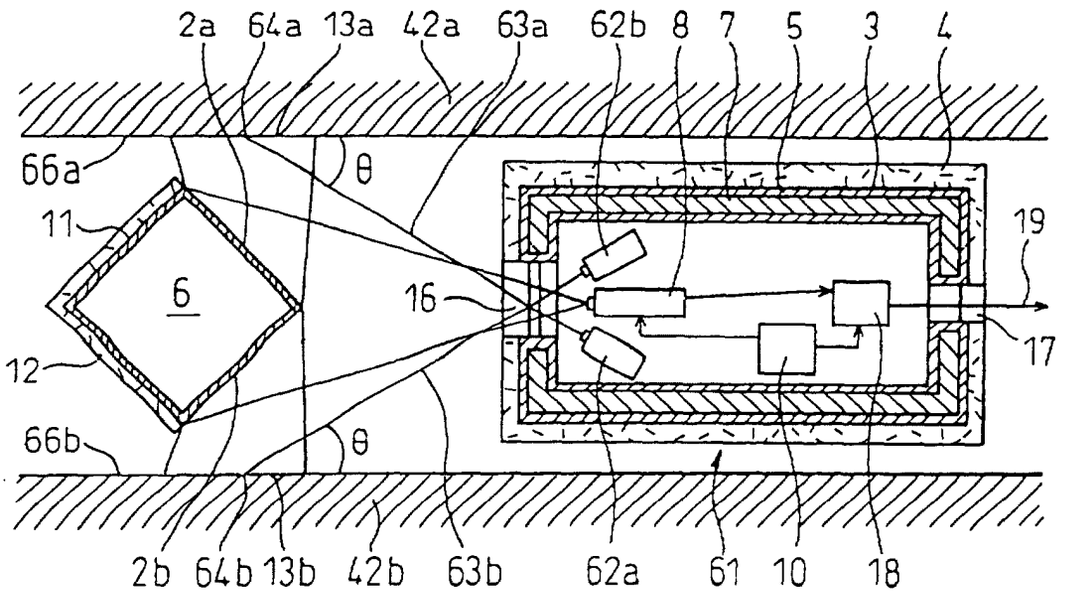
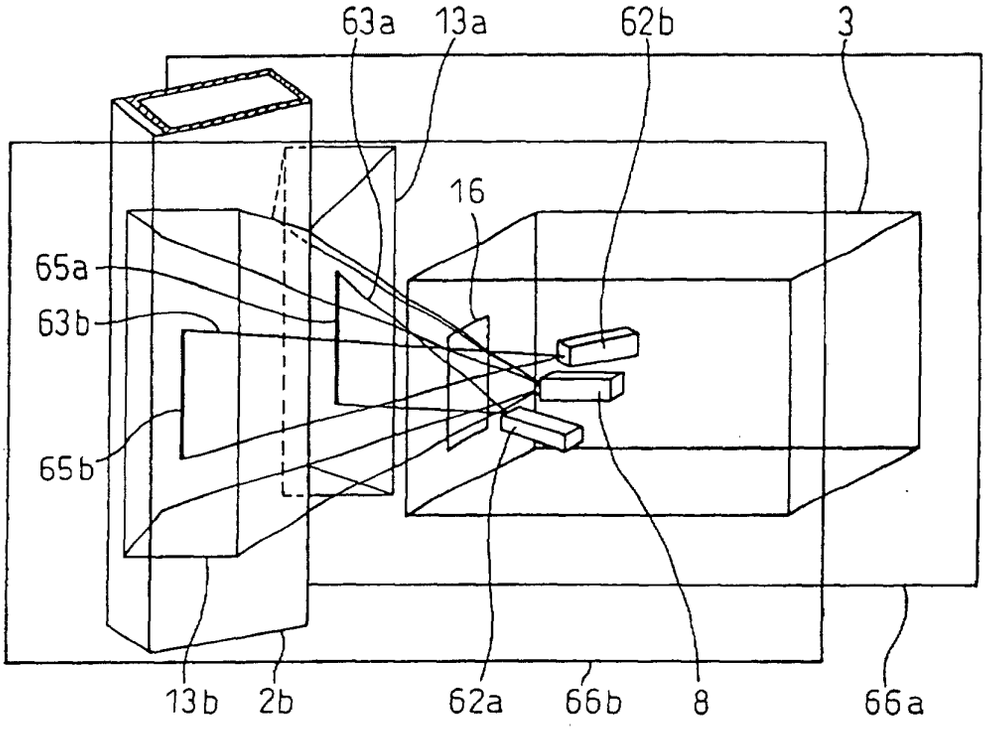

2a
64a
13a
42a
63a
62b
8
7
5
3
4
66a
θ
11
6
16
19
17
12
66b
θ
2b
64b
13b
42b
63b
62a
61
10
18

Fig.12

(a)


63a
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62b
3
16
65a
63b
65b
13b
2b
62a
66b
8
66a

(b)

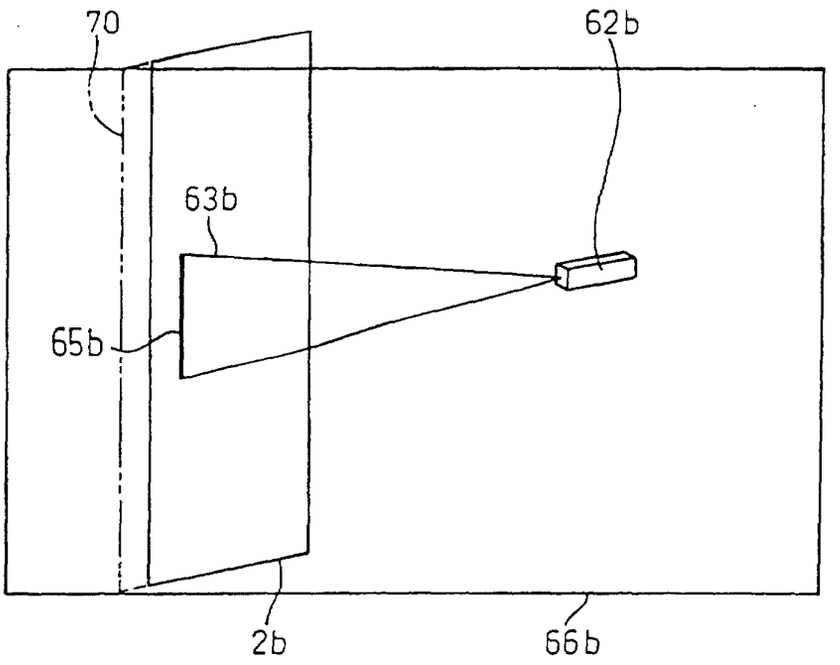

70
62b
63b
65b
2b
66b

Fig.13

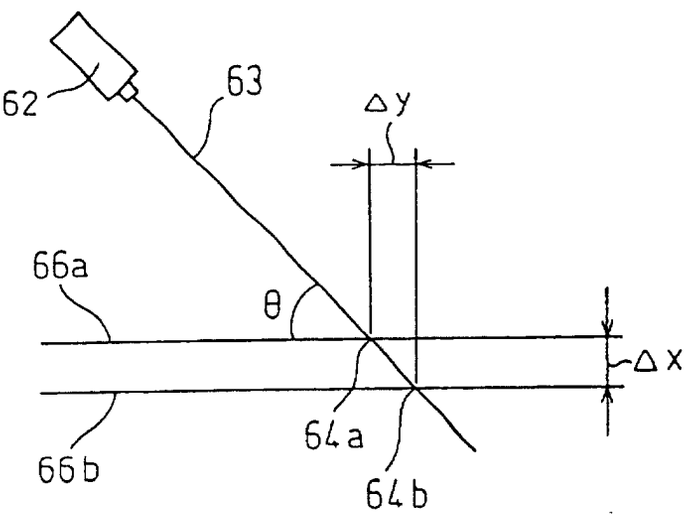
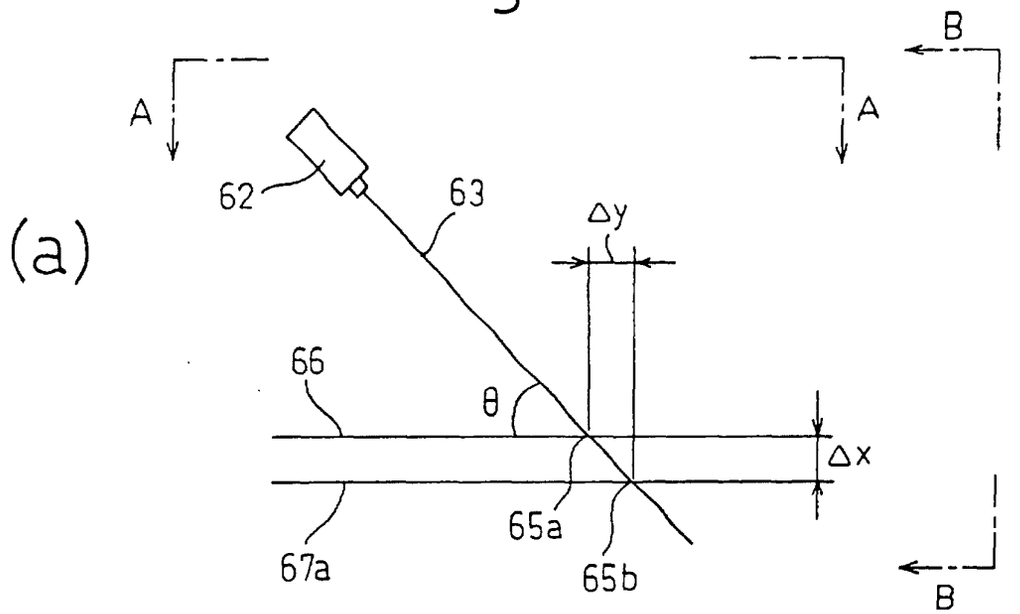
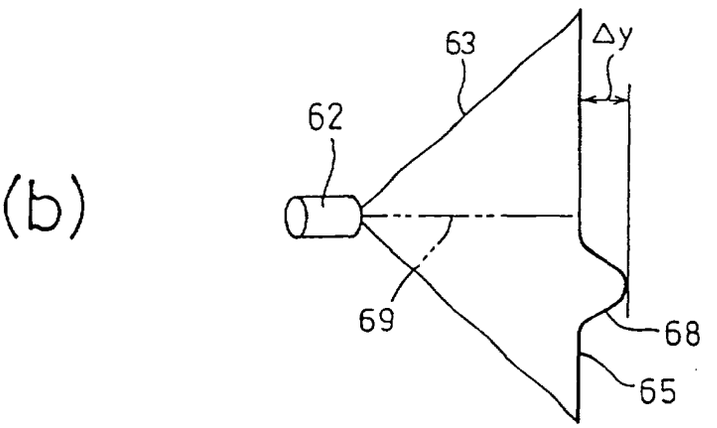


Fig.14


(a)
A
A
B
B
62
63
Δy
66
θ
Δx
65a
67a
65b


(b)
63
Δy
62
69
68
65

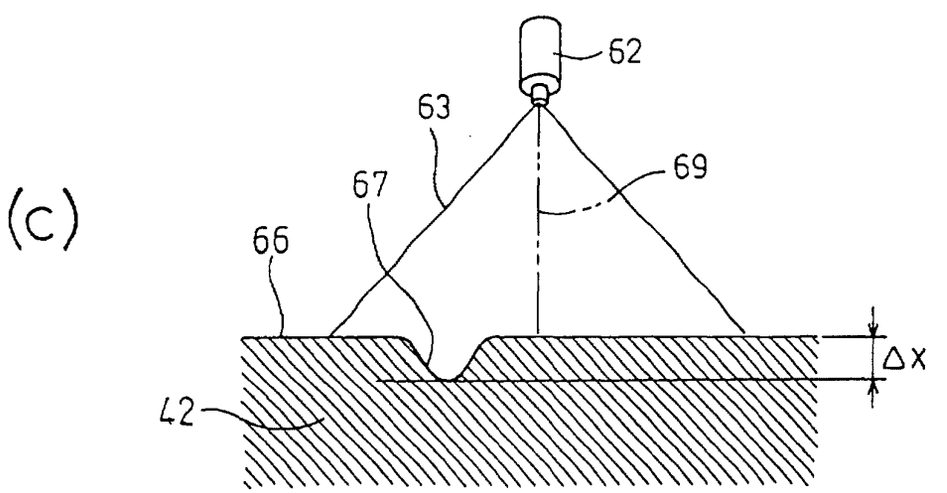
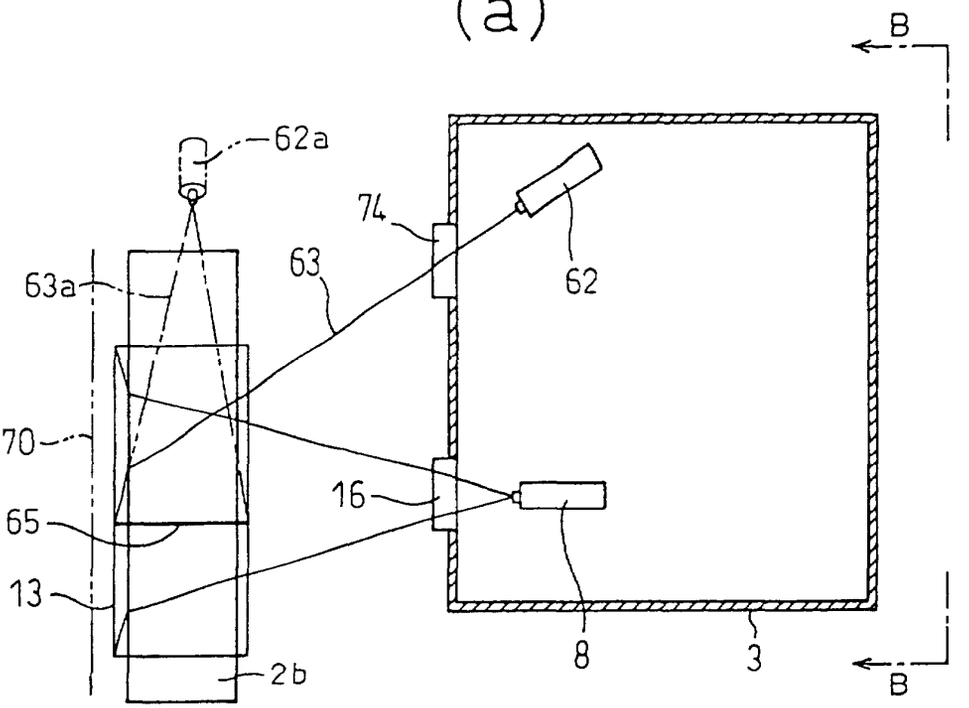

(c)
62
63
69
67
66
Δx
42

Fig.15

(a)


B
62a
74
63
62
63a
70
16
65
13
8
3
2b
B

(b)

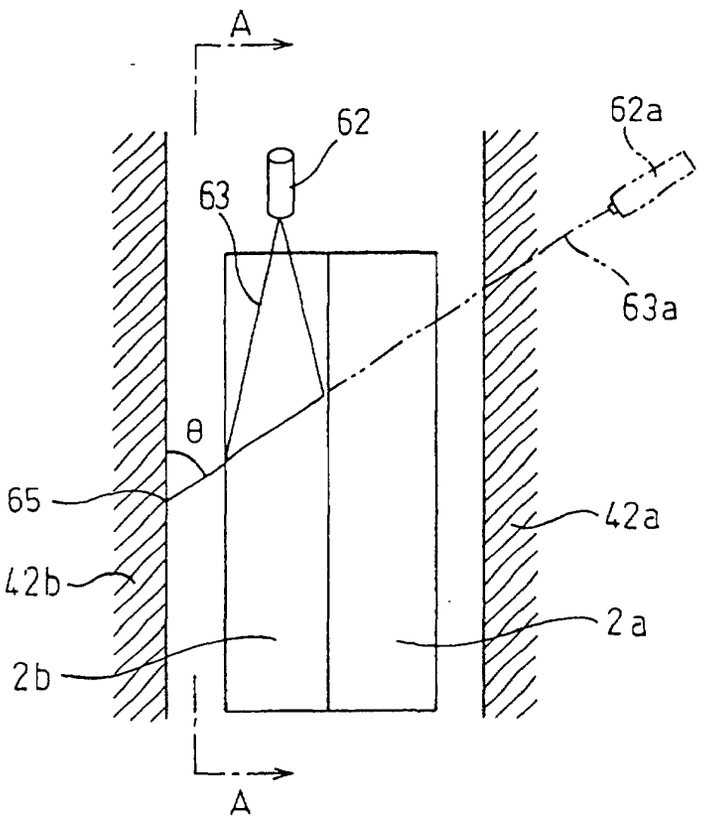
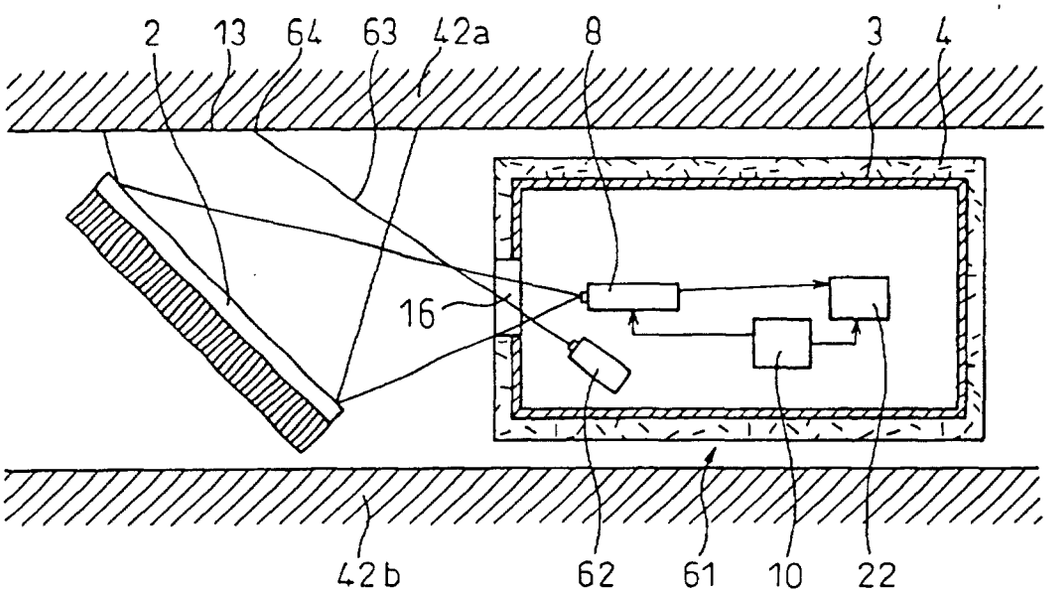

A
62
62a
63
63a
θ
65
42a
42b
2a
2b
A

Fig.16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42a
8
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4
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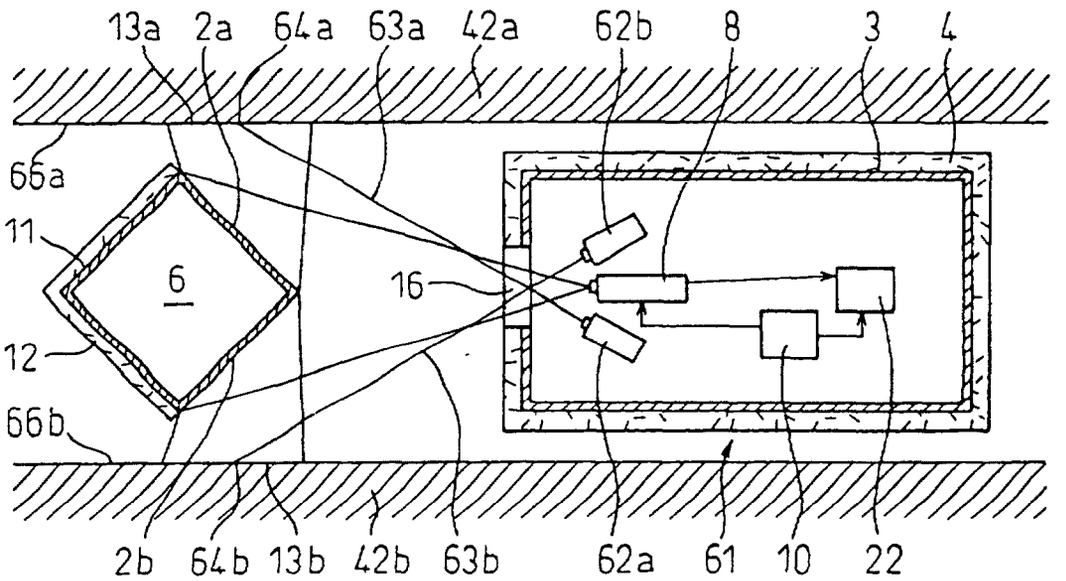
42b
62
61
10
22

Fig.17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12
66b
2b
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13b
42b
63b
62a
61
10
22

Fig.18

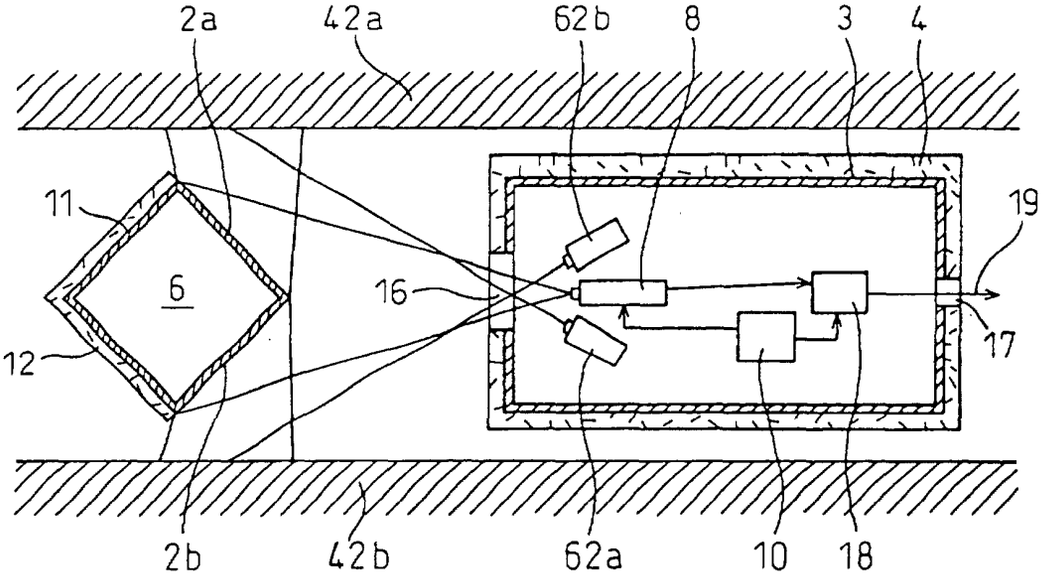
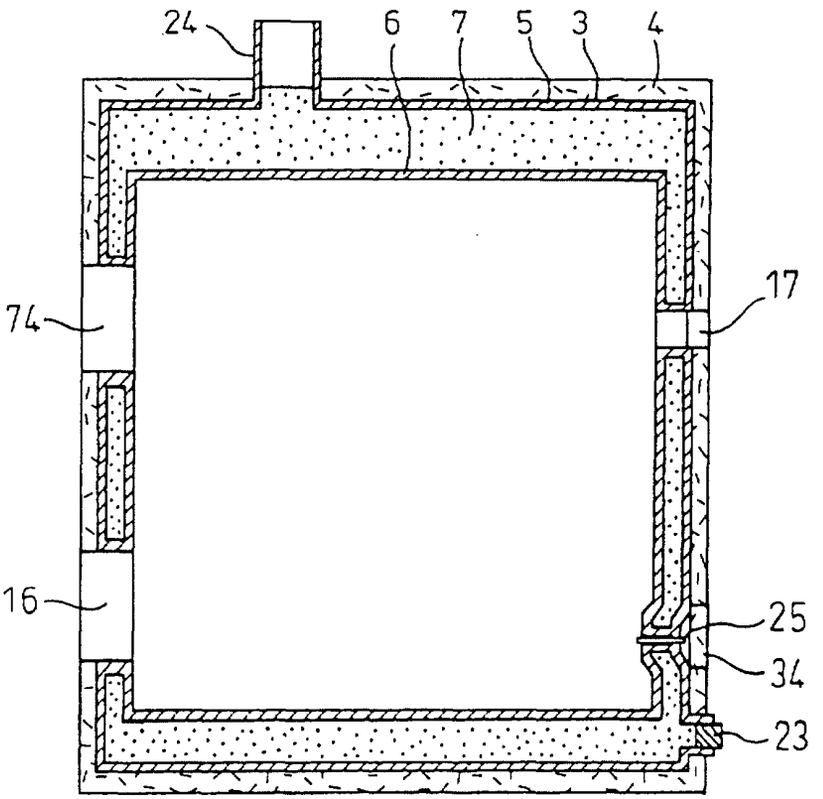

2a
42a
62b
8
3
4
11
6
16
19
12
17
2b
42b
62a
10
18

Fig.19


24
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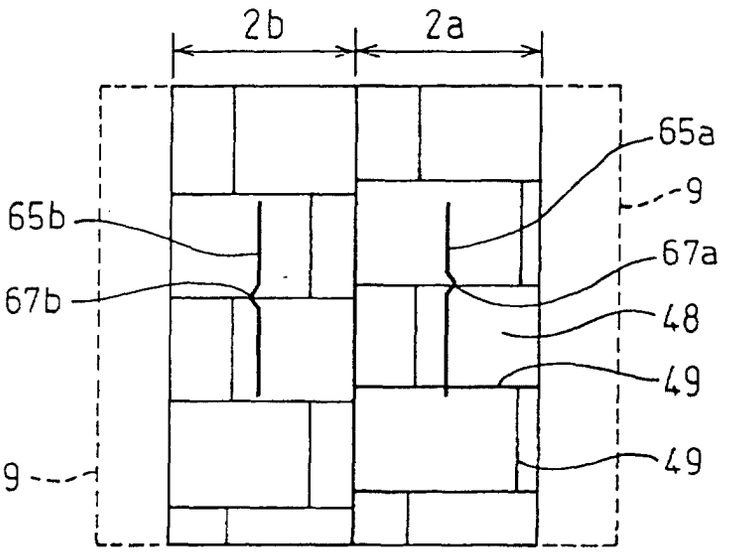
74
16
25
34
23

Fig.20

(a)



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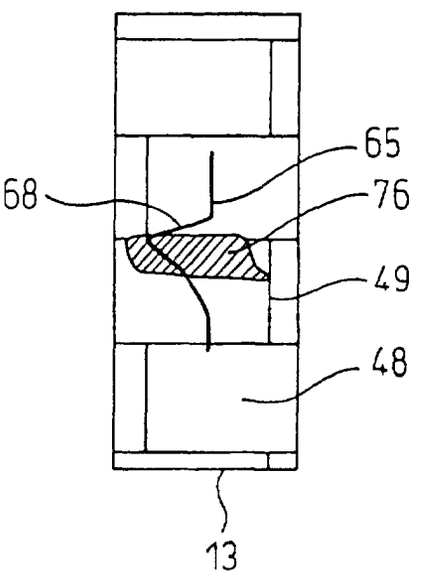
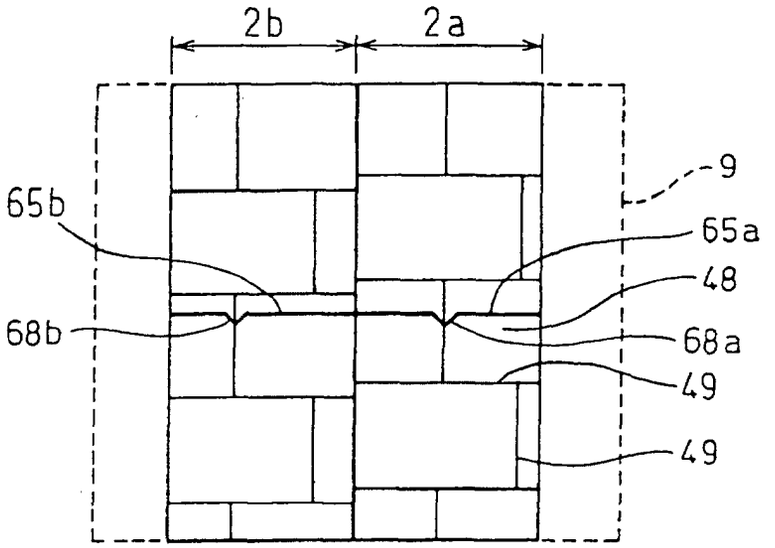
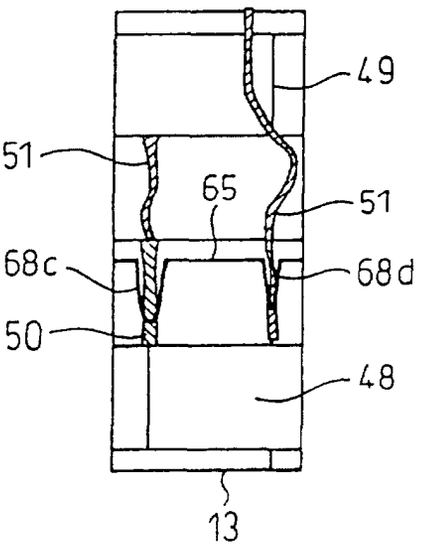


Fig.21

(a)


2b
2a
9
65b
65a
48
68b
68a
49
49

(b)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68c
68d
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48
13

(c)

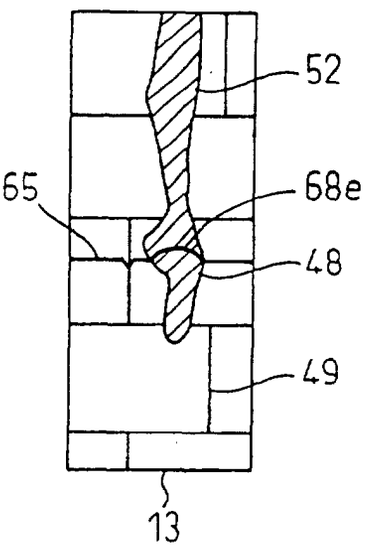
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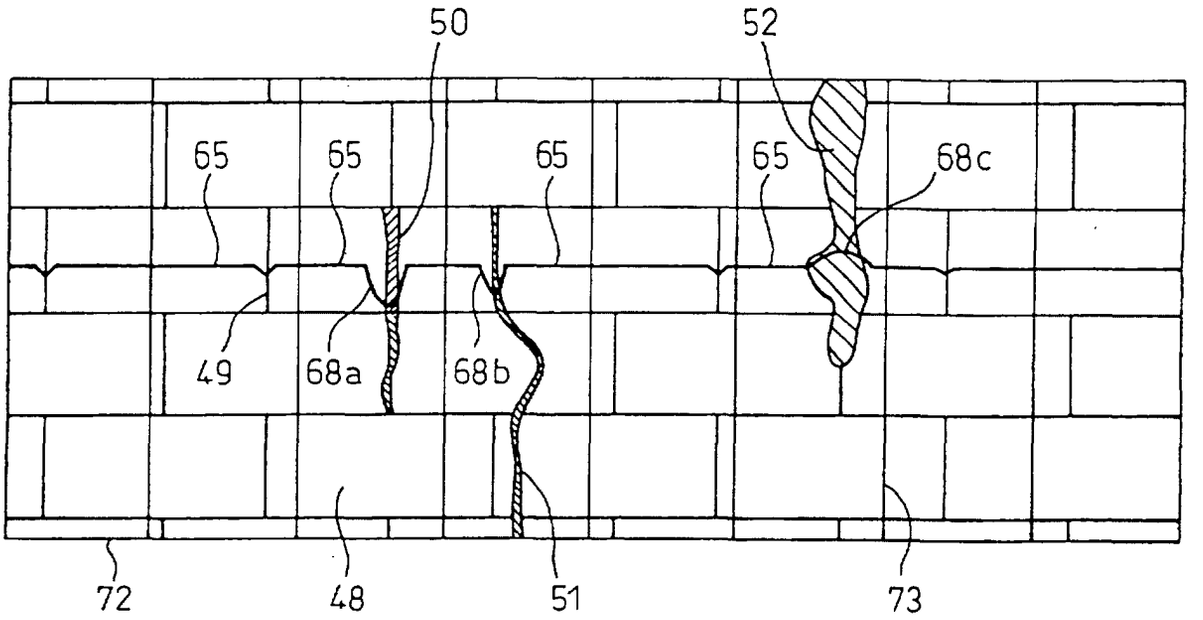
Fig.22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68c
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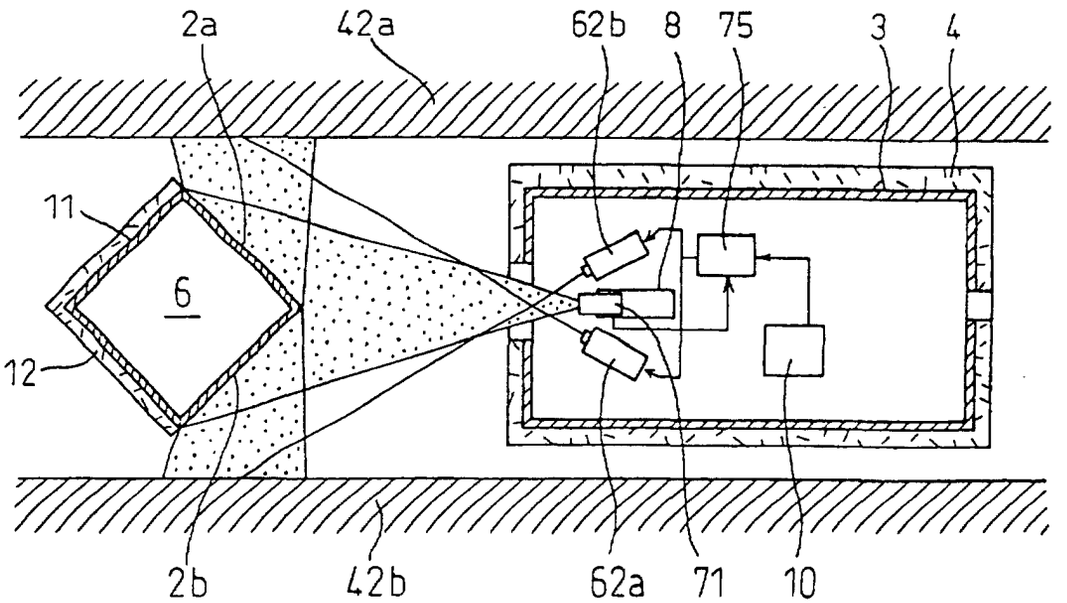
73

Fig.23


2a
42a
62b
8
75
3
4
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6
12
2b
42b
62a
71
10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/00072

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] C10B29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] C10B29/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-106755 A (Nippon Steel Corp.), 20 April, 1999 (20.04.99), (Family: none)	1-24
A	JP 63-263390 A (Kurosaki Corp.), 31 October, 1988 (31.10.88), (Family: none)	1-24
A	EP 1167919 A1 (Nippon Steel Corp.), 02 January, 2000 (02.01.00), & WO 00/55575 A1	1-24
A	JP 3-105196 A (Kawasaki Steel Corp.), 01 May, 1991 (01.05.91), (Family: none)	1-24

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Date of the actual completion of the international search	Date of mailing of the international search report
26 May, 2003 (26.05.03)	10 June, 2003 (10.06.03)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/00072

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-3058 A (Sumitomo Metal Industries, Ltd.), 09 January, 2001 (09.01.01), (Family: none)	1-24
A	JP 2001-11465 A (Sumitomo Metal Industries, Ltd.), 16 January, 2001 (16.01.01), (Family: none)	1-24
A	EP 832408 A1 (Nippon Steel Corp.), 01 April, 1998 (01.04.98), & WO 97/38278 A1 & US 6002993 A & JP 9-279147 A	1-24
P,A	WO 02/40615 A1 (Nippon Steel Corp.), 31 July, 2002 (31.07.02), (Family: none)	1-24

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