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Watanabe

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[54] **VENTILATION METHOD AND APPARATUS WITH DUST COLLECTION BY ELECTRIC STATIC PRECIPITATOR**

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[52] **U.S. Cl.** ..... **98/115 R,** 55/13, 55/119, 55/120, 55/146, 55/149, 55/151, 55/228, 55/240, 55/385, 55/DIG. 29, 75/25, 98/36, 266/15

[51] **Int. Cl.** **B03c 3/28,** B03c 3/41, B03c 3/53

[58] **Field of Search** ..... 55/124, 126, 146, 151, 55/149, DIG. 29, 13, 119, 120, 228, 240, 385; 98/36, 115 R, 115 K; 75/25; 266/15, 16, 17, 18, 19

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Primary Examiner—Dennis E. Talbert, Jr.
Attorney, Agent, or Firm—Sherman & Shalloway

[57] **ABSTRACT**

A method for electrostatic dust collection which comprises introducing a dust particle- or mist-containing high temperature gas formed in the lower portion of a building into a dust-collecting passage provided with a charging electrode and a dust-collecting electrode face, said dust-collecting passage being formed in a ventilating chamber provided in the upper portion of the building and connected with both a suction port mounted at the lower end of said ventilating chamber and an exhaust port mounted on a roof or side wall of said ventilating chamber; forwarding said dust particle or mist-containing high temperature gas through said dust-collecting passage in which an electrostatic field is formed, along said charging electrode and substantially in parallel thereto; thus catching dust particles or mists contained in the gas on the dust-collecting electrode face; and discharging the gas into the exterior of the ventilating chamber, and apparatus therefor.

13 Claims, 10 Drawing Figures

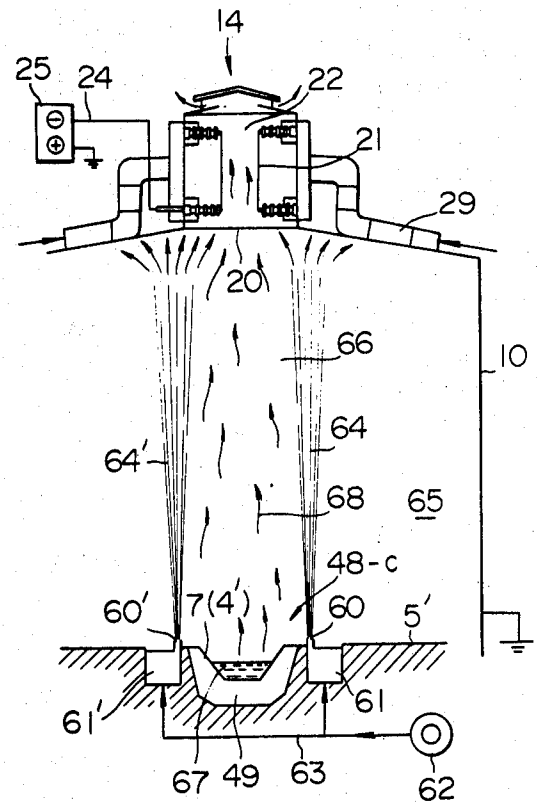

Fig. 1

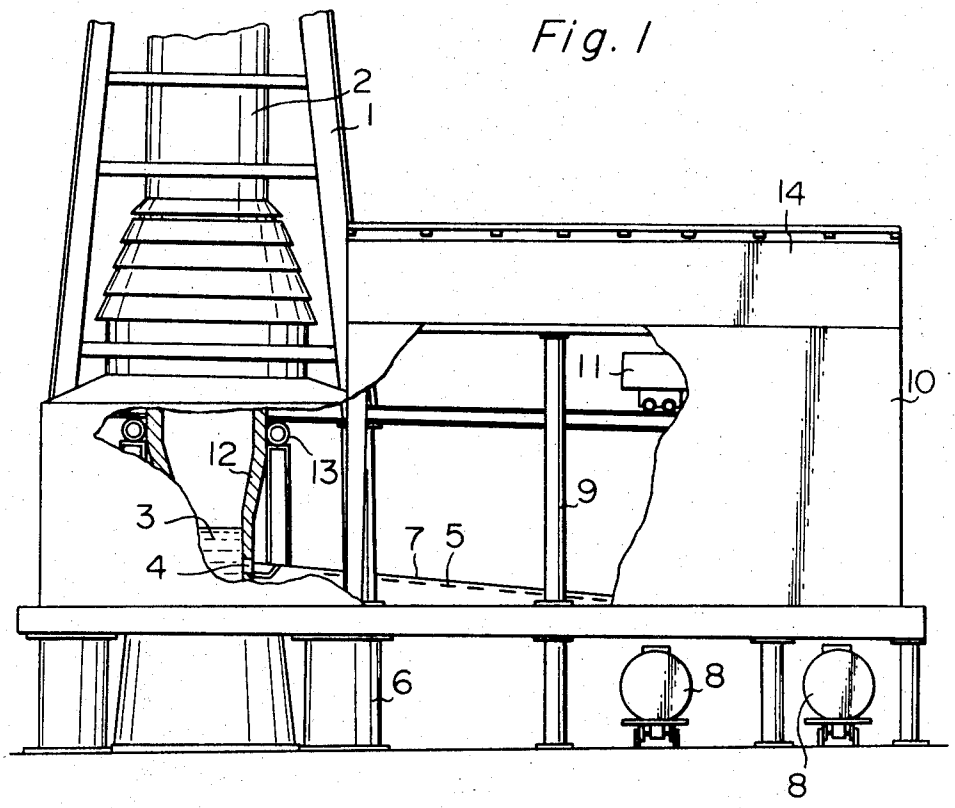

Fig. 2

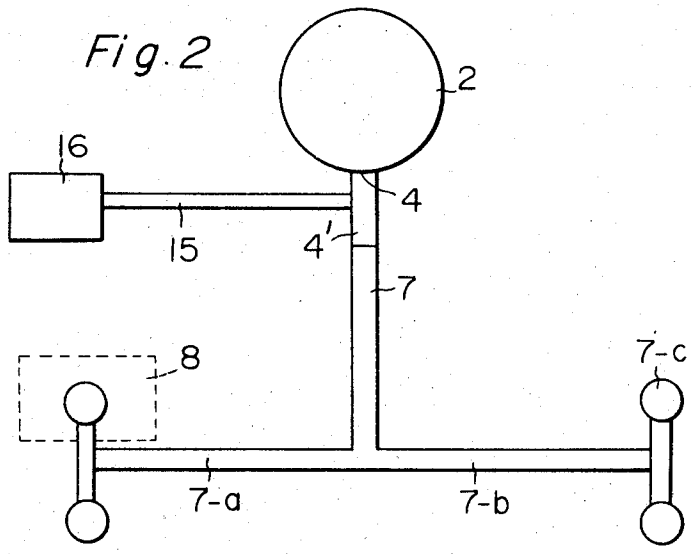

Fig. 3

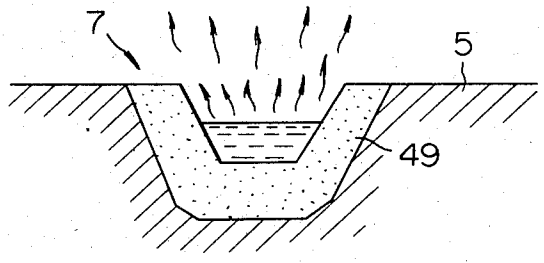

Fig. 4

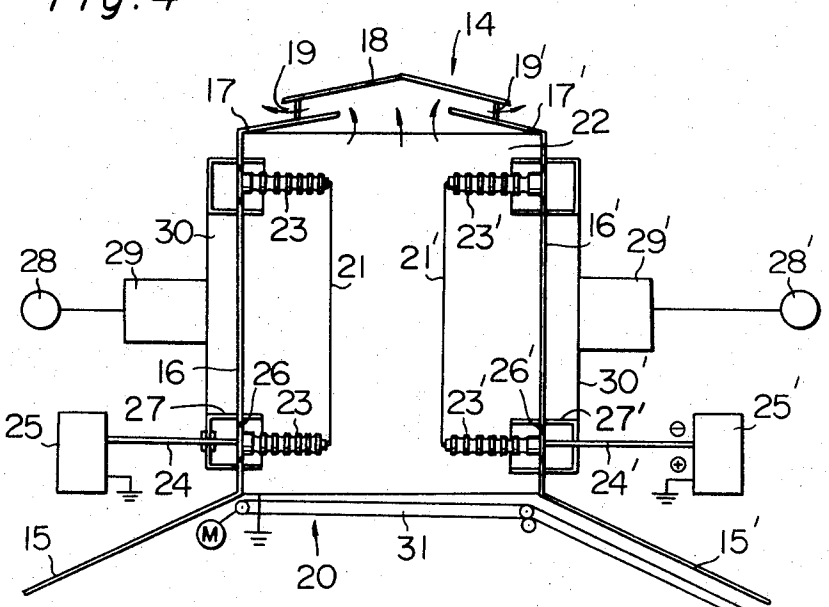
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Fig. 5

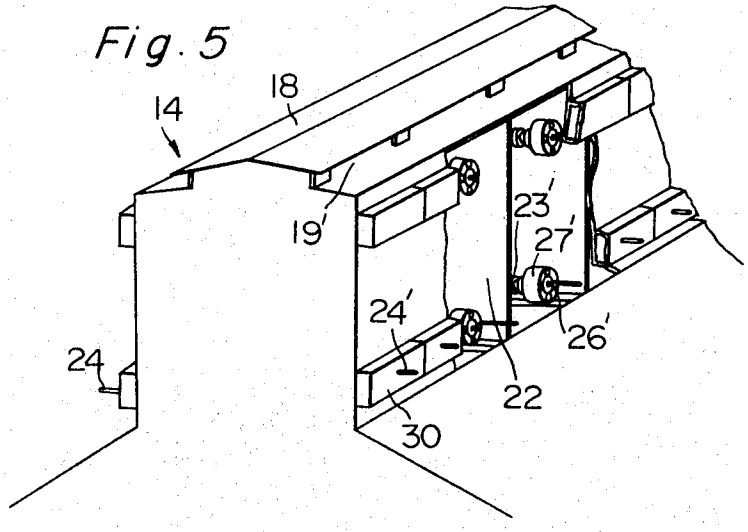
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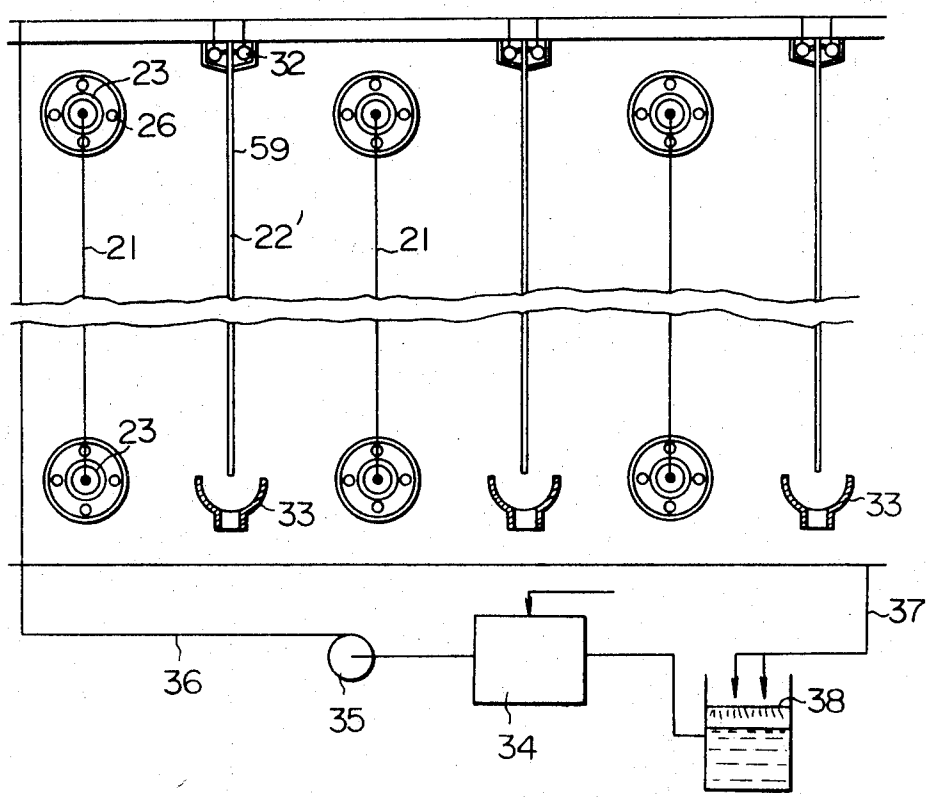
Fig. 6



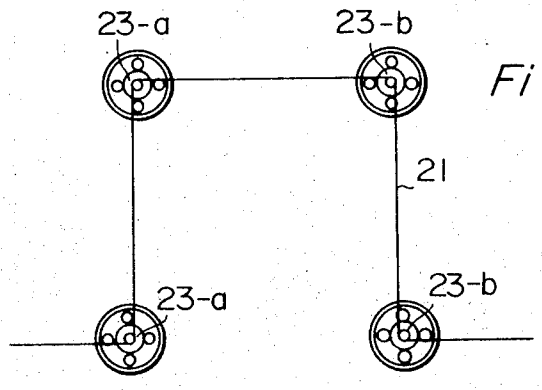
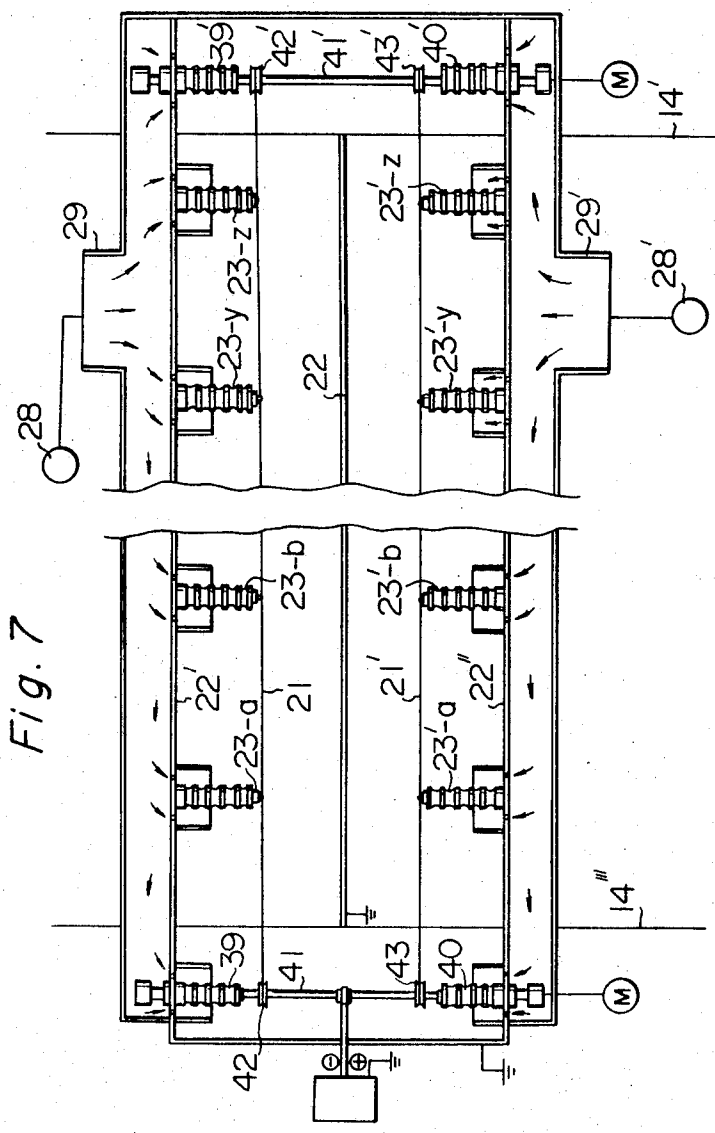


Fig. 8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23-y
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23-b
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23-a
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Fig. 7

Fig. 9

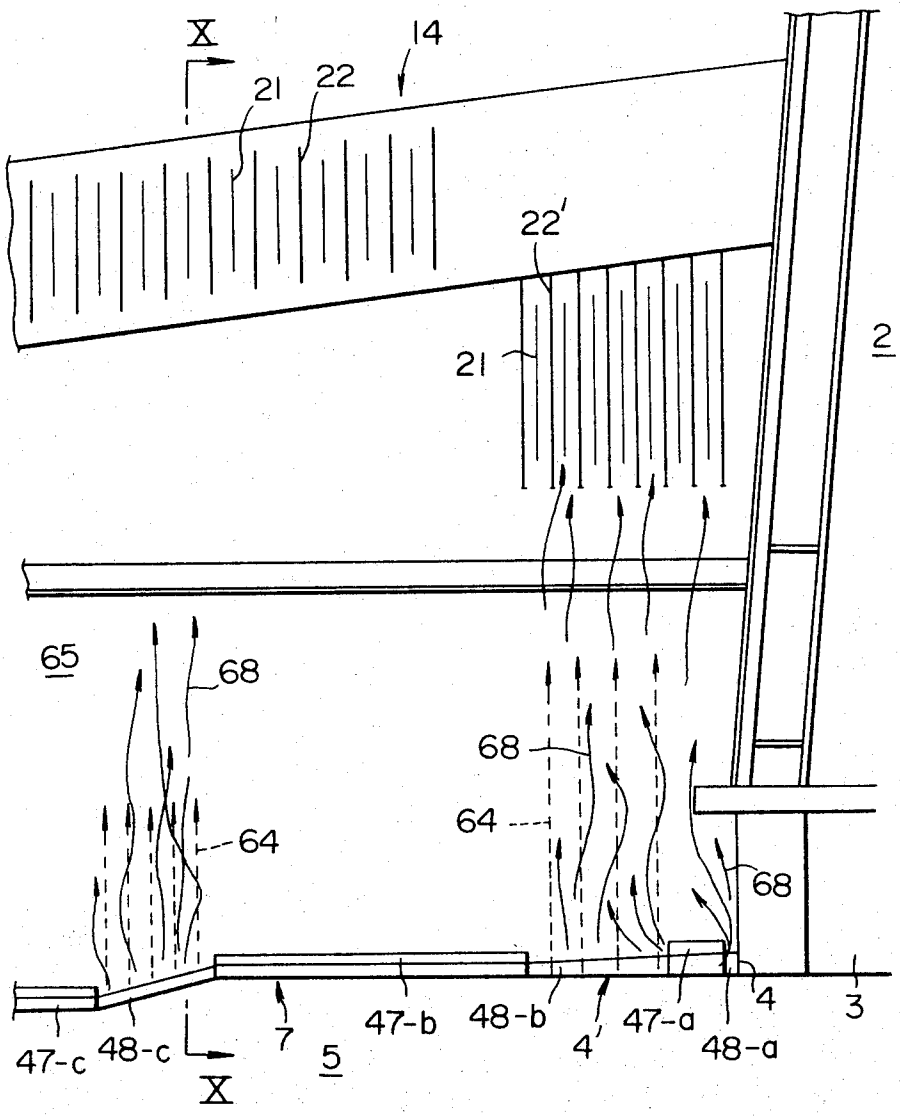
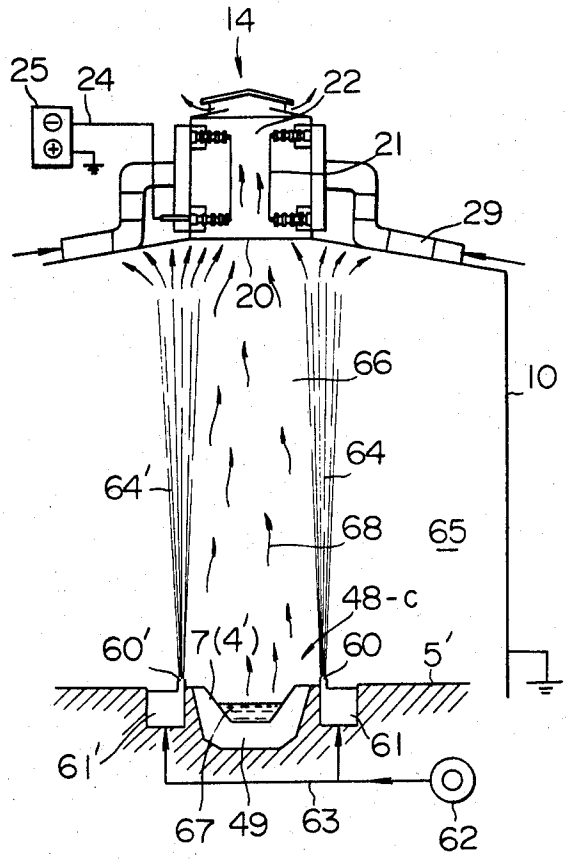


Fig. 10



VENTILATION METHOD AND APPARATUS WITH DUST COLLECTION BY ELECTRIC STATIC PRECIPITATOR

This invention relates to a method and apparatus for collecting dust electrostatically. More particularly, the invention relates to a method for electrostatic dust collection in which a dust particle-or mist-containing gas formed inside a building is directly introduced into a ventilating chamber provided in the upper portion of the building and the electrostatic dust collection is effected in said ventilating chamber, and to an apparatus for practising this method.

Heretofore, in blast furnaces of iron mills, an operation of taking out molten pig iron in a blast furnace from a tap hole provided on a so-called casting house and introducing it through an iron runner provided on the floor of the casting house to mixing car is repeated several times per day. At this iron delivery operation, fumes of fine iron oxide rise from molten pig iron and these fumes of iron oxide are discharged as smoke in the air from a ventilating chamber (monitor). Accordingly, in a building of the casting house, a crane, an iron knoch opener, a mud gun, etc. are provided for opening (boring) or closing tap holes. Further, repair and maintenance of the iron runner and inspection of molten pig iron should be effected. Therefore, it is generally difficult to provide equipment for dust collection or smoke discharge in the building of the casting house, and hence, in the actual working a gas containing particles of iron oxide, which is formed at the operation of molten iron delivery, is discharged directly in the air.

It may be considered to collect dust from such high temperature gas containing particles of dust by providing a smoke exhaust duct and introducing the dust particle-containing gas through this duct to a customary Cottrell precipitator. The customary Cottrell precipitator accomplishes dust collection electrically by passing a dust particle-containing gas through an electric field formed between confonting electrodes. However, the dust catching efficiency by the Cottrell precipitator is low, especially in the case of fine particles. For instance, dust particles having a size less than 1 micron cannot be effectively caught by the Cottrell precipitator. Furthermore, when it is intended to conduct both smoke discharge and dust collection effectively while preventing the building of the casting house from being filled with fumes of iron oxide formed at the molten iron delivery operation, it is necessary to provide extremely large duct, fan and dust collector. However, provision of such equipment is quite impossible from the actual standpoint.

Not only in a building of the above mentioned casting house of a blast furnace, but also in buildings of an open-hearth furnace and a converter in an iron mill, a building of a casting house in an iron foundry and buildings of chemical factories provided with a calcination furnace, a roasting furnace, a drying furnace, a melting furnace and the like, dust particle- or mist-containing high temperature gases are similarly formed in working areas of such buildings, and performance of dust collection is required.

It is a primary object of this invention to provide a method and apparatus in which a dust particle-or mist-containing high temperature gas formed in a working area of a building can be directly subjected to the electrostatic dust collection operation in a ventilating chamber provided in the upper portion of the building.

Another object of this invention is to provide a method and apparatus in which a dust particle- or mist-containing high temperature gas formed in a working area of a building can be introduced directly to a ventilating chamber provided in the upper portion of the building by utilizing the upward current of this gas and the electrostatic dust collection can be effectively accomplished in this ventilating chamber.

Still another object of this invention is to provide a method and apparatus for electrostatic dust collection in which a dust particle- or mist-containing high temperature gas formed in a working area of a building can be subjected to the dust collection operation in a ventilating chamber provided in the upper portion of the building without employing an exhaust duct or exhaust fan and without reduction of the operation efficiency in the working area of the building.

A further object of this invention is to provide a method and apparatus for dust collection in which an iron oxide fume formed in a casting house is moved toward the upper portion of the casting house building in the form of an upward curent in a space surrounded by an upward current of a gas different from the iron oxide fume-containing gas while preventing the working area of the casting house building from being filled with the iron oxide fume, to thereby introduce the iron oxide fume into a dust collector mounted in a ventilating chamber provided in the upper portion of the casting house building, and thus particles of iron oxide can be effectively removed.

A still further object of this invention is to provide a method and apparatus for removing an iron oxide fume formed in a casting house, in which examination or inspection of molten pig iron delivered can be conducted with ease and a danger of workers' falling into an iron delivery passage can be greatly reduced.

In accordance with this invention, there is provided a method for electrostatic dust collection which comprises introducing a dust particle- or mist-containing high temperature gas formed in the lower portion of a building into a dust-collecting passage provided with a charging electrode of a fine wire form and a dust-collecting electrode face confronting to the charging electrode, said dust-collecting passage being formed in a ventilating chamber provided in the upper portion of the building and connected with both a suction port mounted at the lower end of said ventilating chamber and an exhaust port mounted on a roof or side wall of said ventilating chamber; forwarding said dust particle- or mist-containing high temperature gas through said dust-collecting passage in which an electrostatic field is formed between said charging electrode of a fine wire form and said dust-collecting electrode face, along said charging electrode of a fine wire form and substantially in parallel thereto; thus catching dust particles or mists contained in the high temperature gas on the dust-collecting electrode face; and discharging the gas from which dust particles or mists have been substantially removed, into the exterior of the ventilating chamber.

In accordance with this invention, there is also provided an apparatus for electrostatic dust collection which comprises a working area provided in the lower portion of a building in which a dust particle-or mist-containing high temperature gas is formed; a ventilating chamber provided in the upper portion of the build-

ing, said ventilating chamber being connected with said working area through a suction port mounted at the lower end of the ventilating chamber and opened to the open air through an exhaust port mounted on a roof or side wall of the ventilating chamber; and a dust-collecting passage formed in said ventilating chamber and composed of a charging electrode of a fine wire form supported by an insulating member and a dust-collecting electrode face confronting to said charging electrode, an electrostatic field being formed between said charging electrode and said dust-collecting electrode face; said dust-collecting passage having such a length that the residence time of the dust particle- or mist-containing gas passing through the inside of the dust-collecting passage by natural convection is at least 5 seconds, and said charging electrode of a fine wire form being laid along the direction of the advance of the dust particle- or mist-containing gas in the dust-collecting passage.

The invention will now be described by reference to embodiments illustrated in accompanying drawings in which:

FIG. 1 is a partially cut-out side view showing a casting house in a blast furnace;

FIG. 2 is a ground plan illustrating the plan arrangement of the casting house shown in FIG. 1;

FIG. 3 is a view explaining formation of an iron oxide fume;

FIG. 4 is a sectional view illustrating the front of a ventilating chamber according to one embodiment of this invention;

FIG. 5 is a partially broken perspective view showing the ventilation chamber illustrated in FIG. 4;

FIG. 6 is a view illustrating the section of a dust-collecting pss passage according to another embodiment of this invention and also showing diagramatically the dust-collecting system;

FIG. 7 is a sectional view illustrating a dust-collecting passage according to still another embodiment of this invention;

FIG. 8 is an arrangement plan illustrating the state of fitting of a charging electrode of a fine wire form shown in FIG. 7;

FIG. 9 is a sectional view illustrating the side of one embodiment of dust-collecting apparatus of this invention; and

FIG. 10 is a cross-sectional view taken along the line X—X in the apparatus shown in FIG. 9.

In FIG. 1, a furnace proper 2 of a blast furnace is supported vertically by a blast furnace stanchion 1, and a tap hole 4 is provided on a hearth 3 of the furnace proper 2 or in the vicinity of the hearth. One or a plurality of such tap holes 4 are formed around the furnace proper 2. A casting house 5 is provided circumferentially or radially to surround the hearth 3 of the furnace proper 2, and is supported by a stanchion 6. On the floor of the casting house 5, there is provided an iron runner 7 (iron passage) for take-out of molten pig iron, which extends from the tap hole 4 straightly or radially in the appropriately branched form. Molten pig iron flowing out of the tap hole 4 moves on said runner and is charged into a mixing car 8 standing by below the casting house. A building 10 is provided above the floor of the casting house 5 and supported by a stanchion 9. The inside of the building 10 forms a working area. An iron knoch opener (not shown) for opening the tap hole at the time of molten iron delivery or a mud gun (not shown) for closing the tap hole at the end of the molten iron delivery operation is adapted inside the building 10 at a part adjacent to a furnace body 12. A ring-like blast main 13 is disposed around the furnace body 12 to feed hot air into the furnace. In the interior of the building 10, a crane 11 is mounted to transfer materials and devices necessary for operations at the casting house. In the upper portion of the building 10, a ventilating chamber 14, i.e., a small chamber generally called "a monitor", is provided to discharge an iron oxide fume formed at the casting house 5 to the exterior of the building 10. The lower side of this ventilating chamber 14 is opened to the interior of the building 10 and an exhaust chamber 14 is opened to the interior of the building 10 and an exhaust port is mounted on a roof or side wall of the ventilating chamber 14.

At the time of molten iron delivery, a seal of the tap hole is opened by the iron knoch opener and molten pig iron stored at the hearth 3 of the blast furnace is allowed to flow on the iron runner 7 of the casting house 5 from the tap hole 4 and charged into the mixing car 8 through a branched runner 7-*a* or 7-*b* and a shoot 7-*c*, as shown in FIG. 2. Slug coming out together with molten pig iron is withdrawn to a slug tank 16 through a passage 7 mounted on a tap hole 4'. At this time, a great quantity of an iron oxide fume rises from the vicinity of the tap hole 4 (hereinafter referred to as the tap hole portion) and from the runner 7 of the casting house 5, as shown in FIG. 3, and this iron oxide fume fills the working area of the building 10 and a part of the fume is discharged as a smoke into the air from the ventilating chamber provided in the upper portion of the building 10. Accordingly, the atmosphere of the working area of the casting house is extremely contaminated with this iron oxide fume, resulting in degradation of the working environment and causing serious problems on health maintenance of workers. Further, it is generally said that the amount of iron oxide dust discharged in the air by the molten iron delivery operation is in an order of a ton per day, and this causes a serious pollutional problem.

The most important feature of this invention is that a dust-collecting passage composed of a charging electrode of a fine wire form supported by an insulating member and a dust-collecting electrode face confronting thereto is provided in the above-mentioned ventilating chamber so that an electrostatic field is formed between said charging electrode and dust-collecting electrode face and a dust particle- or mist-containing high temperature gas formed in the working area positioned in the lower portion of the building is introduced in the form of an upward current into said dust-collecting passage and forwarded in the dust-collecting passage along said charging electrode substantially in parallel thereto, whereby dust particles or mists contained in the gas can be electrostatically collected effectively.

More specifically, it has been found that the dust particle- or mist-containing high temperature gas to be flown into the ventilating chamber (monitor) in the form of an upward current has a linear velocity within a range most preferred for effecting the electrostatic dust collection, and that when this dust particle- or mist-containing gas is naturally passed through the dust-collecting passage composed of a charging electrode of a fine wire form and a dust-collecting electrode face confronting thereto, along said charging

electrode of a fine wire form and substantially in parallel thereto, the dust collection can be accomplished very effectively with a relatively short length of the dust-collecting passage, as compared with any of conventional dust collectors employing a suction fan or an exhaust fan. Based on this finding, the invention has been achieved. Further, in this invention, since the whole mechanism for the dust collection is contained completely inside the ventilating chamber projecting in the upper portion of the building, the working efficiency in the interior of the building is not degraded at all.

For attaining the above feature, the ventilating chamber (monitor) indicated as a whole by reference **14** in FIGS. **4** and **5** is provided. The ventilating chamber **14** has side walls **16** and **16'** extending vertically to roofs **15** and **15'** of the building, and the upper ends of side walls **16** and **16'** are connected with roof members **17** and **17'**, respectively. The roof members **17** and **17'** have an opening **18** at the head thereof, and a cap **18** is mounted to cover this opening completely. The inside of the ventilating chamber is connected with the open air through exhaust ports **19** and **19'** formed between the side edges of the cap **18** and the roof members **17** and **17'**. A suction port **20** is provided at the lower end of the ventilating chamber **14**, and the ventilating chamber **14** is connected with the inside of the building through this suction port **20**. The structure of the ventilating chamber is not limited to one illustrated in FIGS. **4** and **5**, but exhaust ports may be formed at the upper ends of side walls **16** and **16'** of the ventilating chamber **14**, or gutters may be provided below the openings of roof members **17** and **17'**. In the ventilating chamber **14** shown in FIGS. **4** and **5**, the entire of the lower end thereof is opened to form a suction port **20**, but only a part of the lower end may be opened to form a suction port, or a wire net or foraminated plate may be provided at the lower end of the ventilating chamber **14** as a member acting as a suction port.

In accordance with this invention, a dust-collecting passage composed of a charging electrode **21** (**21'**) of a fine wire form and a confronting dust-collecting electrode **22** is provided to extend from the suction port **20** to the exhaust port **21**. It is important that the dust-collecting passage has such a length that the residence time of a dust particle- or mist-containing gas passing through the inside of the passage in the form of an upward current owing to natural convection is at least **5** seconds, preferably at least **10** seconds, and that the charging electrode **21** of a fine wire form is provided along the direction of the advance of the dust particle- or mist-containing gas in the dust-collecting passage. In case the length of the dust-collecting passage is so short that the residence time is shorter than **3** seconds, removal of dust particles or mists, especially those having a size less than 1 μ, cannot be accomplished effectively. From this point, the length of the dust-collecting passage is so adjusted that the residence time of the gas in the dust-collecting passage is at least 5 seconds, preferably at least 10 seconds. On the other hand, in case the length of the dust-collecting passage is so long that the residence time is more than 15 seconds, any particularly prominent effect cannot be obtained but the loss of the pressure of the dust particle- or mist-containing gas becomes great and the equipment cost becomes high. Accordingly, it is preferred that the length of the dust-collecting passage is so adjusted that the residence time of the gas in the dust-collecting passage is 10 to 15 seconds. Further, in this invention, by providing the electrode **21** (**21'**) of a fine wire form along the direction of the advance of the dust particle- or mist-containing gas passing through the inside of the dust-collecting passage, it is made possible to move floatingly dust particles or mists in the direction traversing the electrostatic field formed between the charging electrode of a fine wire form and the confronting dust-collecting electrode, and therefore, even when the residence time is relatively short, the dust collection can be accomplished effectively. In this invention it is most preferred that, as is illustrated in FIGS. **4** and **5**, the dust-collecting passage is formed vertically and the charging electrode of a fine wire form is also laid vertically, but as far as the loss of the pressure of the dust particle- or mist-containing gas is not extremely great, the dust-collecting passage and the electrode of a fine wire form may be provided in an oblique to lateral direction.

In this invention, the dust-collecting passage and the charging electrode of a fine wire form to be laid in said passage are arranged in the above-mentioned manner and at the same time, the dust particle- or mist-containing gas is allowed to pass through the dust-collecting passage in the form of an upward current, whereby fine dust particles or mists can be caught without use of an exhaust duct or fan at such a high catching efficiency as cannot be expected in conventional electrostatic dust collectors. In the case of natural ventilation, the linear velocity of the dust particle- or mist-containing gas running through the inside of the dust-collecting passage is generally within a range of from 0.3 to 3 m/sec. Accordingly, it is prefered that arrangements are made so that the linear velocity of the dust particle- or mist-containing gas running through the inside of the dust-collecting passage is within a range of from **0.3** to 3 m/sec, especially from 0.5 to 2 m/sec. At a linear velocity lower than 0.3 m/sec, a sufficient removal of smoke from the building cannot be attained and the building is sometimes filled with smoke. In order to attain a linear velocity higher than 3 m/sec, it is necessary to make the length of the dust-collecting passage too great. Therefore, either too high a linear velocity or too low a linear velocity is not preferred.

It is preferred that the diameter of the charging electrode **21** (**21'**) of a fine wire form is, for instance, less than 1 mm, especially 0.3 to 0.6 mm. This charging electrode of a fine wire form provides an effective electric field of corona discharge between the charging electrode and the confronting dust-collecting electrode, and the activity of charging floating dust particles or mists is much higher than the charging activity of the electrode in the conventional Cottrell precipitator. Thus, electrification and collection of fine dust particles or mists can be accomplished very effectively. A voltage applied between the charging electrode and dust-collecting electrode varies depending on the kind of the dust to be removed, the distance between both the electrodes and other factors, but in general, it is preferred that a voltage of 100 to 200 KV, especially 120 to 170 KV, is applied between both the electrodes. In the case of a voltage lower than 100 KV, sufficient dust-collecting effects cannot be attained, and in the case of a high voltage exceeding 200 KV, any particular advantage cannot be attained by increasing the voltage but practical difficulties are brought about in connec-

tion with high voltage-generating apparatus or insulating members. In general, the distance between the charging electrode and dust-collecting electrode is 40 to 100 cm, preferably 50 to 80 cm. In case this distance is greater than 100 cm, sufficient dust-collecting effects cannot be obtained, and on the other hand, when this distance is smaller than 40 cm, the cross-sectional area of the dust-collecting passage through which the gas is allowed to run becomes small, resulting in economical disadvantages. In this invention it is especially desired that the distance between both the electrodes and the voltage are so chosen that an average field intensity in the dust-collecting passage is from 1.0 to 2.5 KV/cm. The length of the dust-collecting passage varies depending on the kind of the dust or mist to be removed, but in general, the length is selected within a range of from 2 to 20 m, especially from 4 to 10 m, so as to maintain the residence time and linear velocity of the gas at the above-mentioned levels.

Various installing methods may be adopted for providing the charging electrode **21** of a fine wire form and the dust-collecting electrode **22** in the ventilating chamber **14.** For instance, as is illustrated in FIGS. **4** and **5,** insulating members **23** (**23'**) such as porcelain insulators are mounted on the upper and lower ends of the side wall **16** (**16'**) of the ventilating chamber **14,** and the charging electrode **21** (**21'**) of a fine wire form is kept tight on the end points of insulating members **23** (**23'**). Dust-collecting electrode plates **22** are fitted in the ventilating chamber **14** in parallel to such charging electrodes **21** (**21'**) of a fine wire form, and a certain distance such as mentioned above is formed between the corresponding charging electrode **21** and dust-collecting electrode plate **22.** A plurality of pairs of such charging electrodes **21** (**21'**) of a fine wire form and dust-collecting electrode plates **22** may be provided in the ventilation chamber **14** to form a plurality of dust-collecting passages in the ventilating chamber. In other words, a plurality of dust-collecting electrode plates are provided so as to act as partition plates for a plurality of dust-collecting passages. As is illustrated in FIGS. **4** and **5,** dust-collecting electrode plates **22** may be provided either in the widthwise direction of the ventilating chamber or in the lengthwise direction of the ventilating chamber.

In this invention, the charging electrode **21** (**21'**) of a fine wire form is connected with the negative terminal on the output side of a high voltage generator **25** (**25'**) through a high voltage cable **24** (**24'**), and the dust-collecting electrode plate **22** is connected with the positive terminal on the output side of the high voltage generator **25** (**25'**). Such structure of the electrodes is preferred because in such construction of the electrodes electrical charging of dust particles or mists running through between both the electrodes can be accomplished stably and effectively.

In the structure of the dust-collecting passage illustrated in FIGS. **4** and **5,** insulators **23** (**23'**) are exposed to the dust-collecting passage, and therefore, dust particles or mists tend to deposit on the exposed surfaces of the insulators, sometimes resulting in breakage of insulation in the insulator. In order to prevent occurrence of this undesired insulation breakage, it is preferred to provide spout or nozzle **26** (**26'**) on the side walls **16** (**16'**) on which insulators **23** (**23'**) are mounted, at parts close to such insulators **23** (**23'**), and to dispose tube-like guides **27** (**27'**) so as to wrap the spout or nozzle **26** (**26'**) and the insulators **23** (**23'**), so that gas stream coming from the spout or nozzle **26** (**26'**) wipe away dust particles or mists being depositing on the insulators. For this purpose, a suitable gas is introduced from a contamination-preventive gas supply source **28** (**28'**) to the spout or nozzle **26** (**26'**) through a duct **29** (**29'**) and a distribution duct **30** (**30'**), and is flown around the insulator from the spout or nozzle **26** (**26'**).

In practising the method of this invention, an iron oxide fume formed from a tap hole **4** and an iron runner **7** of a casting house **5** shown in FIG. **1** moves upwardly in a building **10** in the form of an upward current owing to natural convection, and reaches a suction port **20** of a ventilating chamber **14** provided in the upper portion of the building **10.** The iron oxide dust particle-containing gas which reaches the suction port **20** rises gradually by natural ventilation in a dust-collecting passage composed of a charging electrode **21** (**21'**) of a fine wire form and an electrode plate **22,** between which an electrostatic field is formed, whereby dust particles of iron oxide are arrested on the surface of the dust-collecting electrode **22** effectively while they are travelling through such dust-collecting passage of a relatively short length. The gas from which dust particles of iron oxide have been substantially removed is discharged into the open air through an exhaust port **19** (**19'**) of the ventilating chamber.

Dust particles depositing on the surface of the dust-collecting electrode **22** of the dust-collecting passage are peeled off from the surface of the dust-collecting electrode **22** by the gravity at the time of deposition or after they have deposited in a prescribed thickness, for instance, about **5** to about **20** mm, and they are let to fall. In order to collect these falling dust particles, it is possible to provide, as is illustrated in FIG. **4,** a suitable dust collector **31** in the vicinity of the lower end of the dust-collecting electrode plate **22.** For instance, a conveyor mechanism may be adopted for this purpose. When it is desired to accelerate the peeling and falling of the dust particles adhered to the electrode surface, it is possible to impart a vibration to the surface of the dust-collecting electrode by means of a hammer member which is actuated intermittently. It is also possible to employ as the dust-collecting electrode plate **22** a dust-collecting electrode which moves intermittently or continuously (such as a belt or continuous film) and to effect the dust collection and the peeling of the dust particles in different zones.

Various modifications may be made to the apparatus of this invention as far as they do not deviate from the essence of this invention. For instance, as illustrated in FIG. **6,** an electrode **22'** of a plate form or a net-like or cloth-like form may be used as the dust-collecting electrode. Such electrode is disposed in parallel to the charging electrode **21** of a fine wire form with a certain distance formed therebetween. An overflowing tank or feed pipe **32** is provided at the upper end of said electrode **22'** to form a continuous water film on the electrode **22'** and lets it flow downwardly, and a recovery tank **33** is provided in the vicinity of the lower end of the electrode **22** to recover water which has flown downwardly on the electrode **22'**. More specifically, during the dust-collecting operation or the operation of cleaning the electrode surface, water is fed from a store tank **34** through a pump **35** and a pipe **36** to the overflowing tank or feed pipe **32** provided at the upper end

of the electrode 22', and the dust particle- or mist-containing liquor which has flown downwardly on the electrode 22' is introduced from the recovery tank 33 through a pipe 37 onto a filter 38. The liquor from which a filter cake of the dust particles has been separated is recycled to the store tank 34. In case a water film is formed on the electrode 22' at the time of the dust-collecting operation, this water film 39 acts as the dust-collecting electrode face coincidentally.

In this invention, it is sometimes preferred to move always the charging electrode of a fine wire form, in order to prevent deposition of dust particles or mists thereon. For this purpose, in the embodiment illustrated in FIGS. 7 and 8, dust-collecting electrodes 22, 22' and 22'' are disposed on both side walls 14 and 14' of the ventilating chamber in the longitudinal direction of the ventilating chamber. Pairs of insulators 23-*a* and 23-*a*, 23-*b*, and 23-*b*, ... are fitted on the upper and lower ends of dust-collecting electrodes 22'(22''), respectively. Charging electrodes 21 (21') are stretched so as to connect confronting insulators 23-*a* and 23-*a*, 23-*b* and 23-*b*, . . . at end points thereof and also to connect two adjoining insulators 23-*a* and 23-*b*, 23-i b and 23-*c*, . . . Rotary shafts 41 (41') driven by a motor M and supported by insulators 39 and 40 (39' and 40') are mounted on the outer portions of both side walls 14' and 14'' of the ventilating chamber, and reels 42 and 43 (42' and 43') are fitted on the rotary shafts 41 (41') to wind or unwind charging electrodes 21 and 21' of a fine wire form. Thus, the charging electrodes 21 (21') of a fine wire form extend from reels 42 (43) to reels 42' (43') through the top ends of insulators 23-*a*, 23-*a*, 23-*b*, 23-*b*, . . . At the dust-collecting operation, when one of the rotary shafts, for instance, the shaft 41, is driven by the motor M (at this time the other rotary shaft 41' is kept free), charging electrodes 21 (21') of a fine wire form are unwound from reels 42' (43'), travel through end points of each insulator and are wound onto reels 42 (43) fitted on the rotary shaft 41. When charging electrodes are allowed to travel in the above-mentioned manner during the dust-collecting operation, deposition of dust particles or mists on charging electrodes can be prevented, and if they deposit on the charging electrodes, they may be effectively removed by the contact of the charging electrodes with end points of insulators or reels. The travelling rate of the charging electrode of a fine wire form varies considerably depending on the kind and amount of dust particles or mists to be removed, but in general, it is preferred that the charging electrode is allowed to travel at a rate in an order of 50 to 500 mm per minute. When one of the reels is full of the electrode wire, the other reel is rotated and the winding is effected in the reverse direction.

In this invention, the procedure of introducing a dust particle- or mist-containing gas into the dust-collecting zone is not particularly critical, as far as it is introduced into the dust-collecting zone in the form of an upward current. However, in case this invention is applied to removal of an iron oxide fume formed in a casting house, it is preferred to adopt a method comprising projecting a gas upwardly from a gas projection opening which is provided on the floor of the casting house to surround the exposed portion of a tap hole portion or iron running in the casting house, and allowing an iron oxide fume formed from molten pig iron passing through the tap hole portion or iron running to move upwardly in a space wrapped with an upward current of the gas projected from said projection opening.

An iron oxide fume rising from molten pig iron being delivered from the blast furnace has a relatively high initial speed, for instance, about 10 m/sec, and therefore, it has a great tendency to scatter around. In the above-mentioned embodiment of this invention, by forming an upward current of a gas rising so as to wrap the exposed portion of the tap hole portion or iron running, it is made possible to introduce the iron oxide fume into the dust-collecting zone arranged in the ventilating chamber provided in the upper portion of the building of the casting house without scattering of the fume or filling of the fume in the working area of the casting house.

In the above embodiment of this invention, the gas projection opening to be provided on the floor of the casting house may be disposed in the vicinity of both side edges of the tap hole portion or iron running at the exposed port thereof. For instance, when the entire of the tap hole portion or iron running is exposed, projection openings may be disposed throughout along both side edges of the tap hole portion or iron running. In case a part of the tap hole portion or iron running is exposed and the remaining part is wrapped with a covering, projection openings may be disposed along both side edges of the tap hole portion or running only at the exposed portion thereof. In case a part of the tap hole portion or iron running is wrapped with a covering, a smoke exhaust duct may optionally be mounted on said covering.

The gas projection opening and dust-collecting device may be mounted by vaious methods. For instance, in FIGS. 9 and 10, a tap hole portion 4' formed on the floor of a casting house 5 and an iron running 7 connected to the tap hole portion 4' are partially covered with coverings 47-*a*, 47-*b* and 47-*c*, and exposed portions 48-*a*, 48-*b* and 47-*c* are left for inspection of flow of molten pig iron. As is illustrated in FIG. 10, gas projection openings 60 and 60' are provided on the floor 5' of the casting house at the exposed portions 48-*a*, 48-*b* and 48-*c* of the tap hole portion 4' or running 7 along both side edges of the running 4' or 7, namely in the vicinity of both side edges of a refractory 49 constituting the running, to project a gas in the form of an upward current. Lower ends of gas projection openings 60 and 60' are opened to the insides of feed ducts 61 and 61'. A suitable gas such as air is fed to feed ducts 61 and 61' from a suitable source 62 of compressed air through a pipe 63, and projected through gas projection openings 60 and 60' to rise in the working area 65 of the building 10 in the form of upward currents 64 and 64'. Thus, a space 66 wrapped with upward currents 64 and 64' of the gas is formed at the exposed portions 48-*a*, 48-*b* and 48-*c* of the tap hole portion 4' and iron running 7. A fume 68 is formed from molten pig iron 67 flowing on the tap hole portion 4' and running 7, and this fume 68 moves upwardly in the form of an upward current in the interior of the space 66 wrapped with upward currents 64 and 64' of the gas. Accordingly, in this embodiment of this invention, a space wrapped with an upward current of a gas projected from the gas projection opening is formed above the exposed portions of the tap hole portion 4' and iron running 7, and an iron oxide fume formed from molten pig iron rises in this space in the form of an upward current. Therefore, the working area in the building of the

casting house is not entirely filled with the iron oxide fume, and the working environment in the casting house can be highly improved. Furthermore, gas projection openings **60** and **60'** necessary for controlling the flow direction of the iron oxide fume and preventing the iron oxide fume from scattering around are provided on the floor of the casting house, and it is unnecessary to provide a device projecting in the space of the casting house, such as an exhaust duct, with the consequence that during the iron delivery operation or at the stoppage of this operation, performance of various other operations in the casting house is not hindered at all. Further, at the iron delivery operation, inspection of the flow of molten pig iron and sampling and examination of molten pig iron can be readily conducted without any particular trouble. Still in addition, since gas projection openings are provided in the vicinity of both side edges of the exposed portions of the tap hole portion or iron running, if a worker comes close to the tap hole portion or iron running by mistake, he can readily know from the presence of the projection flow of the gas that he has come close to the tap hole portion or iron running, with the result that a danger of his falling on molten pig iron can be greatly reduced. Moreover, since the circumference of the tap hole portion or iron running is shut off by the upward current of the gas projected from the gas projection opening, a great heat-insulating effect can be attained.

Since the iron oxide fume rising from molten pig iron has a relatively high initial speed, it moves upwardly at a relatively high speed in a space wrapped with the projection flow of the gas. Of course, if the speed of the iron oxide fume is heightened by the upward current of the projected gas, no trouble or disadvantage is brought about. The flow rate of the gas projected from the gas projection opening **60** or **60'** varies greatly depending on the height of the building of the casting house, the slit width of the projection opening and other factors, but in general, it is preferred that the flow rate of the projected gas is within a range of from 50 to 150 m/sec, especially from 100 to 150 m/sec. It is generally preferred that the slit width of the projection opening is within a range of from 5 to 40 cm, especially from 20 to 40 cm.

The iron oxide fume rising in the form of an upward current in the space wrapped with the gas projected from the gas projection opening reaches the ventilating chamber provided in the upper portion of the building is introduced in the dust-collecting apparatus detailed hereinabove.

As described above, the process of this invention is very effective for removing dust particles of iron oxide formed during the molten pig iron delivery operation in the casting house of a blast furnace. Those skilled in the art will apparently understand that such excellent effects can also be attained in removal of dust particles of iron oxide formed in working areas of buildings at various operations conducted in open hearth furnaces, convertors or electric furnaces in iron mills. Of course, the process of this invention can be effectively applied to removal of dust particles of iron oxide formed in buildings of iron foundries treating molten pig iron. Still further, the dust-collecting process and apparatus of this invention may be utilized broadly for removal of dust particles or mists formed in buildings of chemical factories during the working of calcination furnaces, roasting furnaces, drying furnaces or melting furnaces or during other operations.

The term "dust particles or mists" is used in the broadest sense in the instant specification to include any particulate contaminant-containing high temperature gas, and it must be noted that the term is used to express the concept including fine solid or liquid particles suspended in the air and mixtures thereof, and that so called fumes and fogs are included in this concept. Further, the "high temperature gas" includes all of gases that have a temperature higher than ambient temperature and form an upward current by natural ventilation.

By dint of the above-mentioned characteristics, this invention can attain a great technical advantage that dust particles or mists can be effectively collected and removed from dust particle- or mist-containing gases without reducing the efficiency of workings in buildings and without employing an exhaust duct or exhaust fan.

What I claim is:

1. A method for electrostatic dust collection which comprises introducing a particulate contaminant-containing high temperature gas formed in the lower portion of a building into a dust-collecting passage provided with a charging electrode of a fine wire form and a dust-collecting electrode face confronting to said charging electrode, said dust-collecting passage being formed in a ventilating chamber provided in the upper portion of the building and connected with a suction port mounted at the lower end of said ventilating chamber and an exhaust port mounted on a roof or side wall of said ventilating chamber; forwarding said particulate contaminant-containing high temperature gas through said dust-collecting passage in which an electrostatic field is formed between said charging electrode of a fine wire form and said dust-collecting electrode face, along said charging electrode of a fine wire form and substantially in parallel thereto; thus catching particulate contaminants contained in the high temperature gas on the dust-collecting electrode face; and discharging the gas from which particulate contaminants have been substantially removed, into the exterior of the ventilating chamber.

2. A method set forth in claim **1** wherein the average field intensity in said dust-collecting passage is within a range of from 1.0 to 2.5 KV/cm and the particulate contaminant-containing high temperature gas is allowed to pass through said dust-collecting passage so that the residence time of the gas in the dust-collecting passage is at least **5** seconds.

3. A method set forth in claim **1** wherein the particulate contaminant-containing high temperature gas is allowed to pass through said dust-collecting passage so that the linear velocity of the gas in the dust-collecting passage is within a range of from 0.3 to 3 m/sec.

4. A method set forth in claim **1** wherein the particulate contaminant-containing gas is introduced into said dust-collecting passage in the form of an upward current owing to natural convention.

5. A method for dust collection in a casting house which comprises projecting a gas upwardly from a gas projection opening which is provided on the floor of the casting house to surround the exposed portion of a tap hole portion and iron running; allowing an iron oxide fume formed from molten pig iron passing through the tap hole portion and iron running to move

upwardly in a space wrapped with an upward current of the gas projected from the gas projection opening; introducing the rising iron oxide fume into a dust-collecting passage provided with a charging electrode of a fine wire form and a dust-collecting electrode face confronting to said charging electrode, said dust-collecting passage being formed in a ventilating chamber provided in the upper portion of a building of the casting house; forwarding said iron oxide fume through said dust-collecting passage in which an electrostatic field is formed between said charging electrode of a fine wire form and said dust-collecting electrode face, along said charging electrode of a fine wire form and substantially in parallel thereto; thus catching dust particles of iron oxide on the dust-collecting electrode face; and discharging the gas from which dust particles of iron oxide have been substantially removed, into the exterior of the building.

6. Apparatus for electrostatic dust collection which comprises a working area provided in the lower portion of a building in which a particulate contaminant-containing high temperature gas is formed; a ventilating chamber provided in the upper portion of the building, said ventilating chamber being connected with said working area through a suction port mounted at the lower end of the ventilating chamber and opened to the open air through an exhaust port mounted on a roof or side wall of the ventilating chamber; and a dust-collecting passage formed in said ventilating chamber and composed of a charging electrode of a fine wire form supported by an insulating member and a dust-collecting electrode face confronting to said charging electrode, an electrostatic field being formed between said charging electrode and said dust-collecting electrode face; said dust-collecting passage having such a length that the residence time of the particulate contaminant-containing gas passing through the inside of the dust-collecting passage by natural convention is at least **5** seconds and said charging electrode of a fine wire form being laid along the direction of the advance of the particulate contaminant-containing gas in the dust-collecting passage.

7. The apparatus of claim **6** wherein said charging electrode is composed of an electrically conductive fine wire having a diameter not exceeding 1 mm.

8. The apparatus of claim **6** wherein a gas exhaust port is mounted on the side wall of the ventilating chamber on which the insulating member is fixed, and a cylindrical guide is mounted to surround said gas exhaust port and said insulating member, whereby particulate contaminants depositing on said insulating member is wiped away by a gas current flowing out of said gas exhaust port.

9. The apparatus of claim **6** wherein the length of said dust-collecting passage is sufficient to provide a residence time of particulate contaminant-containing gas passing through the inside of said dust-collecting passage by natural convention to at least 10 seconds.

10. The apparatus of claim **6** wherein the dust-collecting electrode comprises a plate member having a surface for forming a water film layer thereon, a water feed mechanism for feeding a water current downwardly on said plate member, and a recovery tank for receiving the water current having flown downwardly on the plate member.

11. The apparatus of claim **6** wherein said insulating member has an end portion supporting movably the charging electrode of a fine wire form, and said charging electrode of a fine wire form is travelled during the dust-collecting operation from a reel for unwinding said charging electrode of a fine wire form toward a reel for winding said charging electrode through said end portion of the insulating member.

12. The apparatus of claim **11** wherein the charging electrode of a fine wire form is travelled at a rate of 50 to 5000 mm/min.

13. Apparatus for dust collection in casting houses, which comprises a casting house provided with a tap hole portion and an iron running connected with said tap hole portion; a gas projection opening provided in the vicinity of side walls of the exposed portion of the tap hole portion and iron running; and a dust-collecting passage formed in a ventilating chamber provided in the upper portion of a building of the casting house and composed of a charging electrode of a fine wire form and a dust-collecting electrode face confronting to said charging electrode, and electrostatic field being formed between said charging electrode and said dust-collecting electrode face; said gas projection opening and dust-collecting passage being disposed in such a positional relationship that an iron oxide fume formed from molten pig iron passing through said tap hole portion and iron running rises in a space formed by an upward current of a gas projected from said gas projection opening and the iron oxide fume rising in said space is introduced into said dust-collecting passage.

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