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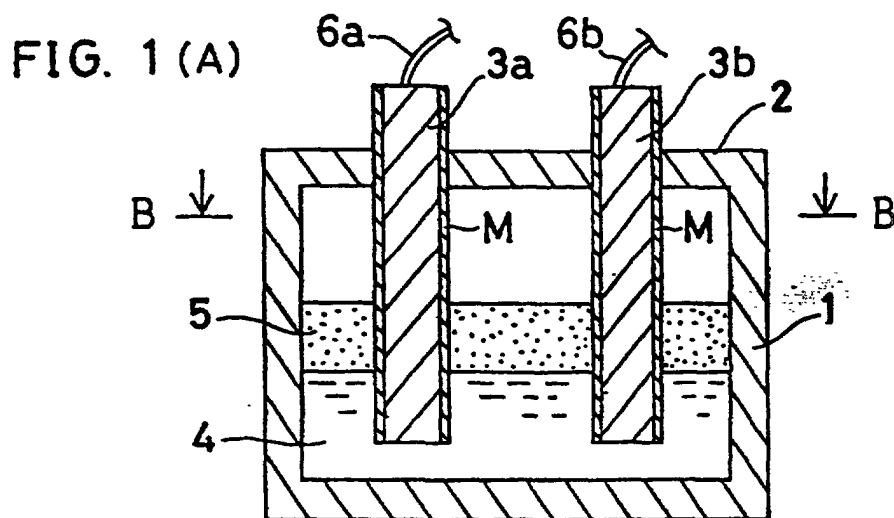
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(54) **Electric resistance type melting furnace**

(57) The electric resistance type melting furnace according to the present invention prevents deformation and destruction of graphite electrodes under high temperature conditions. In a melting furnace 1, graphite

electrodes 3a and 3b each having rectangular cross-section and with outer surface covered with a molybdenum member M are arranged, and surfaces of the graphite electrodes are positioned opposite to each other.



Description

[0001] The present invention relates to an electric resistance type melting furnace for melting and disposing incineration ashes, which are generated when general material waste and industrial waste are incinerated.

[0002] When general material waste and industrial waste are incinerated at temperature lower than 900°C, incineration ash is generated. The incineration ash contains such substances and metal components, which are detrimental to environment and harmful to human and animals. The problems related to these harmful substances such as PCB, dioxin, lead, cadmium, etc., cannot be solved by an incineration furnace using normal type of fuel. If the incineration ash is discharged to reclaimed land, water pollution or soil pollution naturally occurs. In recent years, it has been reported that metal components are eluted due to acidic rain having pH value of 3, and this adversely affects drinking water or the like.

[0003] To solve this problem, various methods have been proposed in the past in order to turn the harmful substances to harmless by melting the incineration ash. A furnace using oil and gas cannot be used for this purpose because such furnace requires a large quantity of air for combustion and it is necessary to minimize the quantity of oxygen in the furnace. Thus, an electric furnace is used for this purpose. A high frequency furnace belongs to the category of the electric furnace, but it is difficult to create a space of large capacity by the use of the high frequency furnace. An electric arc furnace generates arc between molten metal and graphite electrode and produces melt by the heat thus generated. Due to high temperature of more than 3000°C, furnace is often damaged and electrodes are worn out, and this also requires high power consumption. The most desirable furnace for this purpose must be designed in such manner that the furnace is substantially sealed to exclude intrusion of the air, and it is essential to use an electric resistance type melting furnace, which generates heat by utilizing electric resistance to inorganic melt itself and to maintain intra-furnace temperature.

[0004] As a basic patent for the electric resistance type melting furnace, Japanese Patent No. 1334791 (JP-B-60-56963) has been proposed. Description will be given now on this patent referring to Fig. 10. On a ceiling unit 102 of a melting furnace 101, three graphite electrodes 103 for 3-phase AC are penetrating the ceiling unit 102 in such manner that these electrodes can be moved up and down. Further, on the ceiling unit 102, there are provided a chute 105 for placing incineration ash 104, an air inlet 106 for supplying combustion air, and an exhaust port 107. A regulator valve 108 for regulating air quantity is provided at the air inlet 106. At the bottom of the melting furnace 101, a tapping hole 110 for discharging metal melt 109 is arranged.

[0005] Electric current is supplied to the electrodes 103, which are immersed into the metal melt 109. By

Joule's heat generated by using the metal melt 109 as resistant substance, heat higher than the melting temperature of the metal melt 109, i.e. 1400°C to 1500°C, is generated. The incineration ash 104 is supplied through the chute 105 to the entire surface of the metal melt 109. The incineration ash 104 thus supplied is sequentially melted from the portion in contact with the surface of the metal melt 109, and small quantity of exhaust gas generated at the melting is discharged through the exhaust port 107. When the incineration ash 104 is melted, metal components contained in the incineration ash are accumulated at the bottom as a molten metal layer. Inorganic melt from the incineration ash is separated and forms a glass layer above the molten metal layer. The molten metal and the inorganic melt are sequentially discharged through the tapping hole 110.

[0006] In the meantime, in the initial stage of melting process, it is necessary to tightly fill iron and copper scraps in the electric resistance type melting furnace around the electrodes 103 at the bottom of the melting furnace 101 and to supply electric current to the graphite electrodes 103 to form the metal melt 109. However, the conventional type electric resistance type melting furnace as described above is low in strength because the electrodes 103 are made of graphite, and when iron or copper scraps are tightly filled, graphite electrodes are destroyed. Also, graphite electrodes may be destroyed when electric current is continuously supplied under high temperature condition.

[0007] Also, in the conventional electric resistance type melting furnace as described above, the distance between the electrodes 103 is fixed, and melting temperature of the metal melt 109 cannot be accurately controlled. This leads to higher power consumption and inability to accurately determine the timing to charge incineration ash and also results in longer processing time.

[0008] Further, in the conventional electric resistance type melting furnace as described above, the electrodes 103 are designed in cylindrical shape regardless of the material used, and 3-phase electrode is adopted. This means that three cylinder type electrodes are used at all times. Therefore, electric current between the electrodes is distributed in form of a triangle. Electric current is concentrated at the portion where the distance between the surfaces of the cylinder type electrodes is at the shortest. In order to melt the material within short time, the electrodes must be brought closer to each other. As a result, the melting volume of the metal melt 109 is reduced. Further, unless electric current between the electrodes is distributed evenly, power factor is decreased, and it is necessary to have a reactor or a condenser for power factor improvement.

[0009] To solve the above problems, it is an object of the present invention to provide an electric resistance type melting furnace, by which it is possible to prevent deformation and destruction of graphite electrodes under high temperature condition, to reduce the damage

of the electrodes caused by the hitting of waste metal pieces against the electrodes in the initial stage of the operation, and to reduce the processing cost.

[0010] To attain the above object, the invention according to claim 1 provides a melting furnace, which comprises a plurality of graphite electrodes 3a and 3b each having rectangular cross-section and with outer peripheral surface covered with a molybdenum member M, said electrodes being disposed in a melting furnace 1, and surfaces of the graphite electrodes being positioned opposite to each other.

[0011] The invention according to claim 2 provides a melting furnace, wherein there are provided two of the graphite electrodes, and single phase power is supplied to graphite electrodes.

[0012] The invention according to claim 3 provides a melting furnace, wherein the melting furnace comprises a central electrode 3a arranged at the center of the melting furnace 1, and four graphite electrodes 3b - 3e arranged at angular spacing of 90° around the central electrode.

[0013] The invention according to claim 4 provides a melting furnace, wherein there are provided a central electrode driving unit 9 for moving the central electrode 3a in vertical direction and peripheral electrode driving units 10a - 10d for moving the peripheral electrodes 3b - 3e in horizontal direction with respect to the central electrode 3a.

[0014] The invention according to claim 5 provides a melting furnace, wherein there are provided a plurality of non-contact type temperature sensors 11a - 11d in the melting furnace 1, the electrode driving units are driven according to temperature of the incineration ash detected by the temperature sensors, and electric current between the central electrode and the peripheral electrodes is controlled.

[0015] The invention according to claim 6 provides a melting furnace, wherein an opening 23 for moving the peripheral electrodes 3b - 3e is arranged on the upper portion of the melting furnace 1 and foldable sealing plates 12 are disposed on the upper surface of the opening for moving peripheral electrodes.

[0016] The invention according to claim 7 provides a melting furnace as set forth in one of claims 1 to 6, wherein non-contact type level sensors 12a - 12d for detecting surface level of the incineration ash layer 5 in the melting furnace 1 are arranged at arbitrary points on upper portion of the melting furnace, and charging quantity of the incineration ash is controlled according to signal from the level sensors.

[0017] The invention according to claim 8 provides a melting furnace as set forth in one of claims 1 to 7, wherein a plurality of electrode plates 29 each having dielectric member 29a fixed on one side of a metal plate 29b are attached with spacing in an exhaust gas passage 33 of the melting furnace 1, plasma discharge is induced between the electrode plates 29 by applying high voltage on each of the metal plates 29b, and harm-

ful substances such as PCB, dioxin, etc. in the exhaust gas are decomposed and dissociated. The reference numerals attached to the components are given to facilitate the understanding of the present invention and to refer to the attached drawings, and the essential features of the present invention are not limited by any of these numerals.

Fig. 1 shows an embodiment of an electric resistance type melting furnace according to the present invention. Fig. 1 (A) is a longitudinal sectional view of the embodiment, Fig. 1 (B) is a cross-sectional view of the embodiment along the line B - B in Fig. 1 (A), and Fig. 1 (C) is an electric circuit diagram; Fig. 2 is a drawing to explain effects of electrodes in the present invention;

Fig. 3 shows another embodiment of an electric resistance type melting furnace of the present invention. Fig. 3 (A) is a horizontal sectional view of the melting furnace, and Fig. 3 (B) is an electric circuit diagram;

Fig. 4 shows another embodiment of an electric resistance type melting furnace of the present invention. Fig. 4 (A) is a plan view of the melting furnace, and Fig. 4 (B) is a front view of the melting furnace; Fig. 5 shows an arrangement of an electrode driving unit 10a of a movable electrode 3b in Fig. 4. Fig. 5 (A) is a side view of the above, Fig. 5 (B) is a plan view, and Fig. 5 (C) is a perspective view of a cover member;

Fig. 6 is a block diagram of a control system in the embodiment shown in Fig. 4;

Fig. 7 shows an exhaust gas purifier adopted in the electric resistance type melting furnace of the present invention. Fig. 7 (A) is a perspective view showing a partial cross-section of the exhaust gas purifier, and Fig. 7 (B) is a perspective view of an electrode plate of Fig. 7 (A);

Fig. 8 shows an electric circuit of Fig. 7;

Fig. 9 is a perspective view of the exhaust gas purifier 26 when it is mounted on the electric resistance type melting furnace 1 of the present invention; and

Fig. 10 is a perspective view of a conventional electric resistance type melting furnace.

[0018] In the following, description will be given on embodiments of the present invention referring to the attached drawings: Fig. 1 shows an embodiment of an electric resistance type melting furnace according to the present invention. Fig. 1 (A) is a longitudinal sectional view of the embodiment, Fig. 1 (B) is a cross-sectional view of the embodiment along the line B - B in Fig. 1 (A), and Fig. 1 (C) is an electric circuit diagram;

[0019] In Fig. 1 (A) and Fig. 1 (B), a metal melt 4 in the lower portion of an incineration ash layer 5 is produced by melting of metal waste before the incineration ash layer 5 is melted, and the incineration ash layer 5 is

stacked up on upper surface of the metal melt 4. Two graphite electrodes 3a and 3b each having rectangular cross-section are penetrating a ceiling unit 2 of a melting furnace 1 in such manner that the electrodes can be moved up or down. Outer peripheral surface of each of the graphite electrodes 3a and 3b is covered with a molybdenum member M, and tips of the electrodes are immersed into the metal melt 4, and the incineration ash layer 5 is placed on the metal melt 4. To the graphite electrodes 3a and 3b, power feeding cables 6a and 6b are connected respectively. As shown in Fig. 1 (C), the power feeding cables 6a and 6b are connected to power feeding terminals 7b and 7c of secondary side single phase of a power transformer 7 respectively, and connection terminals U, B and W on primary side 7a of the power transformer 7 are connected to a 3-phase power source. In the electrode of the present invention, outer peripheral surface of the graphite material is covered with molybdenum. This is advantageous in that structural strength of each electrode can be increased and the electrodes can be used up to the temperature of about 2600°C. As a result, even when incineration ash or waste metal piece hits the electrode, the electrode is not damaged and this reduces the cost for the processing. When the incineration ash layer 5 is melted, it is discharged to outside as harmless glass-like substance. Harmful or harmless metal materials charged into the melting furnace 1 are melted and are turned to alloy material and are discharged to outside.

[0020] Fig. 2 (A) shows effects of the electrodes in the embodiment shown in Fig. 1. In each of these cases, graphite electrodes 3a and 3b each having rectangular cross-section have the surfaces positioned opposite to each other. When electric current is supplied to the graphite electrodes 3a and 3b, electric current flowing to the metal melt 4 in the melting furnace 1 shows even current distribution. However, in case of the current distribution in conventional cylinder type electrodes 103, resistance value is not even because distance between the surfaces of the cylinder type electrodes is different as shown in Fig. 2 (B). Therefore, the distance between the cylinder type electrodes 103 must be reduced in order to obtain strong current required in the melting furnace, and the quantity of the melt to be processed is decreased.

[0021] Fig. 3 shows another embodiment of the electric resistance type melting furnace of the present invention. Fig. 3 (A) is a horizontal sectional view of the melting furnace, and Fig. 3 (B) shows an electric circuit diagram. In this embodiment, 5 graphite electrodes 3a - 3e each having rectangular cross-section and covered with a molybdenum member are provided. The graphite electrode 3a is arranged at the center of the melting furnace 1, and peripheral electrodes 3b, 3c, 3d and 3e are arranged at equal angular spacing around the central electrode 3a. Each of the peripheral electrodes 3b - 3e is connected to a secondary side terminal 7b of a transformer 7, and the central electrode 3c is connected to a

secondary side terminal 7c. Horizontal cross-section of the melting furnace 1 is designed in polygonal shape. Compared with the furnace having rectangular cross-section, temperature of the melt can be maintained at even level.

[0022] Fig. 4 to Fig. 6 each represents another embodiment of the electric resistance type melting furnace. Fig. 4 (A) is a plan view of the melting furnace, and Fig. 4 (B) is a front view of the melting furnace. This embodiment is an improved variation of the embodiment shown in Fig. 3. The peripheral electrodes 3b - 3e as shown in Fig. 3 are moved in horizontal direction with respect to the central electrode 3a so that electric current flowing between the central electrode 3a and each of the peripheral electrodes 3b - 3e is made variable.

[0023] In Fig. 4, the central electrode 3a is arranged at the center of the melting furnace 1, and peripheral electrodes 3b, 3c, 3d and 3e are arranged around the central electrode 3a. Each of the movable electrodes 3b - 3e is arranged at each of four positions at equal angular spacing of 90° around the central electrode 3a so that these electrodes are moved toward or away from the central electrode 3a on the horizontal plane. The central electrode 3a is mounted on a central electrode driving unit 9 so that the central electrode 3a can be moved up or down in vertical direction by an electric motor 9a. The peripheral electrodes 3b - 3e are mounted on peripheral electrode driving units 10b, 10c, 10d and 10e respectively. As a result, each of the peripheral electrodes 3b - 3e can be moved toward or away from the central electrode 3a. Between the central electrode 3a and the peripheral electrodes 3b - 3e, non-contact type temperature sensors 11a, 11b, 11c and lid for detecting temperature of each portion in the incineration ash layer 5 are arranged. In the upper portion in the melting furnace 1, non-contact type level sensors 12a, 12b, 12c and 12d for detecting surface level of the incineration ash layer 5 are provided. Using ultrasonic wave or electromagnetic wave, which does not affect internal temperature of the melting furnace 1, the level sensors 12a - 12d detect the surface level of the incineration ash layer 5 in the melting furnace 1. By injecting incineration ash through an injection port (not shown) for incineration ash on the upper portion of the melting furnace 1, the incineration ash layer 5 can be controlled to a predetermined level.

[0024] Fig. 5 shows an arrangement of the peripheral electrode driving unit 10a of the peripheral electrode 3b shown in Fig. 4. Fig. 5 (A) is a side view, Fig. 5 (B) is a plan view, and Fig. 5 (C) is a perspective view of a cover member. Each of the other peripheral electrode driving units 10b - 10d has the same arrangement.

[0025] On the upper surface of the melting furnace 1, an electric motor 13a and two guide rails 14 inclined toward the central electrode 3a are provided, and an electrode transport trolley 15 is placed between the guide rails 14. On the electrode transport trolley 15, an electrode support member 17 is mounted and supported via an insulation member 16, and the peripheral electrode

3b is fixed on the electrode support member 17. On the output shaft of the motor 13, a winder 19 is provided via a speed reducing gear mechanism 18, and the electrode transport trolley 14 is connected to a wire cable 20 which is wound up on the winder 19. To the electrode support member 17, a power feeding cable 21 is connected. At an end of the guide rail 14, a stopping member 22 is erected to indicate the shortest distance when the electrode transport trolley 14 is brought closer to the central electrode 3a. On top of the melting furnace 1, an opening 23 for moving electrode is formed. It is necessary to provide sealing so that heat and gas in the melting furnace 1 are not blown up to outside through the opening 23 for moving electrode. For this purpose, foldable sealing plates 24 and 24 are arranged on left and right sides of the insulation member 16 between the guide rails 14 so that the opening 23 for moving electrode can be sealed when the peripheral electrode 3b is moved. Because the guide rails 14 and 14 are inclined toward the central electrode 3a, when electric current between the central electrode 3a and the peripheral electrodes 3b - 3e is increased, the motor 13a is rotated in reverse direction. Then, the wire cable 20 is loosened, and the trolley is moved closer to the central electrode 3a.

[0026] Fig. 6 is a block diagram of a control system of the embodiment shown in Fig. 4. Based on temperature data from the temperature sensors 11a - 11d mounted inside the melting furnace 1, an automatic control unit 25 controls rotation of motors 9a and 13a - 13d arranged on the central electrode driving unit 9 and the peripheral electrode driving units 10a - 10d in normal or reverse direction. Then, the electrode transport trolley 15 is moved toward or away from the central electrode 3a. Electric current between the central electrode 3a and the peripheral electrodes 3b - 3e is increased or decreased, and melting temperature of the incineration ash layer 5 in the melting furnace 1 is maintained at a predetermined temperature level. When the predetermined melting temperature of the incineration ash layer 5 is extensively changed, the motor 9a is driven by the automatic control unit 25 and the central electrode 3a is move up or down. In case the melting temperature differs at each position of the incineration ash layer 5 in the melting furnace 1, it is possible to separately drive each of the peripheral electrode driving units 10a - 10d depending on the difference of temperature.

[0027] As shown in Fig. 3 (B), the secondary side of the transformer 7 is designed as a single phase circuit, and the peripheral electrodes 3b - 3e are commonly connected and are positioned opposite to the central electrode 3a. As a result, difference of electric current between the central electrode 3a and the peripheral electrodes 3b - 3e is not turned to an extreme value, and this means less change in the melting temperature of the incineration ash layer 5. It is a single phase power feeding circuit when the melting temperature is adjusted. In case two or more electrodes are used, the electrodes can be separately moved in horizontal direction.

Electric current between the electrodes can be freely adjusted, and this is advantageous in that there is no need to use power factor improvement reactor, which is required in case of 3-phase circuit cylinder type electrode.

[0028] Next, description will be given on an exhaust gas purifier adopted in the electric resistance type melting furnace of the present invention referring to Fig. 7 - Fig. 9. Fig. 7 (A) is a perspective view showing a partial cross-section of an exhaust gas purifier, and Fig. 7 (B) is a perspective view of an electrode plate of Fig. 7 (A). It goes without saying that the exhaust gas purifier may be applied to an exhaust gas passage in a material waste incineration furnace.

[0029] An exhaust gas purifier 26 comprises an electric insulator case 27 made of a heat-resistant material, a plurality of exhaust gas inlets 17a formed on the bottom of the case 27, an exhaust outlet 27b formed on upper surface of the case 27, and a plurality of electrode plates 29 erected with spacing and arranged in parallel and in vertical direction inside the case 27. The electrode plate 29 comprises a dielectric member 29a made of glass or quartz having a dielectric constant closer to 1 and a metal plate 29b fixed on the dielectric member.

[0030] Fig. 8 is an electric circuit diagram of the exhaust gas purifier shown in Fig. 7. Low voltage is applied to primary side connection terminals U and V of the transformer 30, and high voltage is generated between high voltage terminals C and D on the secondary side. By applying high voltage between metal plates 29b connected to the high voltage connection terminals C and D, plasma discharge is induced between the electrode plates 29 and 29. A sliduck (volt slider) 31 is used to select intensity of plasma discharge by varying voltage between high voltage terminals C and D depending on components of the exhaust gas passing between the electrode plates 29. By plasma discharge induced by high voltage between the high voltage terminals C and D, the exhaust gas passes through a plurality of exhaust gas inlets 29a on the bottom of the electric insulator case 1, and when it reaches the electrode plates 29, harmful substances such as PCB, dioxin, etc. in the exhaust gas are decomposed and dissociated.

[0031] Fig. 9 is a perspective view of the electric resistance type melting furnace of the present invention provided with the exhaust gas purifier 26. An exhaust gas duct (exhaust gas passage) 33 is erected on an exhaust gas outlet 32 of the melting furnace 1, and the exhaust gas purifier 26 and a carbon filter 34 are arranged in the exhaust gas duct 33. The carbon filter 34 is used to absorb gas and eliminate odor in the exhaust gas duct 33.

[0032] As it is evident from the above description, it is possible according to the invention defined in claims 1 to 3 to prevent deformation and destruction of graphite electrodes under high temperature because outer surfaces of the graphite electrodes are covered with molybdenum members. Also, it is possible to eliminate damage of the electrodes caused by the hitting of waste

metal pieces against the electrodes in the initial stage of operation, and this leads to the reduction of processing cost. Because the electrodes have rectangular cross-section, spacing between electrode plates is turned to even, and this contributes to even distribution of electric current. Further, melting temperature can be increased to higher than the melting temperature in the conventional type melting furnace, i.e. to 1500°C to 2000°C. This makes it possible to eliminate harmful substances such as dioxin, carbon monoxide, PBC, etc. or to reduce the content of such substances to lower than the standard values, and this contributes to solve pollution problems. According to the invention of claim 2, the number of electrodes can be reduced. Further, according to the invention defined in claims 4 and 5, the peripheral electrodes are moved toward or away from the central electrode depending on the detection value of the temperature sensors in the melting furnace. As a result, melting temperature of the incineration ash layer in the melting furnace can be quickly and automatically controlled, and power consumption for the melting of the incineration ash layer can be decreased.

[0033] Also, according to the invention of claim 6, gas in the melting furnace can be sealed when the peripheral electrodes are moved. According to the invention described in claim 7, the level of the incineration ash layer in the furnace can be detected, and this makes it possible to accurately control charging quantity of the incineration ash to be melted. According to the invention described in claim 8, harmful gases in the exhaust gas discharged from the melting furnace can be decomposed and dissociated.

Claims

1. An electric resistance type melting furnace, comprising a plurality of graphite electrodes each having rectangular cross-section and having outer peripheral surfaces covered with molybdenum member, said graphite electrodes being disposed inside the melting furnace, and surfaces of said graphite electrodes being positioned opposite to each other.
2. An electric resistance type melting furnace according to claim 1, wherein there are provided two of said graphite electrodes, and single phase power is supplied to the graphite electrodes.
3. An electric resistance type melting furnace according to claim 1 or 2, wherein said melting furnace comprises a central electrode arranged at the center of the melting furnace, and four peripheral electrodes are arranged with angular spacing of 90° around the central electrode.
4. An electric resistance type melting furnace according to claim 3, wherein there are provided a central

electrode driving unit for moving said central electrode in vertical direction, and peripheral electrode driving units for moving said peripheral electrodes in horizontal direction with respect to said central electrode.

5. An electrode apparatus in the incineration ash melting furnace according to claim 4, wherein there are provided a plurality of non-contact type temperature sensors in the melting furnace, said electrode driving units are driven according to temperature of the incineration ash detected by said temperature sensors, and the electric current between the central electrode and the peripheral electrodes is controlled.
6. An electric resistance type melting furnace according to claim 4 or 5, wherein an opening for moving the peripheral electrodes is arranged on the upper portion of the melting furnace and foldable sealing plates are disposed on the upper surface of said opening for moving peripheral electrodes.
7. An electric resistance type melting furnace according to one of claims 1 to 6, wherein non-contact type level sensors for detecting surface level of the incineration ash layer in the melting furnace are provided at arbitrary points on upper portion of the melting furnace, and charging quantity of the incineration ash is controlled according to signal from said level sensors.
8. An electric resistance type melting furnace according to one of claims 1 to 7, wherein a plurality of electrode plates each having a dielectric member fixed on one side of a metal plate are attached with spacing in an exhaust gas passage of the melting furnace, plasma discharge is induced between said electrode plates by applying high voltage on each of the metal plates, and harmful substances such as PCB, dioxin, etc. in the exhaust gas are decomposed and dissociated.

FIG. 1 (A)

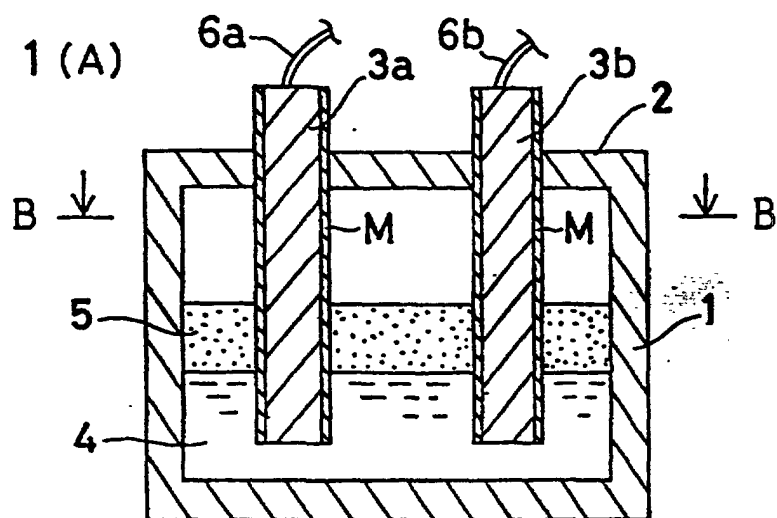


FIG. 1 (B)

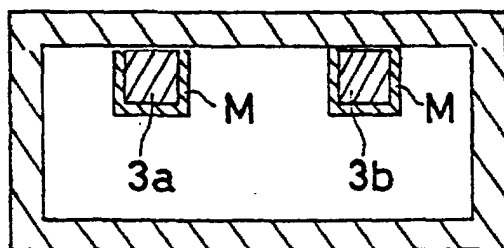


FIG. 1(C)

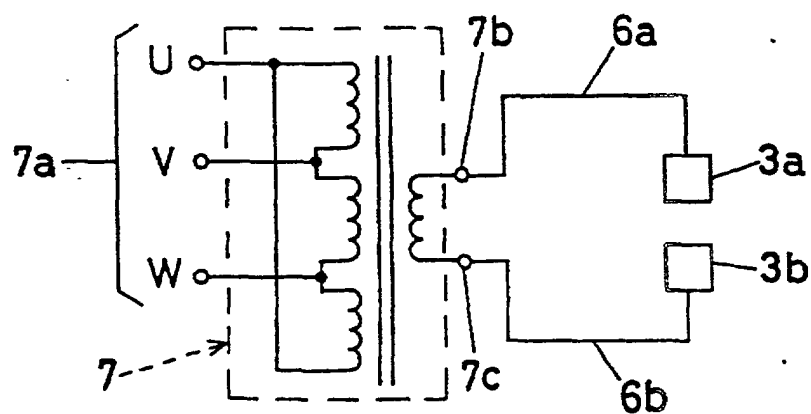


FIG. 2 (A)

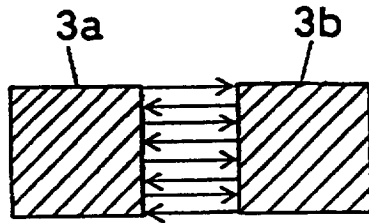


FIG. 2 (B)

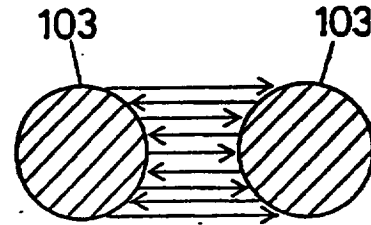


FIG. 3 (A)

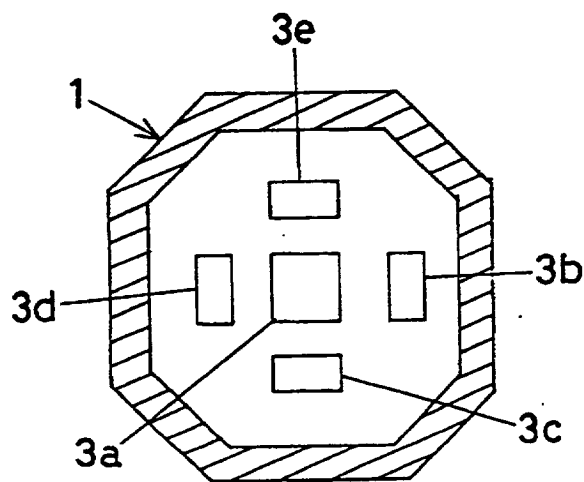


FIG. 3 (B)

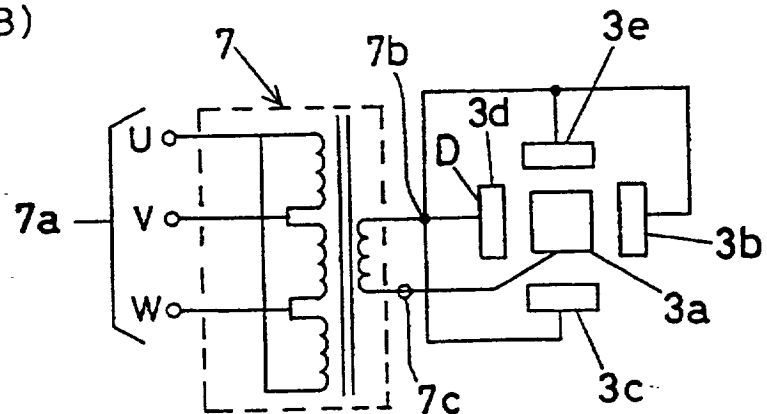


FIG. 4(A)

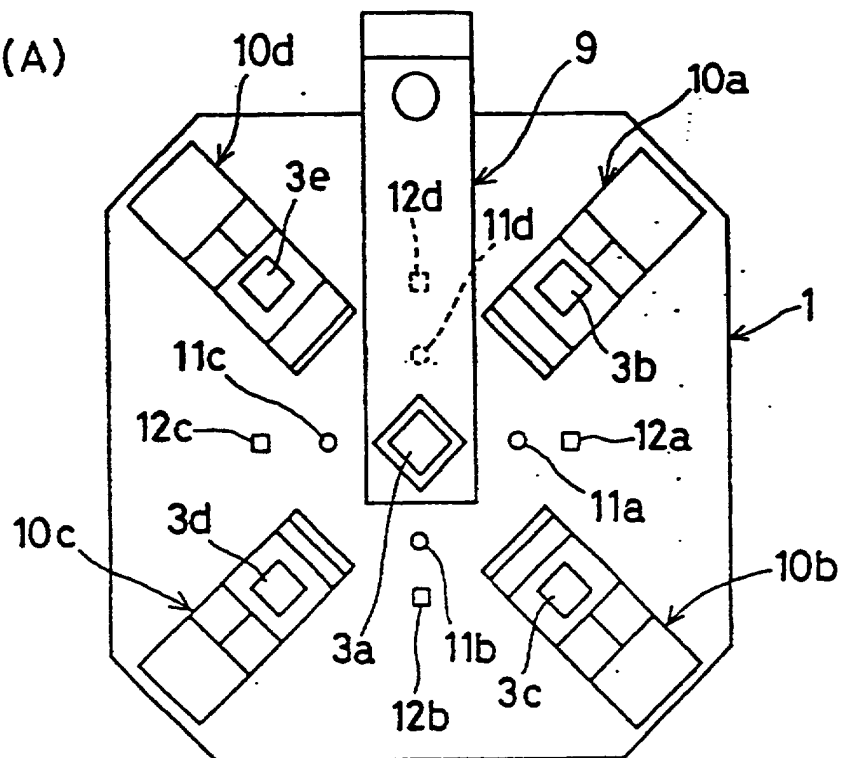


FIG. 4(B)

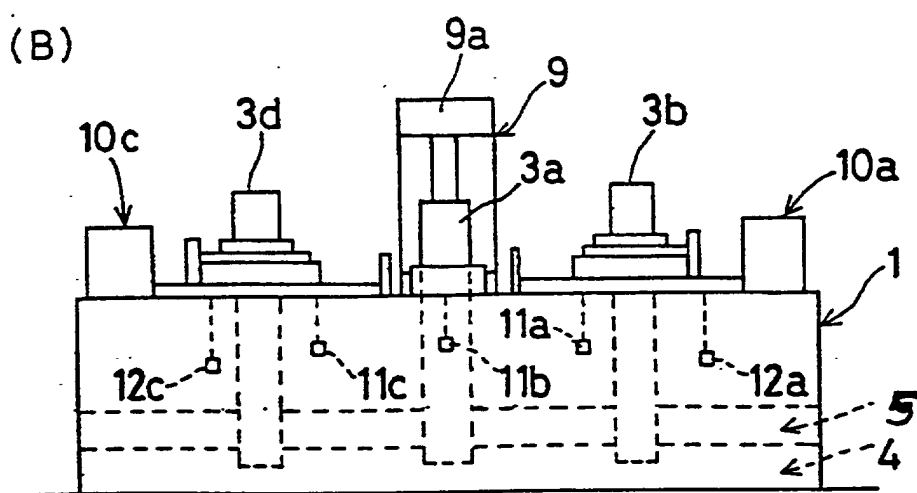


FIG. 5(A)

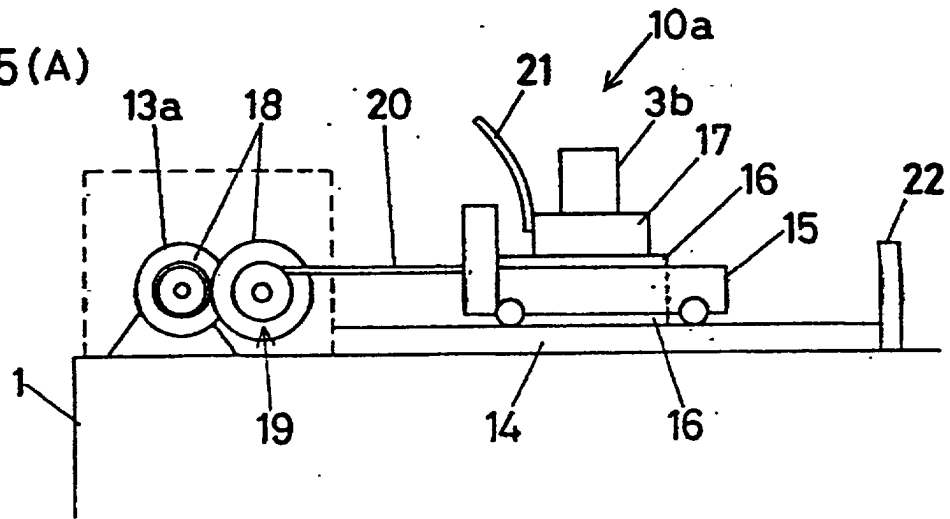


FIG. 5(B)

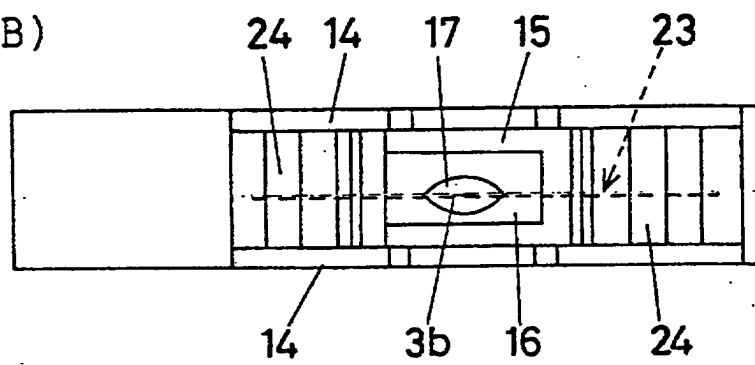


FIG. 5(C)

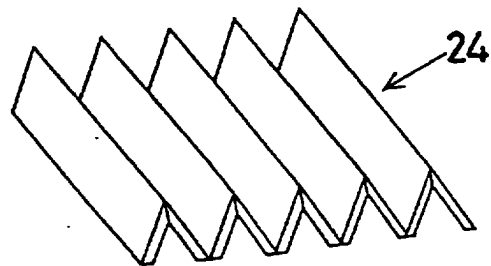


FIG. 6

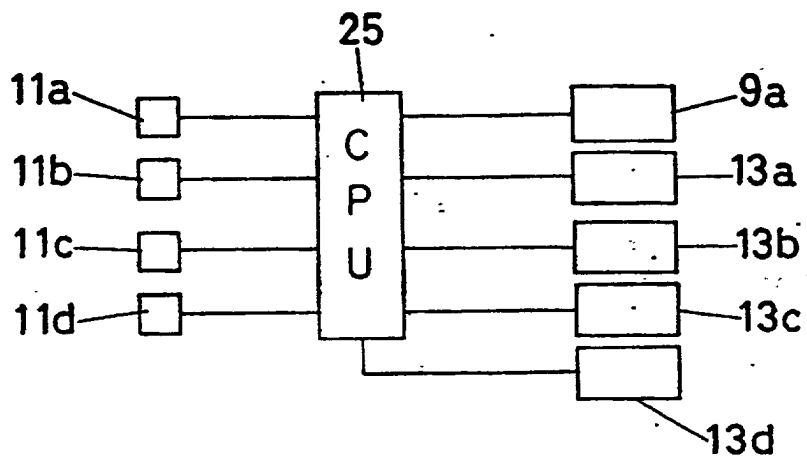


FIG. 7(A)

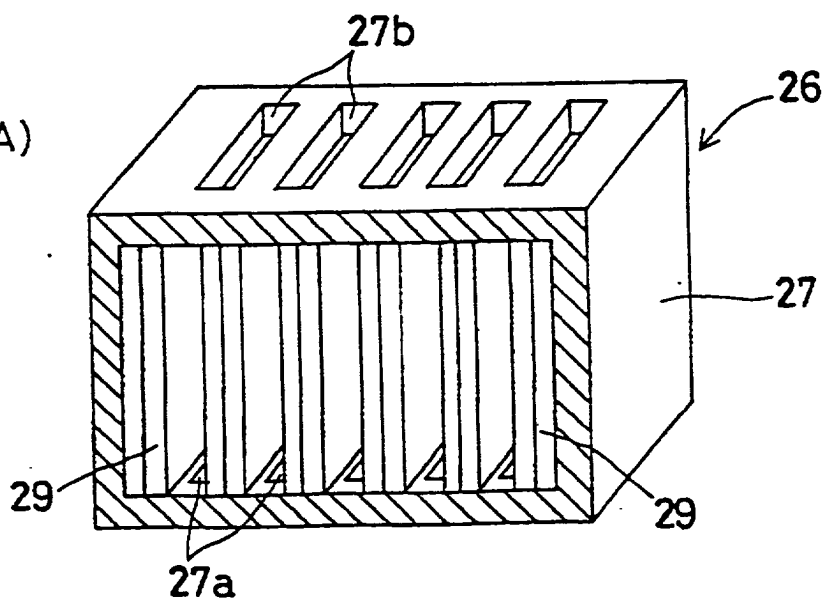


FIG. 7(B)

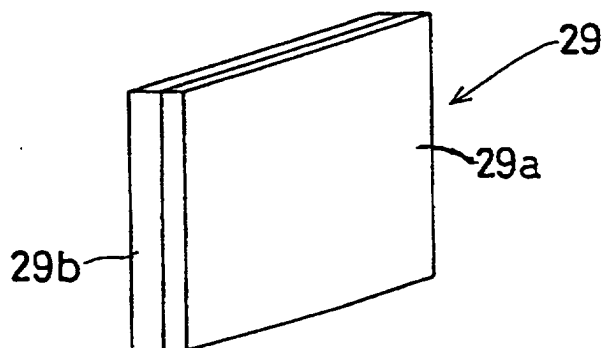


FIG. 8

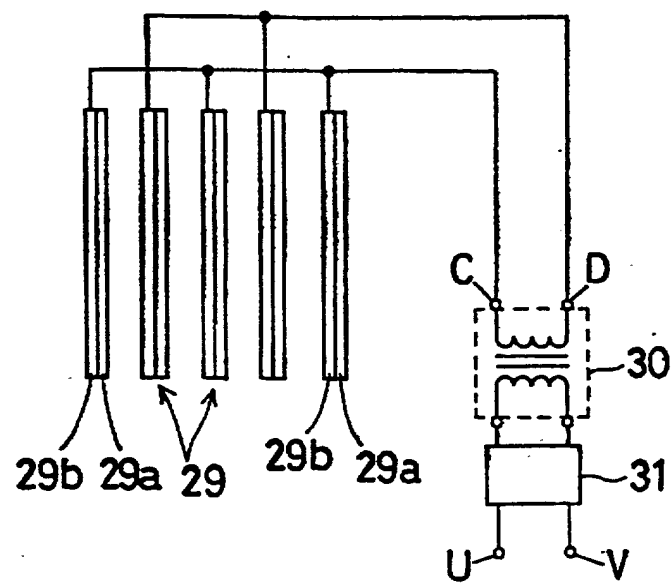


FIG. 9

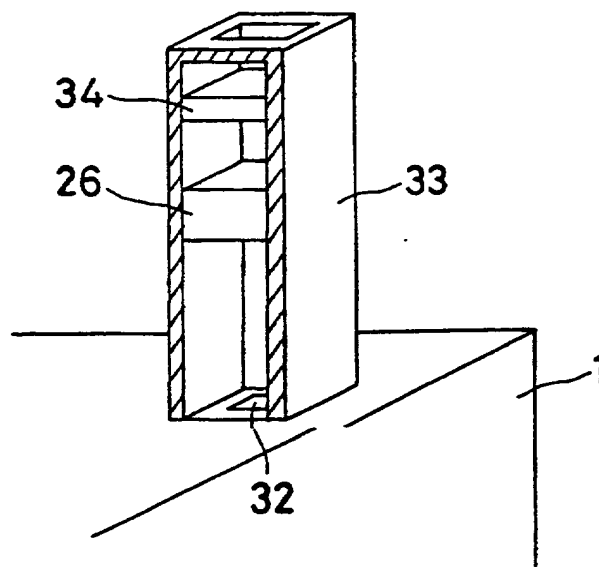
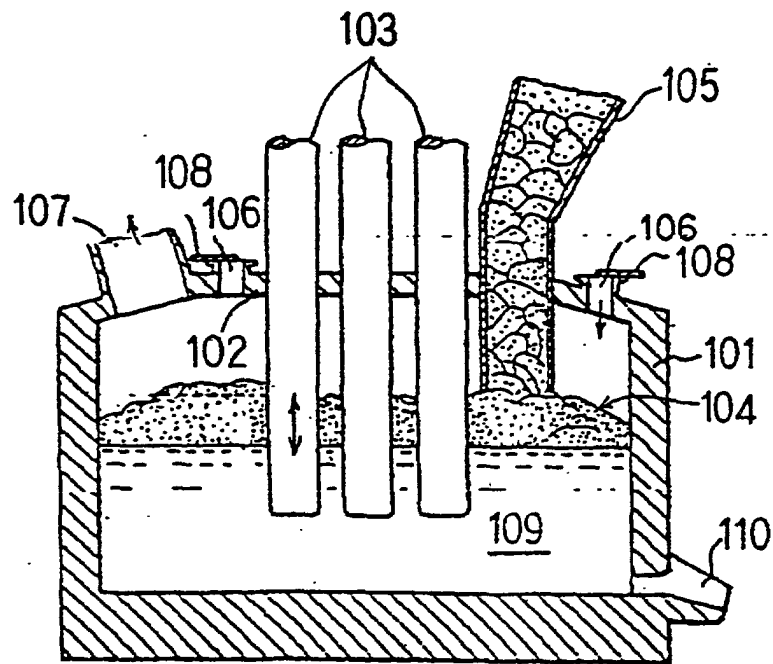


FIG. 10





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 12 3766

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 6 122 308 A (KATAYAMA HIDEO) 19 September 2000 (2000-09-19) * the whole document * -----	1-8	F23G5/10 F27D11/04 H05B3/03 H05B3/62
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F23G F27D H05B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 March 2001	Examiner Mougey, M
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 12 3766

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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27-03-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6122308 A	19-09-2000	JP 2001033021 A	09-02-2001