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Hansen

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[54] **METAL POURING APPARATUS INCLUDING PARTICLE COLLECTING MECHANISM**

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[52] **U.S. Cl.** ..... **98/115 R,** 141/93

[51] **Int. Cl.** **F23j 11/04**

[58] **Field of Search** ..... 98/115 R, 36; 141/93; 55/DIG. 30, DIG. 41, DIG. 29

[56] **References Cited**

UNITED STATES PATENTS

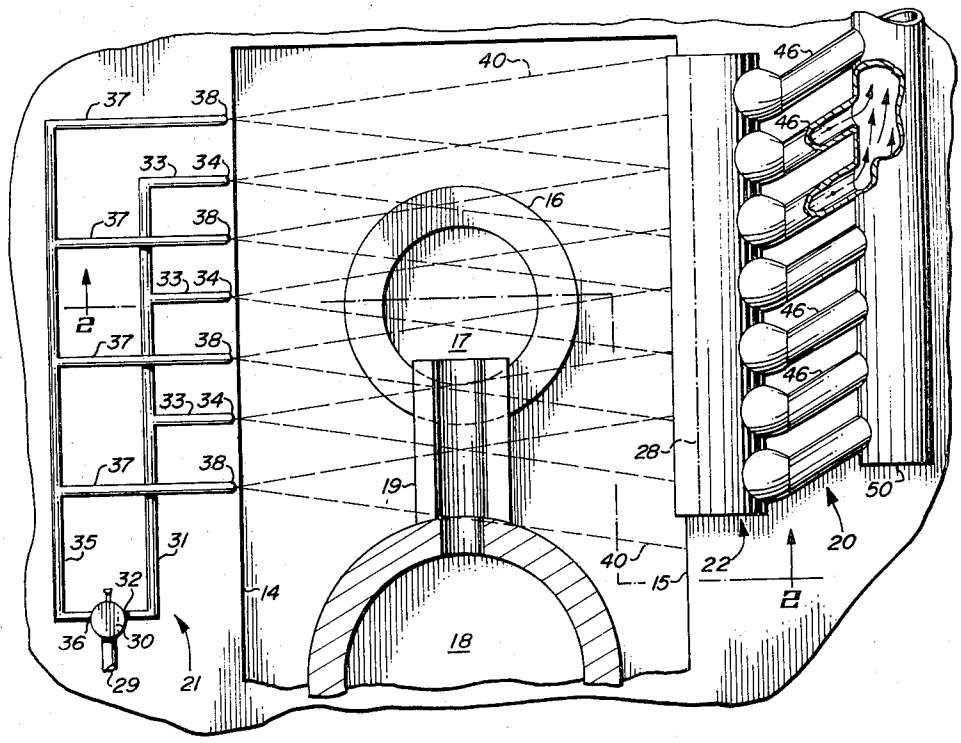
2,074,317	3/1937	Allen et al.	98/115 R X
3,108,150	10/1963	Sem et al.	98/115 R X
3,377,940	4/1968	Werner et al.	98/115 R

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Assistant Examiner—Ronald C. Capossela
Attorney—John A. Robertson et al.

[57] **ABSTRACT**

This specification discloses metal pouring apparatus which includes mechanism for collecting particles generated by explosion as molten metal is poured into a ladle. The collecting mechanism comprises a horizontal collection hood, any vertical cross-section of which is a segment of an ellipse. It is located at one side of a pit in which the ladle is located. A horizontal series of air jet nozzles are positioned at the opposite side of the pit, and, like the collection hood, are disposed at a level above the top of the ladle. The inner surface of the hood determines a focal line of the ellipse and the nozzles are located at the other focal line of the same ellipse. Thus, all of the air emanating from the nozzles, and particles entrained thereby, are reflected onto the focal line of the hood. Withdrawal hoods are mounted on the back of the collection hood. They communicate with a manifold in which a partial vacuum is generated and are effective at the focal line of the hood.

10 Claims, 6 Drawing Figures



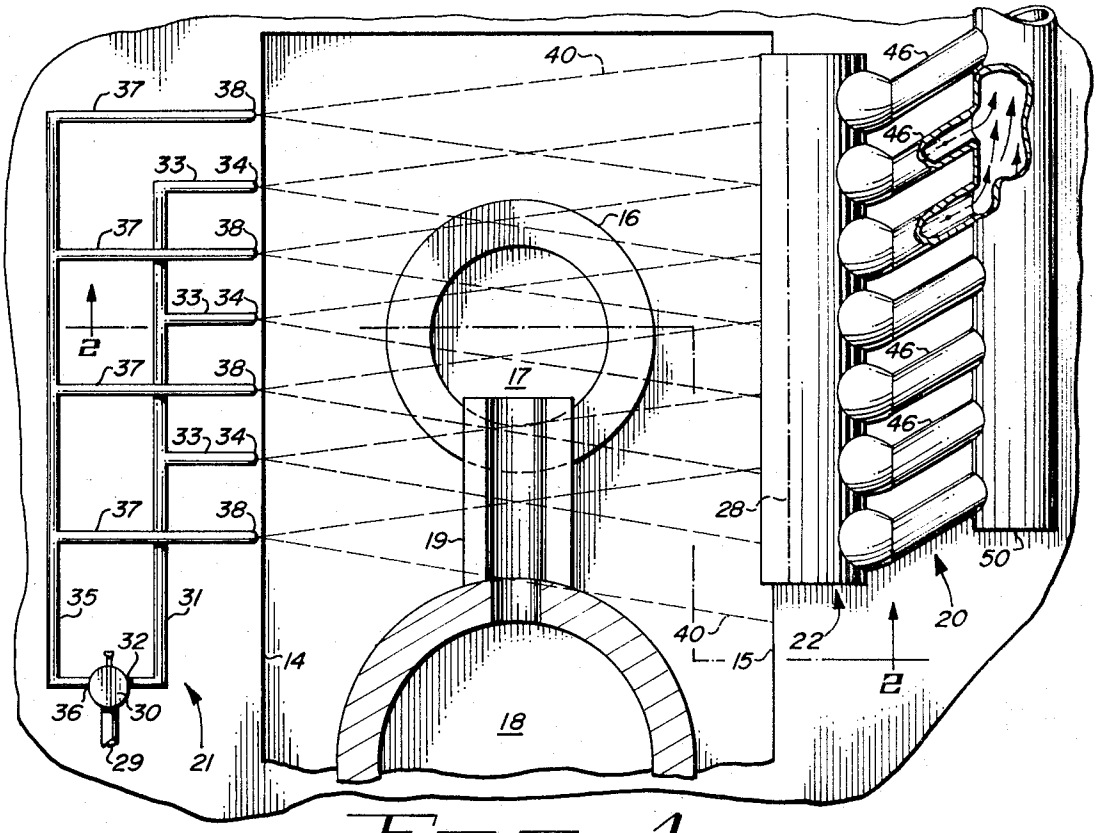

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Fig-1

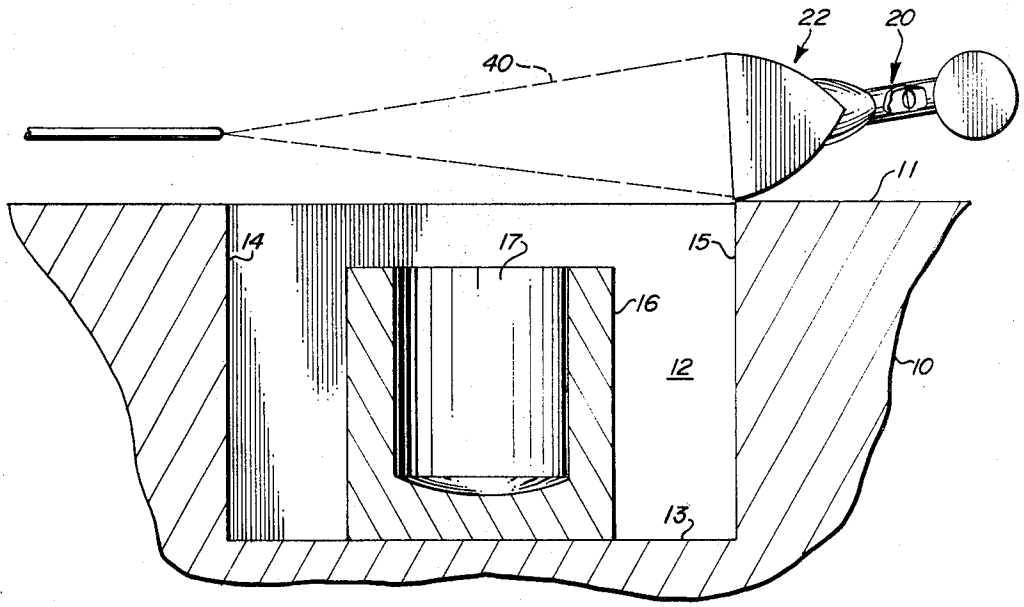

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Fig-2

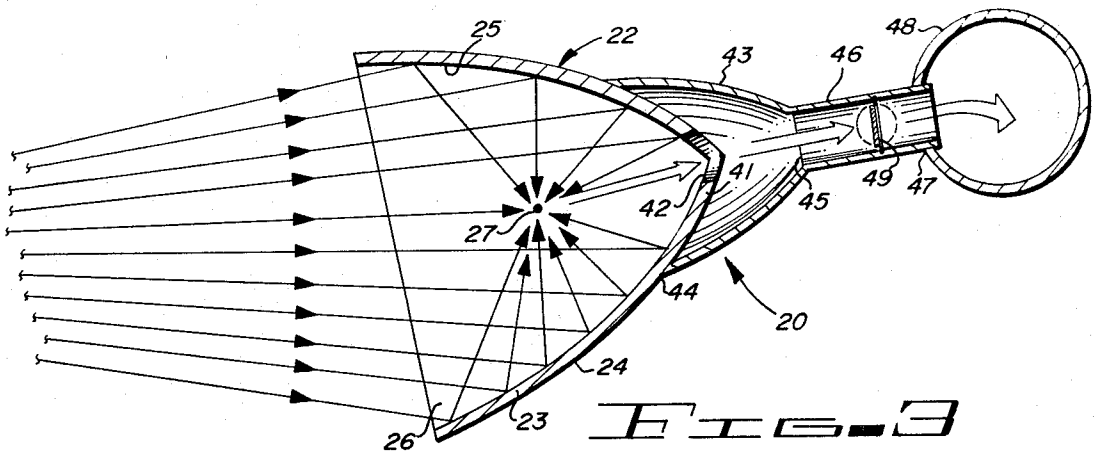


Fig-3

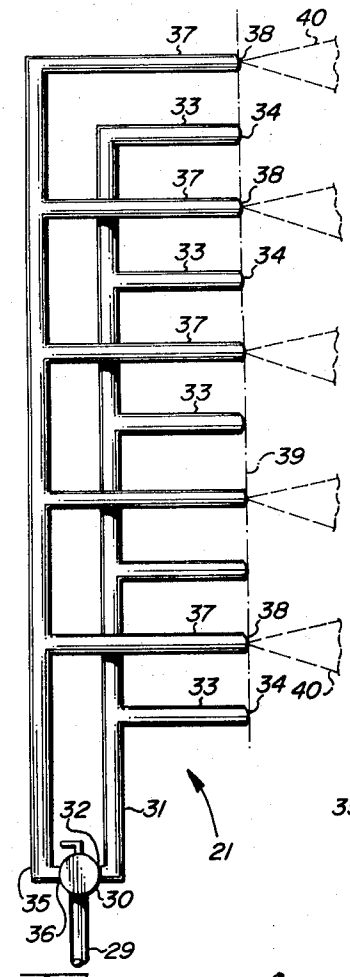


Fig-4

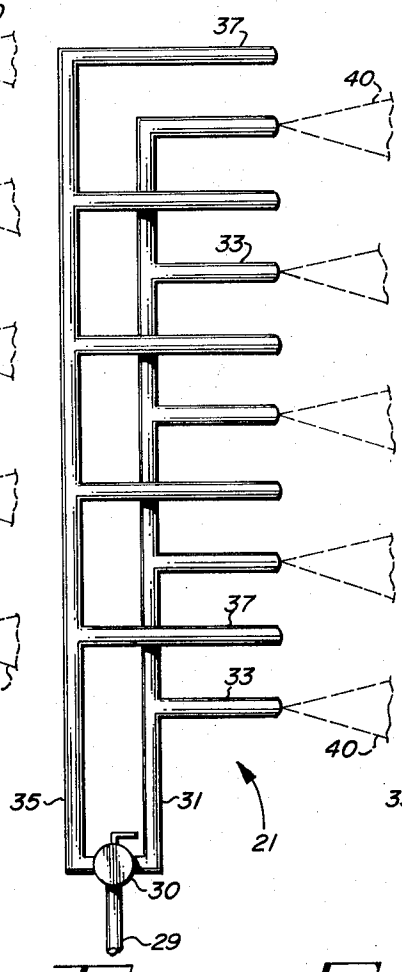


Fig-5

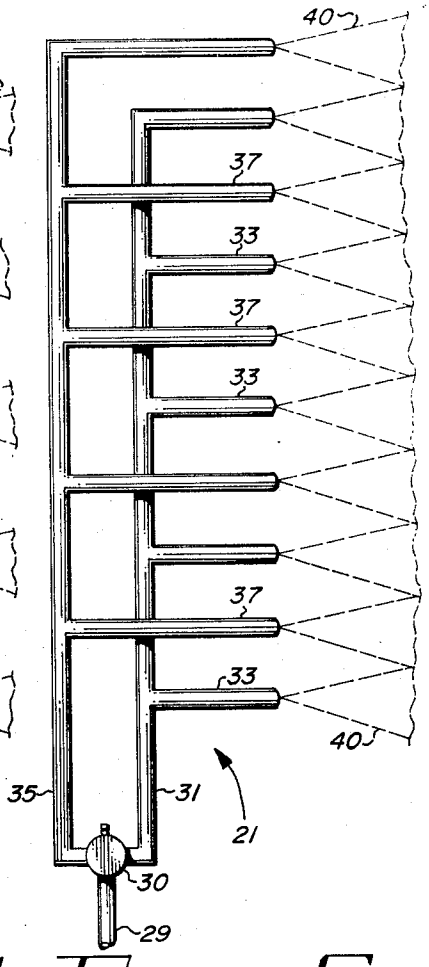


Fig-6

METAL POURING APPARATUS INCLUDING PARTICLE COLLECTING MECHANISM

The present invention relates to apparatus used in pouring molten metal into a ladle and is concerned primarily with the provision in such apparatus of mechanism for collecting fine particles which are generated by the engagement of molten metal with the ladle.

BACKGROUND OF THE INVENTION

At the present time metallurgical processes involve the pouring of molten metal from an arc furnace in which it is formed into a metallic ladle located in a pit at one side of the furnace. When the molten metal strikes that of the ladle, what is literally an explosion takes place. This explosion is caused by the fact that the ladle and ambient air are at a temperature much lower than that of the molten metal. This explosion creates small particles which are mostly of metal and which move upwardly in fumes which emanate from the ladle. These fumes with the particles therein are a decided detriment to the ecology and impair the conditions about the pit.

The present invention is founded on the concept of providing a horizontal curtain or blanket of air which moves across the top of the pit and over the ladle. It is highly important that this moving air blanket be capable of picking up and entraining the particles which are present in the fumes. It is believed that under many conditions encountered in actual service usage, a steady blast of air will not be as effective in entraining particles as will a pulsating blast of air.

An ellipse is the path of a point that moves so that the sum of its distances from two fixed points (called foci) is constant. A property of an elliptical reflecting surface is that a line or ray emanating from one focus of the ellipse will be reflected onto the other focus. Thus, it is entirely practical to form an elongated, horizontally positioned collection hood having an inner reflecting surface, any vertical cross-section of which is a segment of an ellipse, with the foci of all such segments determining the focal line of the hood.

OBJECTS OF THE INVENTION

With the foregoing conditions in mind, the present invention has in view the following objectives:

1. To provide, in apparatus for pouring molten metal which includes a pit in which a ladle is positioned and into which the molten metal is poured, mechanism for creating a horizontal blanket or curtain of air which moves across the open top of the ladle and which mechanism constitutes means for entraining and collecting particles in the fumes rising from the ladle.

2. To provide, in apparatus of the type noted, particle collecting mechanism which includes a collection hood located at one side of the pit at a level above that of the top of the ladle and which hood has an inner reflecting surface, any vertical section of which is a segment of an ellipse. Thus, the reflecting surface of the hood is determined by a focal line which is in effect the loci of all the foci of such vertical sections.

3. To provide, in apparatus of the character aforesaid, particle collecting mechanism which includes a plurality of jet nozzles arranged in a horizontal series and located at the side of the pit opposite to that on which the collection hood is located, with the discharge ends of the nozzles being located at a line which is a focal line of the same ellipse which determines the reflecting surface of the collection hood.

4. To provide, in apparatus of the kind described, a plurality of air jet nozzles comprising two sets with the nozzles of one set being alternately interposed between the nozzles of the other set, together with means for supplying air under pressure to either set of nozzles individually or to both sets together.

5. To provide, in apparatus of the character aforesaid, an air supply system for the nozzles including two manifold conduits, with the nozzles of one set connected to one of these conduits and the nozzles of the other set to the other conduit, together with a valve for admitting air under pressure from a source of supply to either or both of said conduits.

6. To provide, in apparatus of the type noted, particle collecting mechanism including a hood in the shape of a segment of an elongated, horizontally positioned ellipse and on the back of which are mounted a plurality of withdrawal hoods which are connected to a manifold in which a vacuum condition is created, with the suction effect of the vacuum being concentrated at the focal line of the collection hood.

7. To provide, in particle collecting mechanism of the character aforesaid, a plurality of conduits each of which connects one of said withdrawal hoods to the vacuum manifold and which includes an adjustable damper.

Various other more detailed objects and advantages of the invention, such as arise in connection with carrying out the above ideas in a practical embodiment, will, in part, become apparent and, in part, be hereafter stated as the description of the invention proceeds.

SUMMARY OF THE INVENTION

The foregoing objects are achieved by providing metallurgical equipment including a floor or base formed with a pit, a ladle in the pit, and a furnace mounted on the base and from which molten metal is poured into the ladle with particle collecting mechanism. This mechanism comprises a collection hood that is mounted on the base at one side of the pit and which takes the form of an elongated segment of an ellipse. The hood has an inner reflecting surface, any vertical cross-section of which is a segment of the ellipse and which vertical sections define a focal line that is a composite of the infinite number of such sections.

Mounted on the side of the pit opposite to that on which the collection hood is mounted are a plurality of jet nozzles, the discharge ends of which are arranged in a horizontal line and which collectively define another focal line of the ellipses which determine the reflecting surface of the collection hood. These jet nozzles are arranged in two sets, with the nozzles of one set being alternately disposed between the nozzles of the other set. The nozzles of each set are connected to a manifold and the two manifolds are connected to a source of air under pressure with a four-way valve being included in the connection. Thus, air under pressure may be supplied to either of the manifolds individually or to both manifolds simultaneously.

Mounted on the back of the collection hood are a plurality of withdrawal hoods, each of which is connected to a vacuum manifold conduit by a tube including a damper. The withdrawal hoods apply a suction to the collection hood at the focal line thereof.

For a full and more complete understanding of the invention, reference may be had to the following description and the accompanying drawings wherein:

FIG. 1 is a top plan view of metal pouring apparatus including the particle collecting mechanism of the present invention;

FIG. 2 is a vertical section through the apparatus of FIG. 1 being taken on the plane of the line 2—2 of FIG. 1;

FIG. 3 is a transverse vertical section taken on an enlarged scale through the collection hood per se;

FIG. 4 is a top plan view, somewhat diagrammatic, of the two sets of air jet nozzles and depicting the nozzles of one set in effective operation;

FIG. 5 is a top plan view similar to FIG. 4, illustrating the other set of nozzles in effective operation, and

FIG. 6 is another top plan view of the jet nozzles showing both sets of nozzles in effective operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference characters denote corresponding elements throughout the several views, and first more particularly to FIGS. 1 and 2, metallurgical apparatus used in the pouring of metal is shown as comprising a base or foundation 10 presenting a floor surface 11 and formed with a pit 12 having a flat bottom 13 and vertical side surfaces 14 and 15.

Resting on bottom 13 and substantially midway between the side surfaces 14 and 15 is a ladle 16 presenting a central recess 17 into which molten metal is to be poured. A furnace such as an electric arc furnace is indicated somewhat diagrammatically at 18 and is mounted on floor surface 11. Extending from furnace 18 to ladle 16 is a trough 19, the discharge end of which overlies the recess 17. Molten metal from furnace 18 is poured into ladle 16 by trough 19.

As explained above, the engagement of molten metal which is at a relatively high temperature with the wall of recess 17 of ladle 16 which is at a comparatively low temperature creates what is in effect an explosion which generates a multiplicity of fine particles which are carried upwardly by the fumes emanating from ladle 16. Thus, pit 12 constitutes an open top receptacle which receives liquid material from which fumes emanate.

To prevent these fumes and particles from contaminating the ambient atmosphere, particle and fume collecting mechanism is provided. This mechanism comprises two basic assemblies. One of these is a hood assembly referred to in its entirety by the reference character 20 which is mounted on floor surface 11 above side wall surface 15, and a jet nozzle assembly which is indicated generally at 21 and which is mounted on floor surface 11 immediately above side surface 14.

The hood assembly 20 includes a collection hood designated generally 22. This hood 22 is of a shape which is best described as an elongated segment of an ellipse. Thus, collection hood 22 comprises a wall 23 (FIG. 3) presenting an outer surface 24 and an inner reflecting surface 25. Wall 23 is closed at each end by an end wall, one of which is shown at 26 in FIG. 3. Any vertical cross-section of reflecting surface 25 is determined by the two foci of an ellipse, one of which is represented at 27 in FIG. 3. A plurality of such foci establishes what for the purposes of this specification is called a focal line which is represented by a broken line at 28 in FIG. 1.

Referring now more particularly to FIGS. 1, 4, 5 and 6, a source of supply of air under pressure is represented by pipe 29. At the end of pipe 29 is a four-way valve 30. A manifold 31 has one end connected to valve 30 as indicated at 32. Extending laterally from manifold 31 are a plurality of jet nozzles 33. Manifold 31 is positioned above floor surface 11 and over side surface 14. Each of the jet nozzles 33 has a discharge end 34 which are in horizontal alignment.

A second manifold 35 has one end connected to the side of valve 30 opposite to connection 32 as indicated at 36. Extending laterally from manifold 35 are a plurality of jet nozzles 37, which it will be noted, are arranged alternately with respect to jet nozzles 33. Each of the jet nozzles 37 has a discharge end 38 which are in horizontal alignment with each other and with the discharge ends 34 of nozzles 33. These discharge ends 34 and 38 determine a line which is shown in FIG. 4 and designated 39, which is in effect a focal line of the same elliptical formation which determines focal line 28.

It will be noted that in FIG. 1 only three nozzles 33 and four nozzles 37 are illustrated, whereas in FIGS. 4, 5 and 6 five of each of these sets of nozzles are depicted. This reduction in number of the nozzles in FIG. 1 is purely for the purpose of facilitating illustration.

Air discharged from any of the discharge ends 34 or 38 will take the conical formation illustrated at 40 as illustrated more clearly in FIG. 2 and partially in FIGS. 4, 5 and 6. The angle of air cones 40 is, of course, determined by the structural formation of the nozzle from which it emanates, as well as the air pressure. Whether air is discharged from either nozzles 33 or 37 individually, or from both sets of nozzles collectively, a blanket or curtain of air is formed over the open end of the recess 17 of ladle 16 and enters the open side of collection hood 22 as illustrated in FIG. 3. This air and particularly the particles entrained therein are reflected by surface 25 and are concentrated at focal line 28.

The elliptical wall 23 of hood 22 includes a so-called back or rear portion 41, the nose of which is formed with a plurality of apertures 42, one of which is illustrated in FIG. 3. Mounted on this back 41 are a plurality of withdrawal hoods 43, with each hood 43 encompassing an aperture 42. Withdrawal hoods 43 may be secured to collection hood 22 in any preferred manner, such as by welding or soldering as indicated at 44. Each withdrawal hood 43 terminates in an open end 45 to which one end of a tube 46 is connected. The other end of tube 46 is received in an opening 47 formed in a vacuum conduit 48. Mounted in each tube 46 is a damper 49 which is adjustable in a well known manner. It will be noted that tubes 46 are inclined from a normal relation to collection hood 22 in order to facilitate the flow of air and particles entrained thereby as indicated by the arrows in FIG. 1. The end of conduit 48 represented at 50 is closed, while a vacuum is applied to the other end.

OPERATION

It will be understood that the four positions of valve 30 are 1) fully closed, 2) establishing communication from pipe 29 to manifold 31, 3) establishing communication from pipe 29 to manifold 35, or 4) establishing communication from pipe 29 to both manifold 31 and

35. It also will be understood that valve 30 may be electrically operated by remote control.

Let us first assume that a particular set of service conditions indicate a full and continuous air curtain as being desirable. In such case, valve 30 is adjusted to the position depicted in FIG. 6 in which air under pressure flows to both of the manifolds 31 and 35. The cones 40 emanate from the discharge nozzles 34 and 38 and assume the overlapping relation depicted in FIG. 1 which completely blankets the area above the open end of recess 17 of ladle 16. Fumes arising from recess 17 and particularly the particles therein are entrained by the air blanket provided by cones 40. This air and entrained particles are reflected from surface 25 and are concentrated at focal line 28. The vacuum condition in vacuum manifold 48 is effective through openings 45 and 42 and is concentrated on imaginary sections of focal line 28 to withdraw the fumes and entrained particles therefrom. These fumes and particles are withdrawn through hoods 43 and tubes 46 and vacuum manifold 48 to a suitable point of discharge as indicated by the arrows in FIG. 1.

Should the service conditions indicate that a pulsating air curtain will be more effective to entrain the particles, then the valve 30 is repeatedly operated to change from the condition of FIG. 4 to that depicted in FIG. 5, then back to FIG. 4, and so on. Thus, cones 40 are first created by air discharged from nozzles 37. These cones then die down or dissipate, and cones 40 are created by the discharge of air from nozzles 33. Thus, as one set of cones are created and die down, the other set of cones are created and dissipated. Thus, a pulsating effect is achieved and is particularly effective in having the air curtain entrain the particles in the fumes coming from ladle 16.

While a preferred specific embodiment is herein disclosed, it is to be clearly understood that the invention is not to be limited to the exact construction, mechanisms and devices illustrated and described because various modifications of these details may be provided in putting the invention into practice.

What is claimed is:

1. In metal pouring apparatus including a pit formed in a base below the floor surface thereof and having opposed sides and a ladle in said pit below said floor surface and into which molten metal is poured, particle collecting mechanism comprising:

a. a collection hood at one side of said pit above the floor surface and comprising a horizontally disposed wall structure having an inner reflecting surface in the shape of an elongated ellipse presenting an open side disposed toward the pit and identifying a focal line;

b. said collection hood having a back formed with a plurality of apertures arranged in horizontal alignment;

c. a plurality of withdrawal hoods mounted on the back of said collection hood with each withdrawal hood being positioned about one of said apertures;

d. a vacuum manifold connected to said withdrawal hoods to create vacuum conditions in said collection hood at said focal line;

e. a plurality of air jet nozzles arranged in horizontal alignment above said floor surface at the other side of said pit, said air jet nozzles presenting discharge openings in horizontal alignment and establishing a line which is the other focal line of the elongated segmental ellipse structure which defines the collection hood, and

f. means for supplying air under pressure to said air jet nozzles.

2. The particle collecting mechanism of claim 1 in which the means for supplying air to said air jet nozzles is adjustable to provide a pulsating air curtain over said ladle.

3. The particle collecting mechanism of claim 1 in which said air jet nozzles comprise two sets with the nozzles of one set being alternately interposed between the nozzles of the other set, a manifold for each set of nozzles, and a valve controlling the flow of air from said source of supply to said manifolds.

4. The particle collecting mechanism of claim 3 in which said valve is a four-way valve adjustable to any of the following positions: closed, establishing communication from the air supply to one manifold alone, establishing communication from the air supply to the other manifold alone, or establishing communication from the air supply to both manifolds simultaneously.

5. The particle collecting mechanism of claim 1 in which the vacuum manifold is connected to said withdrawal hoods by tubes, together with an adjustable damper included in each of said tubes.

6. The particle collecting mechanism of claim 5 in which said vacuum manifold has a closed end and said tubes are inclined in a direction away from said closed end.

7. In apparatus including an open top receptacle which receives liquid material from which fumes emanate, fume collecting mechanism comprising:

a. a collection hood at one side of said receptacle and at a level spaced above the level of the open top of said receptacle, said hood comprising a horizontally disposed wall structure having an inner reflecting surface in the shape of an elongate ellipse presenting an open side disposed towards said receptacle and identifying a focal line;

b. said collection hood having a back formed with a plurality of apertures arranged in horizontal alignment;

c. a plurality of withdrawal hoods mounted on the back of said collection hood with each withdrawal hood being positioned about one of said apertures;

d. a vacuum manifold connected to said withdrawal hoods to create vacuum conditions in said collection hood at said focal line;

e. a plurality of air jet nozzles arranged in horizontal alignment above the level of the open top of said receptacle and on the side of said receptacle opposite to that where said hood is located, said air jet nozzles presenting discharge openings in horizontal alignment and establishing a line which is the other focal line of the elongated ellipse structure which defines said collection hood, and

f. means for supplying air under pressure to said air jet nozzles.

8. The fume collecting mechanism of claim 7 in which the means for supplying air to said air jet nozzles is adjustable to provide a pulsating air current under said receptacle.

9. The fume collecting mechanism of claim 7 in which said air jet nozzles comprise two sets, with the nozzles of one set being alternately interposed between the nozzles of the other set, a manifold for each set of

nozzles, and a valve for controlling the flow of air from said source of supply to said manifolds.

10. The fume collecting mechanism of claim **9** in which said valve is a four-way valve adjustable to any of the following positions: closed, establishing communication from the air supply to one manifold alone, establishing communication from the air supply to the other manifold alone, or establishing communication from the air supply to both manifolds simultaneously.

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