

Oct. 27, 1964

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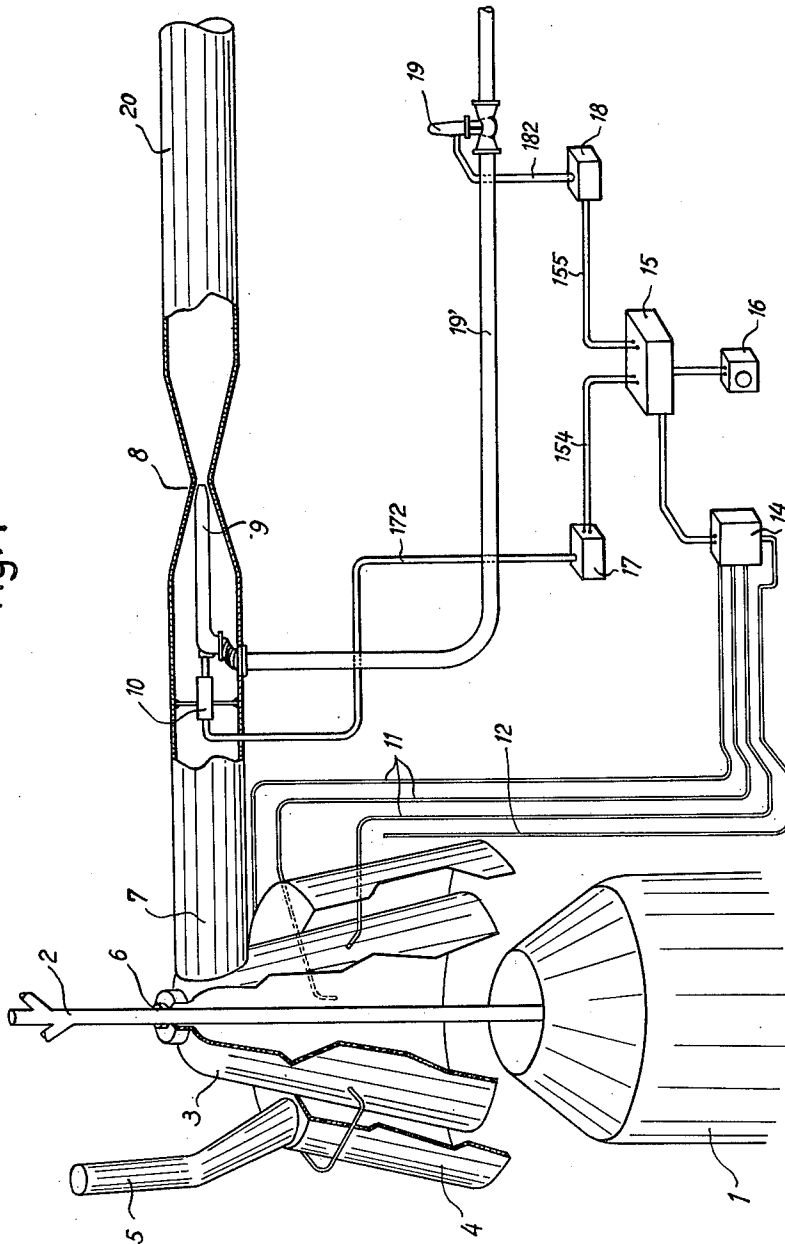
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EXHAUST FOR STEEL CONVERTER

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5 Sheets-Sheet 1

Fig. 1



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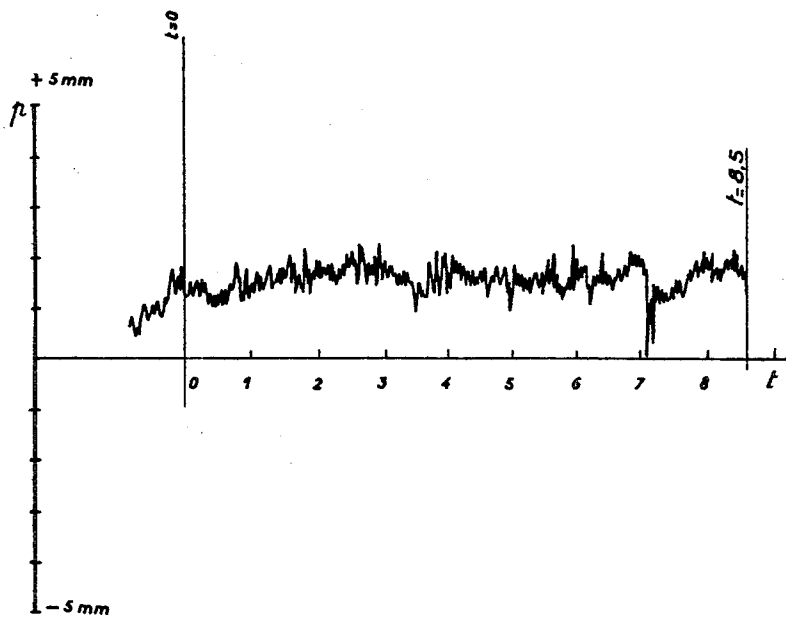
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Fig. 2



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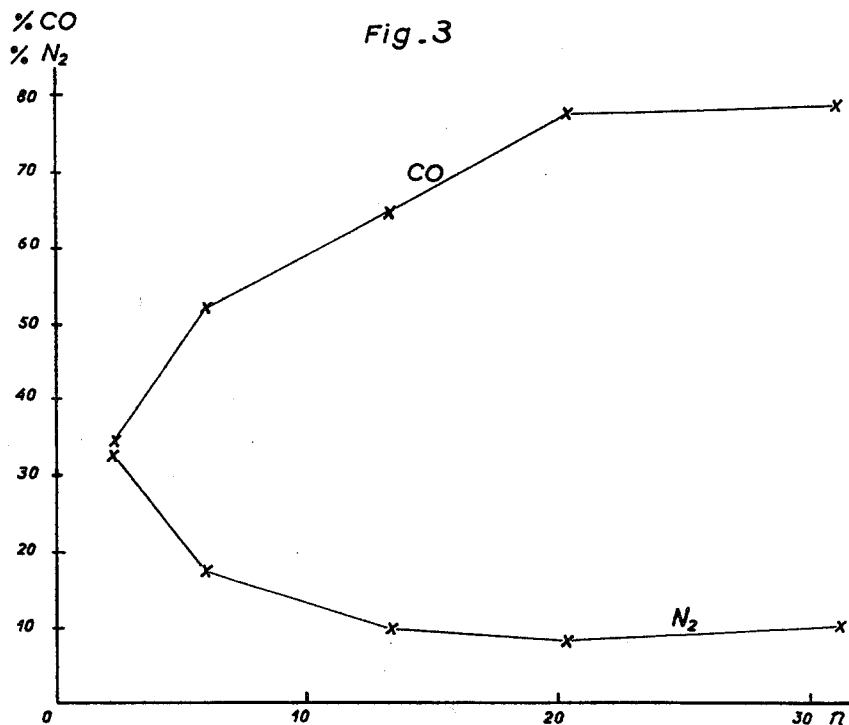
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EXHAUST FOR STEEL CONVERTER

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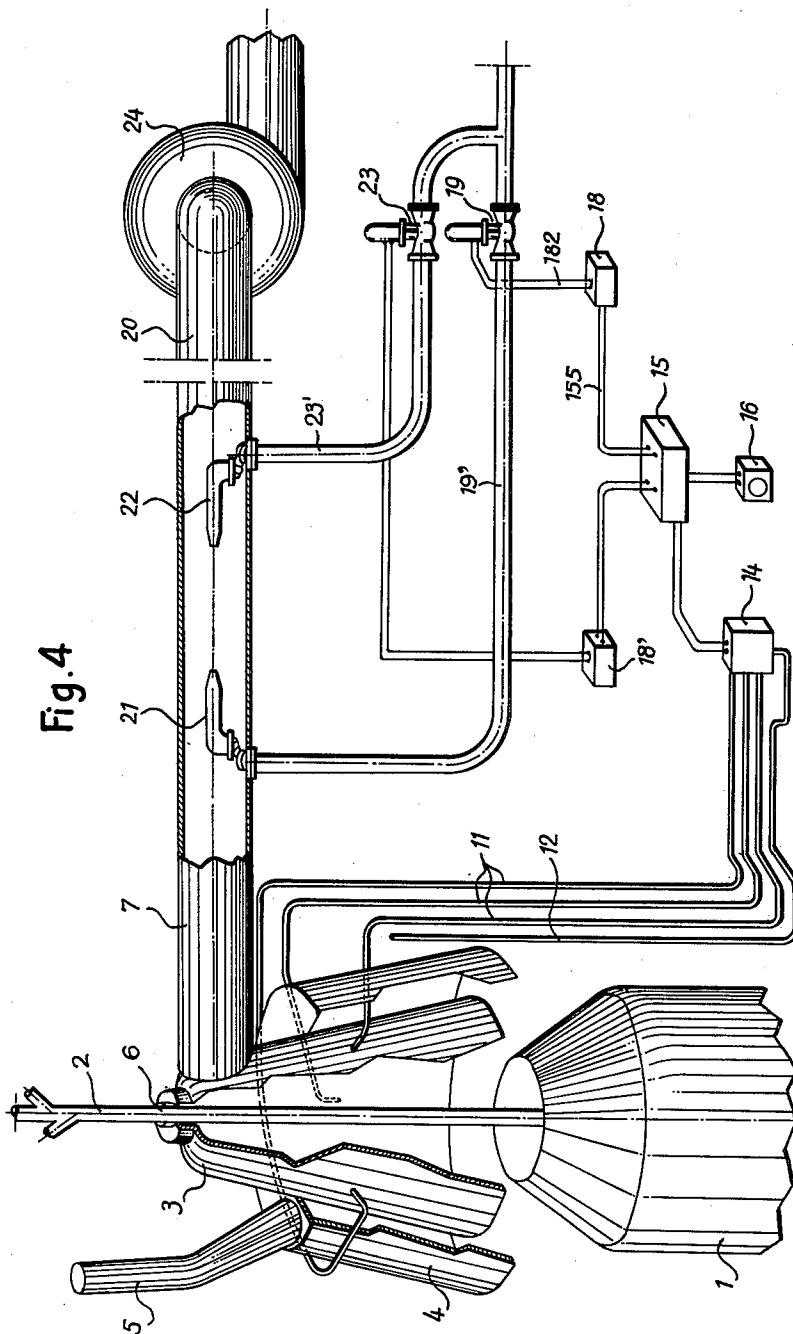
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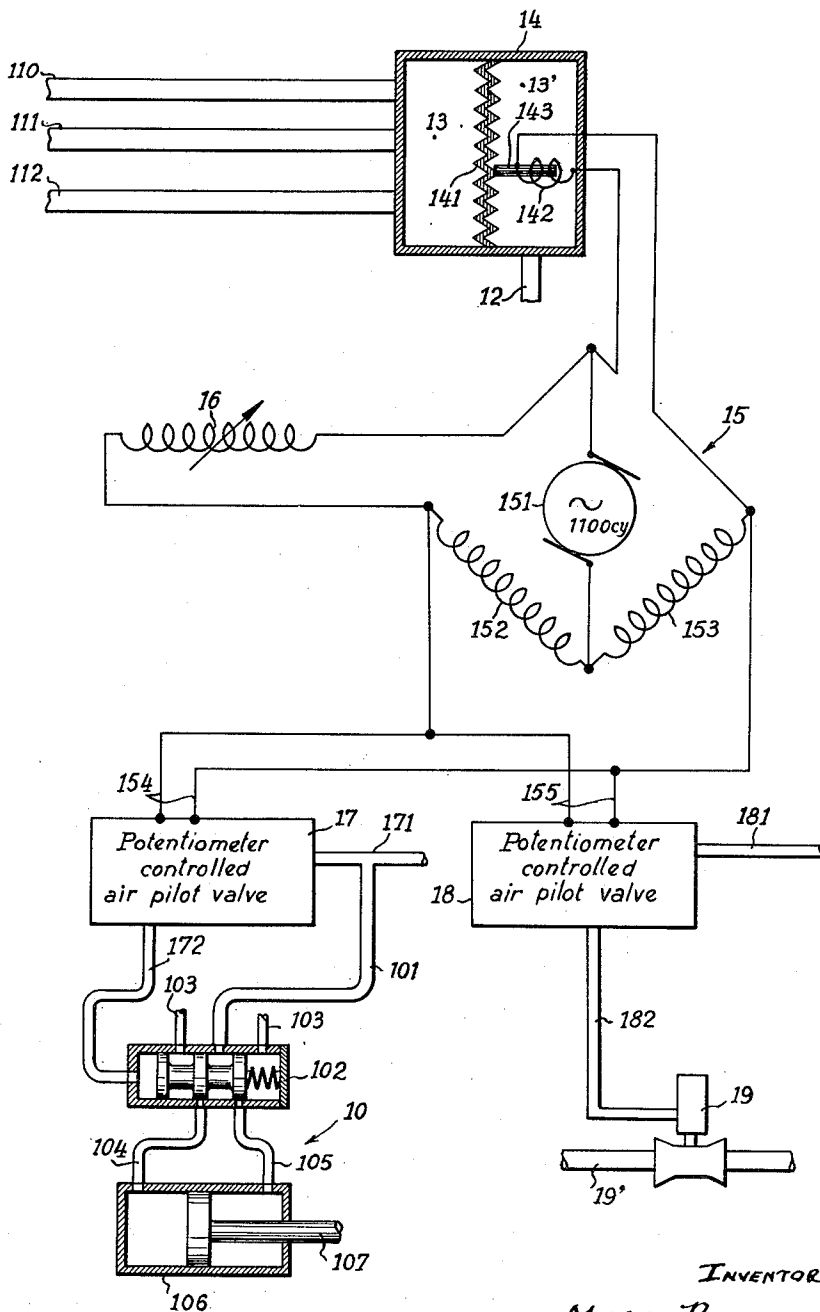
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EXHAUST FOR STEEL CONVERTER

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5 Sheets-Sheet 5

Fig. 5



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EXHAUST FOR STEEL CONVERTER

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Claims priority, application France, Jan. 28, 1959, 785,165, Patent 1,223,518; May 5, 1959, 793,935; Dec. 22, 1959, 813,790

14 Claims. (Cl. 75-60)

The present invention relates to improvements in the refining of molten metal baths by oxygen blasts directed into the bath through its surface, and more particularly to a process and apparatus for cooling the gases emanating from such baths and for evacuating the cooled gases from the premises.

This application is a continuation-in-part of my copending application Serial Number 4,646, filed on January 26, 1960, now abandoned.

It is known that, when a molten metal bath is refined by more or less oxidizing gases, the oxidation of the carbon in the molten metal bath, for instance pig iron, produces carbon monoxide and carbon dioxide. At the same time, reddish fumes of very finely divided iron oxide mingle with the refining gases at a high temperature as the gases leave the conversion vessel.

When such refining gases have a high heat content and are charged with iron oxide, which is the case when operating with pure oxygen, they must be recovered not only to use their thermal energy but also to remove therefrom, or to remove from the fumes issuing from their final combustion, iron oxide particles which would otherwise pollute the air.

However, the temperature of the gases emanating from the refining apparatus is almost equal to the temperature of the metal bath and thus may reach about 1550° C. This temperature may be raised even higher if even a small portion of these gases is burnt with air that may enter the stream of hot gases between the converter and the gas exhaustion apparatus.

Before these gases can be conducted to a purification stage, they must be cooled and this has been done by successively or simultaneously injecting atomized water into the gases and burning the mixture with a great excess of air, or by the use of heat exchangers, or waste boilers, permitting the heat of the fumes to be recuperated. All these known cooling processes have certain disadvantages, such as excessive humidity of the fumes, the great quantity of air necessary for the combustion and cooling, bulky installations situated necessarily immediately adjacent the steel producing apparatus and others.

Gas recovery apparatus is commonly designed to prevent mixing of air into the gas stream to avoid its combustion and the resultant increase in temperature. Conventional apparatus of this type includes a hood which is connected to the mouth of the converter, an air-tight seal being obtained, for instance, either by means of movable flaps, or by discharge of a certain amount of steam simultaneously inside and outside the hood, but it is difficult to produce a smooth surface around the mouth of the converter to attach the hood air-tightly thereto. Also, foaming of the slag may cause the hood to become obstructed and thus shut off the gas exhaust system. The flame in the converter cannot be seen through such a hood, which is a grave inconvenience in the refining operation.

It is the primary object of the present invention to overcome these disadvantages in the recovery, cooling and exhausting of hot gases from a steel refining bath

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and to provide a system in which the hot gases are recovered without admixing of the surrounding air and without escaping thereto.

It is also an object of this invention to cool the hot gases and to transport or entrain them a certain distance while being cooled. The cooled gases may then readily be further treated by extracting any dust particles therefrom and may be subjected to combustion in suitable apparatus removed from the steel producing locale.

These and other objects and advantages are obtained in accordance with the invention by recovering the hot refining gases at a point separated from and above the converter or other container for the molten metal bath to be refined. The recovered gases are entrained through a discharge conduit, a cooling agent is injected into this conduit and the cooling agent injection is so adjusted that there is substantially no pressure difference between the gases at the point of recovery and the atmosphere surrounding this point. For this purpose, the pressure of the gases at the point of recovery and the pressure of the surrounding atmosphere are sensed and the cooling agent injection is adjusted in response to the pressures sensed to maintain the pressure differential substantially at zero.

The cooling agent may be any suitable cold, non-oxidizing gas, such as blast furnace gas, nitrogen, or steam.

The apparatus devised to effectuate this process according to the invention comprises a hood positioned at a distance above the molten metal bath container and not air-tightly connected to this container. The evacuation conduit has means for entraining and cooling the gases. Furthermore, means is provided for adjusting the gas entraining means to regulate the volume of evacuated gases and the means for actuating the adjusting means is responsive to the respective pressures, of the gases at the lower portion of the hood and of the atmosphere surrounding this lower hood portion, means being provided for determining these pressures and the entraining means being so adjusted in response to these pressures that the pressure differential is maintained substantially at zero.

In accordance with one preferred embodiment, the hood is concentrically surrounded by a jacket which receives any small amounts of gases accidentally escaping from the hood.

According to another feature of the invention, the gas entraining and cooling means comprises a venturi tube and a cooling gas injector mounted in the evacuation conduit, preferably immediately adjacent to the neck of the venturi tube, this means being adjusted by adjusting the longitudinal position of the injector in a relation to the venturi tube and/or by varying the cooling gas supply to the injector, the direction of injection coinciding with the direction of the gas stream in the conduit. At the end of the refining operation, the injector may be moved into the venturi tube so as to close the same.

According to another embodiment of the invention, the gas entraining and cooling means comprises at least two injectors mounted in the evacuation conduit and extending substantially parallel to its axis, the gas injection of at least one of the injectors being effected in the direction opposite to the direction of gas injection of the other injectors, and means is provided for varying the supply of cooling gas to the oppositely directed injectors.

The above and other objects, advantages and features of the present invention will be more fully explained in connection with certain preferred embodiments thereof, as illustrated in the accompanying drawing, without

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in any way limiting the scope of the invention. In the drawing,

FIG. 1 is a schematic side view, with parts broken away, of an apparatus for recovering, cooling and evacuating refining gases according to the invention;

FIG. 2 is an illustrative chart showing the gas pressure curve in the hood during a refining operation;

FIG. 3 charts the composition of the gas recovered in the hood during a refining operation;

FIG. 4 is a view similar to that of FIG. 1 of another embodiment of the apparatus of the invention, and

FIG. 5 shows the control devices of the apparatus of FIG. 1 in a schematic manner illustrating detail features not visible in FIG. 1.

Referring now to the drawing and more particularly to FIG. 1, there is shown an upright cylindrical converter 1 which contains a charge of molten metal not visible in the drawing, such as of pig iron. A water cooled oxygen lance 2 extends through the mouth of the converter above the surface of the molten charge. A water cooled hood 3 of conical shape is mounted coaxially above the mouth of the converter. The orifice of the hood 3 at the base of the cone is spaced approximately 40 cm. from the mouth of the converter 1. A frustoconical sheet metal skirt 4 coaxial with the hood 3 defines with the latter an annular jacket space open at the bottom. The lower annular orifice of the jacket is on approximately the same level as that of the hood 3. The jacket is vented to a chimney or the like by a flue pipe 5. The oxygen lance 2 is axially slidable in the hood 3 in a packing 6 which is gas tight.

Near the apex of the conical hood 3 a discharge conduit 7 radially extending from the hood communicates with the hood cavity. The conduit 7 is integral with a venturi tube 8 in which an injector nozzle 9 is axially movable toward and away from a position in which the tip of the nozzle sealingly engages the constricted portion of the venturi tube. Axial movement of the injector nozzle 9 is actuated by a fluid pressure operated actuator 10 which will be presently described in more detail.

Three tubes of relatively small diameter have terminal openings in the cavity of the hood 3 on a level axially spaced from the hood orifice by a distance somewhat greater than the radius of the orifice, but smaller than the orifice diameter. The tube openings are uniformly offset about the axis of the hood 3. A similar tube 12 is mounted outside and adjacent the hood 3 and communicates with the surrounding atmosphere. The tubes transmit the pressure prevailing inside and outside the hood 3 to a control station sufficiently removed from the converter 1 not to be influenced by the heat radiated.

The control station and its cooperation with the aforesaid elements of the exhaust system will be most readily understood by simultaneous consideration of FIGS. 1 and 5. The three tubes 11, individually designated 110, 111, and 112 in FIG. 5 are connected to one chamber 13 of the two chambers in a differential pressure indicator 14. The other chamber 13' is permanently connected to the tube 12. The chambers are separated by a flexible diaphragm 141 which is flexed toward or away from a pick-up coil 142 by any difference in pressure in the two chambers, thereby varying the impedance of the coil 142. An iron core 143 is attached to the diaphragm and moves into and out of the coil.

The coil 142 is the variable element of a bridge circuit which includes an adjustable fixed element 16 consisting of a coil of adjustable impedance. The other elements of the bridge circuit are enclosed in a common housing 15 and include a source 151 of electrical current alternating at 1100 cycles per second and two coils of fixed impedance 152, 153. The output of the bridge circuit is fed to two conventional potentiometer controlled air pilot valves 17 and 18 by conductors 154 and 155 respectively. The pilot valves, which are of the well known nozzle-and-flapper type are operated by com-

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pressed air admitted through pressure pipes 171 and 181 respectively. They include a pneumatic relay, or amplifier, in order to increase the available power, and control the pressure of the compressed air in respective output pipes 172 and 182, according to the output signal of the bridge circuit.

The pipe 182 communicates with the pneumatic actuator of a diaphragm valve 19 which is arranged in a pressure gas conduit 19' and is normally held open by a return spring (not shown).

The air pressure in the pipe 172 actuates movement of a pilot controlled slide valve 102 in one direction whereas the return movement of the valve is spring actuated. The slide valve 102 receives compressed air through a conduit 101 and is equipped with a vent 103. It communicates with the two spaces of a cylinder 106 in front of and behind a piston 107 by means of tubes 104 and 105 to charge one of the cylinder spaces with compressed air from the conduit 101 and simultaneously to vent the other cylinder space so that the piston 107 is moved inward or outward of the cylinder 106 depending on the position of the valve 102. The slide valve 102, the cylinder 106, the piston 107, and the piping connecting them jointly constitute the aforementioned fluid pressure operated actuator 10.

The aforesaid apparatus operates as follows:

The gases projected from the converter mouth in a stream enter the lower orifice of the hood 3. A very small portion of the gases and of the solid particles entrained thereby may spill over the edge of the hood and is exhausted through the jacket formed by the skirt 4 and through the flue 5. The pressure under the hood is maintained very close to atmospheric pressure as will presently become apparent. Only an extremely small amount of the atmosphere surrounding the gas stream is entrained by the movement of the latter. The lack of a significant pressure differential between the interior cavity of the hood 3 and the atmosphere prevents air from being sucked into the exhaust system, and also prevents the stream of combustion gases from being diverted laterally from its intended path.

The gas stream is cooled somewhat by contact with the water cooled hood and may additionally be cooled in a well-known manner, if so desired, by injecting a water spray into the discharge conduit 7. The amount of water sprayed may be controlled by a pyrometer or other temperature sensitive device arranged under the hood 3 or by a flowmeter measuring the rate of gas flow, or both.

The necessary pressure drop along the discharge conduit 7 for inducing flow of the gas stream away from the hood 3 is supplied by a non-oxidizing gas such as nitrogen or steam supplied through the pressure conduit 19' and axially discharged by the nozzle 9 into the central constriction of the venturi tube 8. The suction effect produced is controlled by the position of the nozzle 9 which may more or less obstruct passage through the venturi tube, and by the amount of pressure of the non-oxidizing or inert gas injected.

The position of the nozzle 9 and the flow of inert gas to the nozzle 9 are controlled by the pressures sensed by the tubes 11 and 12. The pressure within the hood 3 should be taken at a point axially inwardly spaced from the orifice to make sure that the sensing element, in this case a terminal opening of a tube 11, be actually in the gas stream and not in the air surrounding it. Yet, it is desirable to measure the pressure as close as possible to the point where the entry of ambient air into the hood 3 is to be prevented. A compromise will readily be found for any given operating conditions. In an arrangement of the type illustrated, with a conical hood tapering from the hood orifice uniformly toward the apex at an angle of approximately 75°, the preferred location of the terminal openings of the tubes 11 is slightly more than one radius of the hood orifice above the level of the latter.

FIG. 2 shows a pressure recording derived from the output of the bridge arrangement 15 in a well-known manner and indicating pressure differentials sensed by the tubes 11 and 12 inside and outside the hood 3 in millimeters water column as a function of time in minutes. The beginning and end of the refining operation for a batch of pig iron in the converter 1 occur respectively at time zero and at 8½ minutes. Six tons of pig iron are refined in this period by oxygen fed through the lance 2 at a rate of 21 cubic meters per minute, as measured at standard temperature, and pressure (STP).

As can readily be seen from the recording, the average pressure differential between the inside of the hood and the ambient atmosphere is approximately 1.5 millimeters water column at the level of measurement, the pressure being higher inside the hood. The pressure differential measured is influenced by the difference in density between the hot gases and the ambient air, and also by the pressure drop in the hood due to the fact that the apertures of the tubes 11 are not actually at the orifice of the hood 3. These two factors balance each other in such a manner that the actual pressure differential at the level of the hood orifice is very close to zero on an average when the average differential of 1.5 millimeters is recorded.

The instantaneous values of the pressure differential represented in FIG. 2 vary between one and two millimeters with the exception of a brief instant toward the end of the run when the pressure drops to zero at the point of measurement for extraneous reasons. The very great uniformity of the pressure differential is maintained by the above described control system. The bridge circuit can be adjusted by means of the coil 16 to be at equilibrium for any desired value of the pressure differential. The displacement of the membrane 141 by changes in pressure differential from the desired value causes proportional voltage to appear across the output terminals of the bridge. The air pilot valves 17 and 18 are potentiometer controlled and deliver air pressure proportional to said bridge circuit output voltage, respectively shifting the slide valve 102 and membrane valve 19. When the pressure differential exceeds any desired value, the slide valve 102 initiates relatively slow movement of the nozzle 9 toward or away from the constriction of the venturi 8, according to the direction of the pressure differential. Simultaneously, the air pilot valve 18 actuates the membrane valve 19 and controls the passage of inert gas from the pressure conduit 19' toward the nozzle 9. The variations of gas flow through the conduit 19' compensates almost immediately for pressure fluctuations in the hood.

The valve 19 thus responds quickly, for example, within ½ second, to short term changes in pressure within the hood 3, whereas the slower movement of the nozzle 9 is controlled by long term changes in the system, and has a response time of about two seconds.

The connection of the three tubes 11 to the differential pressure indicator 14 tends to compensate for any pressure differences that may develop across the opening of the hood, as the resulting pressure applied to indicator 14 is the mean pressure in the three tubes. It will also keep the apparatus functioning if any one, or even two of the terminal apertures of the tubes in the hood should be obstructed by flying dust particles.

FIG. 3 shows the concentrations of nitrogen and carbon monoxide determined in the gases withdrawn from the conduit 7 during the run mentioned above in connection with FIG. 2. The gas concentrations are plotted in percent of the total gas discharged versus the oxygen fed to the converter as expressed in cubic meters oxygen STP per ton of pig iron charge. The stream of gas released from the converter consists virtually exclusively of carbon monoxide and carbon dioxide. The nitrogen content of the gases withdrawn through the conduit 7 thus can originate only in the ambient air of which a portion is drawn into the exhaust system. Although there

is no fixed connection between the mouth of the converter 1 and the hood 3, it is seen that the amount of air sucked into the exhaust system is very small, particularly after relatively stable conditions have been established.

A somewhat modified arrangement of the apparatus of FIG. 1 is shown in FIG. 4, the same reference numerals being used for identical parts to obviate a repetition of the description of the elements of the apparatus described hereinabove.

As shown in FIG. 4, the venturi tube 8 and single movable injector nozzle 9 of FIG. 1 are replaced by two injector nozzles 21 and 22 located in the conduit 7 for discharge of gases in opposite axial directions. An inert cooling gas such as steam or nitrogen is injected by the nozzle 21 in the direction of movement of the collected waste gases, whereas the nozzle 22 discharges a cooling gas in the opposite direction. The flow of gas to the nozzles 21 and 22 is controlled by diaphragm valves 19 and 23 arranged in the respective supply pipes 19' and 23'. The valve 19 is controlled in the manner described above in connection with the apparatus of FIG. 1. The valve 23 is controlled by a potentiometer controlled air pilot valve 18' identical in structure and function with the pilot valve 18. The diaphragm valve 23, however, is held in a normally closed position by a return spring (not shown) and is opened by the action of the pilot valve 18' when the pressure differential between the hood 3 and the ambient atmosphere exceeds a predetermined value, whereas the valve 19 is simultaneously closed.

Adequate draft for transporting the waste gases over a substantial distance to a location remote from the converter 1 is provided by a turbine fan 24 of known type connected to an exhaust pipe 20 which may be integral with the discharge conduit 7.

The reddish dust particles which are suspended in the exhausted gases may be precipitated from the gases and recovered in any desired manner either prior to or after combustion of the carbon monoxide contained in the gas. The gases withdrawn from the immediate area about the converter may be conveyed at a relatively low temperature to distant locations for further processing or for utilization of their latent heat content without any difficulty. There is no compelling reason to install the gas purification plant or the waste boilers under which the gases may be burnt in the immediate vicinity of the converter, and more convenient location may be selected at will, thus facilitating access to the converter for operation and maintenance.

While the invention has been specifically described in connection with certain specific embodiments, it will be clearly understood that many variations and modifications in apparatus and procedure may occur to the skilled in the art, particularly when benefitting from the present teachings, without departing from the spirit and scope of this invention as defined in the appended claims.

What I claim is:

1. An exhaust arrangement for a metal converter and like container, comprising discharge means communicating with the ambient atmosphere for discharging a stream of gases from said container; hood means having an orifice communicating with the ambient atmosphere and arranged opposite said discharge means for receiving said stream, said orifice being spaced from said discharge means; a conduit communicating with said hood means; suction means in said conduit for conveying gas from said hood means to said conduit; and suction control means responsive to a difference of the respective pressures of said ambient atmosphere and of said gases received in said hood means for controlling said suction means, whereby dilution of said gas stream by said ambient atmosphere may be substantially avoided.

2. The arrangement of claim 11, wherein said suction control means is responsive to said respective pressures for maintaining the pressure of said gases in said conduit

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adjacent said orifice substantially equal to the pressure of said ambient atmosphere.

3. The arrangement of claim 1, further comprising jacket means having an orifice opposite said discharge means and substantially surrounding said orifice of said hood means for receiving portions of said stream spilled from the orifice of said hood means.

4. An apparatus for cooling gases emanating from a molten metal bath being refined in a container by a blast of oxygen forced into the bath and for evacuating the cooled gases, comprising a hood having a downwardly open lower portion positioned at a distance above the container and defining therewith a space open to the atmosphere, an evacuation conduit connected to said hood, a venturi tube in said conduit, a longitudinally extending and movable injector mounted in said venturi tube, means for supplying a cooling gas to said injector, the gas injection being effected in the direction of the stream of gases in the conduit, the venturi tube and the cooling gas injector constituting means for entraining and cooling the gases in said conduit, means for adjusting the longitudinal position of the injector in relation to the venturi tube, means for determining the pressure of the gases at the lower portion of the hood, means for determining the pressure of the atmosphere surrounding said lower portion, and means responsive to the pressures determined for actuating the adjusting means so that the difference between said pressures is maintained substantially at zero, whereby dilution of said gases by said atmosphere is substantially avoided.

5. The apparatus of claim 4, further comprising additional means responsive to said pressures for varying the rate of supply of said cooling gas to said injector.

6. An apparatus for cooling gases emanating from a molten metal bath being refined in a container by a blast of oxygen forced into the bath and for evacuating the cooled gases, comprising a hood positioned at a distance above the container and not air-tightly connected thereto, an evacuation conduit connected to said hood, a venturi tube in said conduit, a longitudinally extending injector mounted in said venturi tube, means for supplying a cooling gas to said injector, the gas injection being effected in the direction of the stream of gases in the conduit, the venturi tube and the cooling gas injector constituting means for entraining and cooling the gases in the conduit, means for varying the supply of cooling gas to said injector to regulate the volume of evacuated gas entrained by the cooling gas through the venturi tube, means for determining the pressure of the gases at the lower portion of the hood, means for determining the pressure of the atmosphere surrounding said lower portion, and means responsive to said pressures for actuating the cooling gas supply adjusting means so that the difference between said pressures is maintained substantially at zero, whereby dilution of said gases by said atmosphere is substantially avoided.

7. An apparatus for cooling gases emanating from a molten metal bath being refined in a container by a blast of oxygen forced into the bath and for evacuating the cooled gases, comprising a hood positioned at a distance above the container and not air-tightly connected thereto, an evacuating conduit, connected to said hood, a venturi tube in said conduit, a longitudinally extending and movable injector mounted in said venturi tube, means for supplying a cooling gas to said injector, the gas injection being effected in the direction of the stream of gases in the conduit, the venturi tube and the cooling gas injector constituting means for entraining and cooling the gases in said conduit, means for adjusting the gas entraining means to regulate the volume of evacuated gases, means for determining the pressure of the gases at the lower portion of the hood, means for determining the pressure of the atmosphere surrounding said lower portion, means responsive to said pressures for actuating the adjusting means so that the difference between said pressures is

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maintained substantially at zero, whereby dilution of said gases by said atmosphere is substantially avoided, and means for displacing the injector in relation to the venturi tube so that the injector closes the tube at the end of the refining operation.

8. An apparatus for cooling gases emanating from a molten metal bath being refined in a container by a blast of oxygen forced into the bath and for evacuating the cooled gases, comprising a hood positioned at a distance above the container and not air-tightly connected thereto, an evacuation conduit connected to said hood, at least two injectors mounted in said conduit and extending longitudinally substantially parallel to the axis of the conduit, means for supplying a cooling gas to said injectors, the gas injection of at least one of said injectors being effected in a direction opposite to the direction of gas injection of the other injectors, the oppositely directed injectors constituting means for entraining and cooling the gases in said conduit, means for varying the supply of cooling gas to said injectors to regulate the volume of evacuated gases, means for determining the pressure of the gases at the lower portion of the hood, means for determining the pressure of the atmosphere surrounding said lower portion, and means responsive to said pressures for actuating the adjusting means so that the difference between said pressures is maintained substantially at zero, whereby dilution of said gases by said atmosphere is substantially avoided.

9. In a process for removing a gas from an open container substantially without dilution by ambient air, the steps of:

- (a) discharging a stream of gas from said container in a predetermined direction;
- (b) receiving the discharged stream in an orifice communicating with a conduit, the orifice being spaced from said container in said direction, and the gas stream communicating with the ambient atmosphere while in the space between said container and said orifice;
- (c) sensing the pressure of said atmosphere;
- (d) sensing the pressure of said gas in a portion of said conduit; and
- (e) actuating movement of said gas in said conduit in a direction away from said orifice responsive to the difference between the sensed pressures of said atmosphere and of said gas to make the pressure of said gas in said orifice substantially equal to the pressure of said atmosphere.

10. In a process for exhausting waste gases from an open container through a conduit, said conduit communicating with an orifice separated from said container by a space open to the ambient atmosphere substantially without diluting said gas by said atmosphere, the steps of:

- (a) discharging said waste gases from said container in a stream toward said orifice;
- (b) establishing a gas pressure gradient in said conduit, the pressure in said conduit diminishing in a direction away from said orifice, whereby said stream enters said orifice and flows in said conduit away from said orifice;
- (c) sensing the pressure of said atmosphere adjacent said space;
- (d) sensing the pressure of the gas in a portion of said conduit; and
- (e) controlling said pressure gradient in response to the difference between the sensed pressures of said atmosphere and of said gas in such a manner as to maintain the gas pressure at said orifice at a value substantially identical with the pressure of said atmosphere adjacent said space.

11. An exhaust arrangement for a stream of gas comprising, in combination:

- (a) discharge means for discharging a stream of gas in a predetermined direction;
- (b) gas receiving means having an orifice spaced from

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said discharge means and arranged opposite said discharge means for receiving said stream, said discharge means and said orifice defining therebetween a space open to the atmosphere, said gas receiving means including a conduit communicating with said orifice;

(c) suction means for drawing said stream through said conduit away from said orifice;

(d) first sensing means for sensing atmospheric pressure adjacent said space;

(e) second sensing means for sensing gas pressure in said conduit intermediate said orifice and said suction means; and

(f) suction control means connected to said first and second sensing means for controlling the suction of said suction means in response to the difference of the respective pressures sensed by said first and second sensing means in such a manner as to maintain the pressure in said gas receiving means adjacent said orifice at a value substantially identical with the atmospheric pressure adjacent said space, whereby dilution of said stream of gas by said atmosphere is substantially avoided.

12. An arrangement as set forth in claim 11, wherein

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said second sensing means is in said conduit and spaced from said orifice.

13. In the process of claim 9, said movement of said gas in said conduit being actuated by injecting a fluid into said gas in said conduit in a direction away from said orifice, the rate of injection of said fluid being varied in response to said sensed pressures.

14. In the process of claim 13, said gas being combustible, and said fluid being inert to said gas.

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