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[54] **WASTE GAS FLOW SYSTEM FOR METAL-TREATING APPARATUS**

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[58] **Field of Search** ..... 266/16, 17, 35, 36 P

[56] **References Cited**

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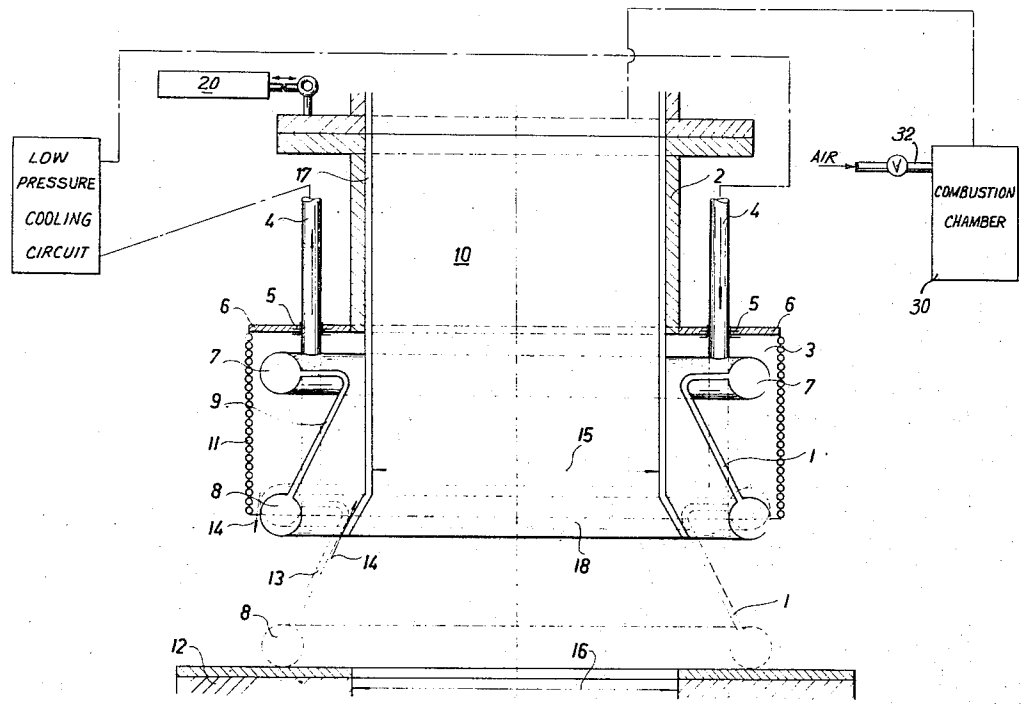
[57] **ABSTRACT**

A metal-treating apparatus which includes a vessel in which metal is refined and a waste-gas conduit which receives gas issuing from the vessel. Between the latter conduit and the top end of the vessel is a ring assembly which is movable along the end of the waste-gas conduit adjacent the vessel between a closed position engaging the vessel and an open position spaced therefrom. A structure which surrounds the waste-gas conduit defines a chamber in which the top end of the ring assembly is located even when the latter is in its closed position, and in this closed position the ring assembly defines with this latter structure and with the waste-gas conduit a pair of gaps through which any waste gas which seeks to escape while flowing into the waste-gas conduit must flow while changing its direction at least twice.

16 Claims, 2 Drawing Figures



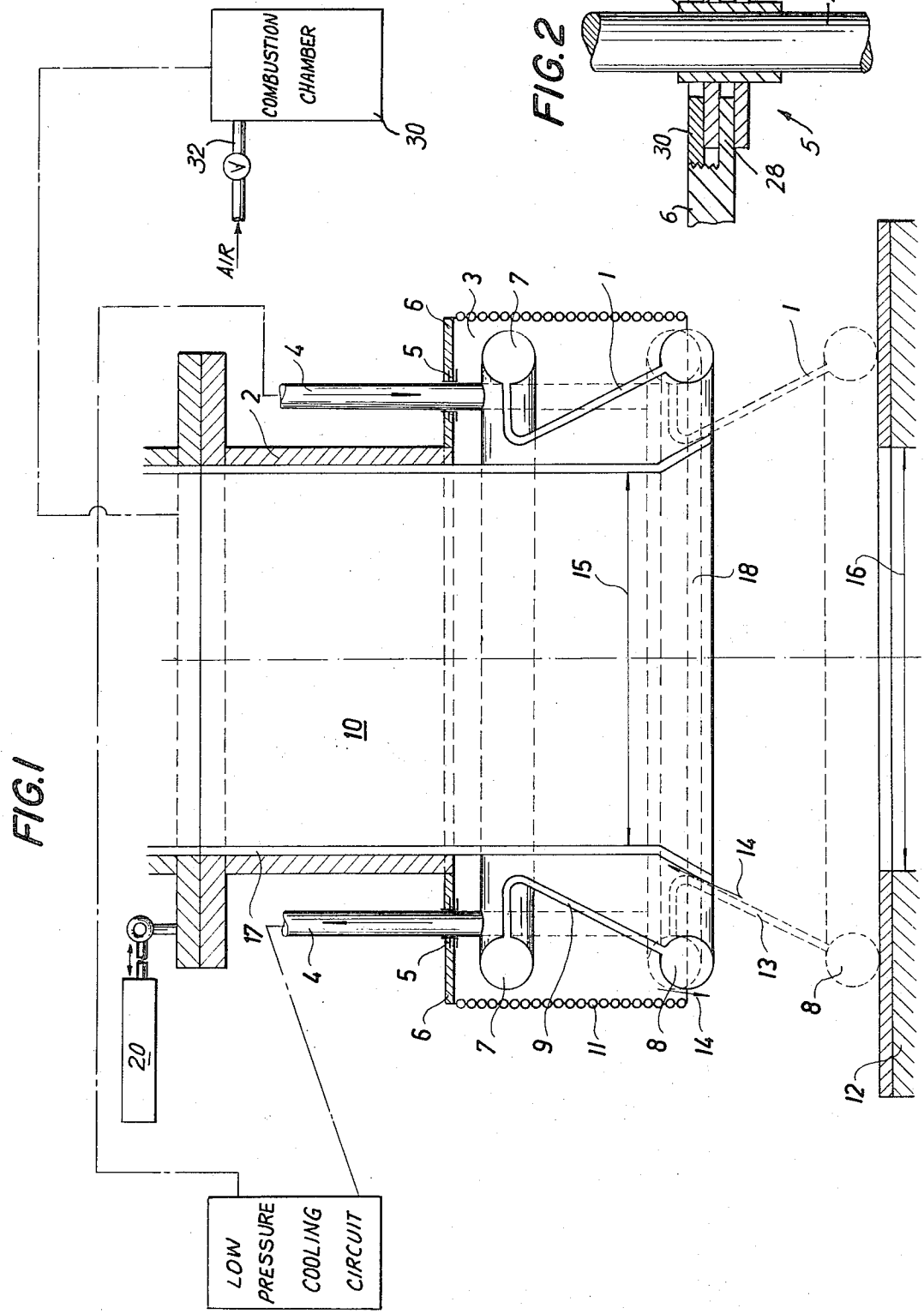

COMBUSTION CHAMBER
30
32
AIR
LOW PRESSURE COOLING CIRCUIT
20
10
1
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FIG. 1

22
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FIG. 2

WASTE GAS FLOW SYSTEM FOR METAL-TREATING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for treating metal.

In particular, the present invention relates to that type of metal-treating apparatus in which metal is refined in a vessel such as a converter with the waste gas which issues from the vessel being received in a waste-gas conduit. Since a vessel such as a converter is tiltable the waste-gas conduit must be spaced from the top discharge end of the vessel, and suitable structure must be provided to close the space between the top end of the vessel and the waste-gas conduit so as to prevent the waste gas from escaping to the outer atmosphere before it reaches the waste-gas conduit.

In metal-treating apparatus of this general type which conventionally includes a converter and a waste-heat boiler for receiving the waste gas, it is known to provide shiftable ring assemblies for sealing the space between the vessel and the waste-gas conduit. Such conventional ring assemblies suffer, however, from several disadvantages. For example, conventional ring assemblies of this type readily acquire during operation deposits of slag and scale formations at their exterior surface so that as a result of these latter factors such ring assemblies can be moved only with increasing difficulty as scale continues to form, for example. Moreover, the seal between the hood of the waste-heat boiler and the shiftable ring assembly is not tight during operation, so that there is a continuous escape of carbon monoxide containing converter gas into the surrounding atmosphere.

Particularly in recent times, plants such as steel works have been operated in such a way as to increase the output of the metal-treating installations which are on hand. These attempts to increase the output have not been accompanied, however, by any significant redesign of the waste-gas cooling and cleaning installations. The result is that a considerable part of the waste gas expands out into the work areas where the operating personnel are situated so as to subject them to undesirable working conditions and as to their endanger health.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to eliminate the above drawbacks.

In particular, it is an object of the present invention to provide between the discharge end of a metal-treating vessel and a waste-gas conduit which receives waste gas therefrom a structure which will operate effectively to prevent escape of waste gas without reaching the waste-gas conduit.

It is a further object of the present invention to provide a structure of this type which does not in any way detract from or provide any burden on the normal operation of the metal-treating installation.

Furthermore it is an object of the present invention to provide a structure of this type which will operate effectively to prevent escape of waste gas before reaching the waste-gas conduit not only during normal operations but also during abnormal operations or, in fact, at any time when less than ideal operating conditions prevail.

Yet another object of the present invention is to provide a construction of this type which will achieve the desired results while having a long operating life with full capability of withstanding not only the high temperatues but also the great degree of changes in temperature which occur in installations of the above type.

Furthermore, it is an object of the present invention to provide a structure of this type which will reliably prevent combustion of the waste gas from taking place in the waste gas conduit itself.

In accordance with the invention, the metal-treating apparatus includes a tiltable vessel means in which metal is treated as by being refined in the interior of the vessel means. This vessel means has a top open end through which waste-gas discharges, and a waste-gas conduit means is aligned with but spaced from the discharge end of the vessel means to receive the waste gas therefrom. An annular means surrounds the waste-gas conduit means at its end region which is adjacent the vessel means, and this annular means defines a chamber in which a ring means is located when this ring means is in an upper open position. The ring means is shiftable down to a lower closed position engaging the top end surface of the vessel means and extending between the latter and the waste-gas conduit means to close the space between the top end of the vessel and the end of the waste-gas conduit means nearest to the top end of the vessel. This ring means when in its closed position still has an upper end region extending into the above chamber, and this upper end region defines with th waste-gas conduit means and with an outer wall of this chamber a pair of gaps through which any waste gas which seeks to escape must flow while changing its direction at least twice.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic sectional elevation of one embodiment of a construction according to the invention, FIG. 1 showing the upper end of a metal-treating vessel and the lower end of a waste-gas conduit means as well as diagrammatically illustrating various installations which cooperate with the structure of the invention; and

FIG. 2 is a fragmentary sectional elevation showing at an enlarged scale, as compared to FIG. 1, details of a sealing means for a rod which shifts the ring means.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, there is fragmentarily illustrated in FIG. 1 the top end region of a vessel means 12 such as a converter in which metal is refined. As is well known such converter vessels are supported on suitable trunnions so as to be tiltable to an inclined position for receiving a charge, for example, while during operations such as during blow periods for steel converters the vessel means 12 will have an upright position as indicated in FIG. 1.

Situated over the vessel means 12 is a waste-gas conduit means 2 which is aligned with the discharge opening 16 of the vessel means 12 so as to receive the waste gas which issues from the vessel means 12 during the metal-refining operations. This waste-gas conduit means 2 is in the form of a laterally shiftable hood which may be horizontally shifted by a conventional

structure such as the hydraulic assembly **20** schematically shown in the drawing connected operatively with the waste-gas conduit means **2**.

The end region of the waste-gas conduit means which is nearest to the vessel means **12** is surrounded by an annular means which defines the chamber **3**, this annular means being made up of an annular wall **6** which is fixed to the waste-gas conduit means **2** in order to define that end of the chamber **3** which is distant from the vessel means **12**. The annular means includes in addition to the end wall **6** of the chamber **3** a cylindrical outer wall **11** formed by a plurality of tubes. Thus, the annular means **6, 11** defines the chamber **3** in which expansion of gas may take place, as referred to below. The interior of the chamber **3** receives a shiftable ring means **1** which is shown in FIG. **1** in two positions. The solid-line position is the upper open position of the ring means **1** where the latter is situated almost entirely within the chamber **3**, while the lower dotted line position **13** is the closed position of the ring means **1** where it engages the top end surface of the vessel means **12** and extends between the latter and the waste-gas conduit means **2** for closing the space between the vessel means **12** and conduit means **2**. In the illustrated open position of the ring means **1** it is possible for air to enter freely into the waste-gas conduit means **2**. However, in the lower closed position of the ring means **1**, the latter has a sealing function for preventing waste gas from reaching the space which surrounds the installation while at the same time preventing air from entering into the waste-gas conduit means.

The ring means **1** is made up of upper and lower circular headers **7** and **8**, respectively, in the form of endless pipes. Between these headers **7** and **8** the ring means **1** includes a plurality of upright tubes **9** having the angular configuration illustrated and fixed at their opposed ends to the headers **7** and **8** while communicating with the interiors thereof. These tubes **9** are located one directly next to the other and are springy for the purpose referred to below. Because of the angular configuration of the tubes **9** the ring means **1** has the tapered construction illustrated according to which the ring means **1** converges in the direction of flow of waste gas from the vessel means **12** into the waste-gas conduit means **2**.

As is clearly shown in FIG. **1**, in the lower closed position **13** of the ring means **1**, the latter defines with the waste-gas conduit means **2** and the annular means **6, 11**, a pair of gaps **14**. Thus, the tubes **9** form at their upper portions with the lower region **18** of the wast-gas conduit means **2** an inner narrow gap **14** while the header **7** forms with the lower end of the cylindrical tubular wall **11** an outer annular gap **14**. The lower part **18** of the waste-gas conduit means **2** is tapered so that it diverges toward the vessel means **12**. Depending upon the prevailing pressure relationships, the outside ambient air may seek to flow into the gas-conduit means **2** or the waste gas may seek to escape into the outer surrounding atmosphere, and either of these types of gas flow must take place with the structure of the invention through the gaps **14** which compel the gas to change its direction and flow at least twice. As a result of the formation of these gaps **14**, as well as as a result of the magnitude of the chamber **3**, the tapered configuration of the end **18** of the conduit means **2** and the size of the interior cross section **15** thereof, it is possible to influence the pressure loss of the flowing gases in such a way that there will be practically no infiltration of air into the waste-gas conduit means **2** or escape of waste gas out to the outer atmosphere through the above combination of gaps. As a result of this construction it is furthermore possible to convey the waste gas through the waste-gas conduit means **2** to a waste-heat boiler with combustion taking place at a low, less than atmospheric pressure, without, however, causing pulsations of waste gas to result in escape of poisonous, dust-containing waste gas into the outer atmosphere.

With the above wast gas flow system of the invention the following relationships prevail:

First, considering the waste gas which issues from the vessel means **12**, the reactions taking place during refining in the vessel means **12** and the generation of hot waste gases which are driven upwardly result in the issue of a free jet of waste gas through the discharge opening **16** of the vessel means **12** into the free surrounding area, and the construction of the vessel means **12** at its discharge opening **16** causes the latter to operate as a nozzle. The speed profile of this jet directly at the discharge opening **16** is almost uniform throughout, except that at the outer edge regions of the jet the speed thereof falls to a zero value. As a result of the sharp speed gradient, pronounced torsional shearing forces act at the exterior surface of the jet and the instability at this exterior surface of the stream of waste gas results in the creation of disorganized individual whirling gas regions so that turbulence is created at the exterior surface of the gas stream. The torsional shearing forces in the free turbulent exterior surface of the jet of waste gas results in acceleration of the medium which surrounds this jet, so that the surrounding air is carried along with the waste gas stream while particles of gas in the region of the exterior surface of the gas stream have their movement retarted. In the immediate vicinity of the stream of waste gas the surrounding air which is carried along with the waste gas has a low speed and the pressure gradient transversely of the stream, from the interior stream to the outer surrounding atmosphere can be considered small as long as the flowing stream of waste gas does not reach the speed of sound. As a result there prevails in the interior of the gas stream almost the same pressure as at the exterior of this stream.

The kinetic energy of the free jet of upwardly driven waste gas is adequate to carry the waste gas up through a flue or chimney from the gallery in which the operations take place through the roof thereof into the outer atmosphere, but this kinetic energy is not sufficient to overcome the resistance encountered in a waste-gas cooling and cleaning installation. Therefore it is necessary to utilize a suction installation for the purpose of drawing the waste gas through the waste-gas cooling and cleaning installations.

The suction installation creates in the space surrounding the inlet **18** to the waste-gas conduit means a low-pressure field of less than atmospheric pressure, and under the influence of this latter low pressure the free jet of waste gas and the air at the exterior surface thereof flow into the inlet **18** and into the interior of the waste-gas conduit means **2**.

The size of the interior cross section **15** of the waste-gas conduit means **2** is reduced to such an extent that the extent of vacuum which prevails is still sufficient to pull the waste gas into the conduit means **2**. However, the air at the edge of the inlet opening **18** is not moved

or is moved only to an extremely small extent. The size of the interior cross section **15** of the waste-gas conduit means is made about 20 percent smaller than the size of the discharge opening **16** of the vessel means **12.**

This latter reduction in the size of the interior cross section **15** furthermore reduces to a minimum the extent to which the surrounding air is carried along with the stream of waste gas entering into the conduit means **2.**

The air chamber which surrounds the jet of waste gas issuing from the discharge opening **16** of the vessel means **12** and which is limited by the ring means **1** when the latter is in its lower closed position is under the influence of the stream of waste gas which carries along the surrounding air and the extent of vacuum prevailing at the edge of the inlet **18.** There is, therefore, a tendency to suck air from the exterior through the gaps **14** into the chamber which surrounds the stream of waste gas between the discharge outlet **16** and the waste-gas inlet **18.** However, becuase of their configuration, these gaps resulting from the structure of the invention prevent the flow of outer air into the ring means **1** to a very great extent.

Thus, during normal refining operations a faultless seal is assured.

The structure of the invention also is effective, however, even during abnormal operations.

If it should happen that the column of waste gas starts to pulsate, either as a result of reactions which take place in the converter or as a result of combustion in the waste-heat boiler, then the pressure will increase in the stream of waste gas at the discharge opening of the converter with the same frequency as the pulsations. During a pressure increase in the stream of waste gas there will first be a compression of the air in the chamber between the ring means **1,** when the latter is in its lower closed position **13,** and the stream of waste gas, so that the waste gas will fill this latter chamber and will finally expand through the inner gap **14** into the chamber **3.** The size of the chamber **3** is disigned so that it is capable of receiving the expanding gas and the resistance to flow provided by both of the gaps **14** is designed to provide an effective prevention of escape of the waste gas into the outer atmosphere.

A particularly intense vacuum at the edge of the inlet **18** acts on the pulsating stream of waste gas so that the waste gas which expands into the chamber **3** is again sucked into the waste-gas conduit means **2.**

A second abnormal type of operation takes place when the stream of waste gas does not flow straight up from the discharge opening **16** but instead is inclined as a result, for example, of slag deposits primarily at one side of the discharge opening **16.** The inclined stream will indeed for the most part reach the inlet **18** of the waste-gas conduit means, but part thereof will engage the ring means **1** when the latter is in its lower position **13** and after overcoming the resistance of the inner gap **14** will flow into the chamber **3.** Since, however, the extent of vacuum at the edge of the inlet **18** becomes even stronger at the side of the stream of waste gas which is diametrically opposed to the part thereof which engages the ring means **1,** the gases which reach the chamber **3** will be sucked into the waste-gas conduit means at this diametrically opposed side of the gas stream. The gap **14** between the header **7** and the cylindrical shielding wall **11** is dimensioned so that the localized increase in pressure in the chamber **3** effectively prevents escape of waste gas into the outer atmosphere.

Since the size of the interior cross section **15** of the waste-gas conduit means **2** is smaller than the size of the discharge opening **16** of the vessel means **12,** any slag which is thrown out of the vessel means will immediately flow back into the interior thereof. Moreover, the refining process will take place in a very smooth manner, additionally because the slag forms at the converter surface in a quicker and better manner with the discharge opening of the converter closed by the ring means **1,** and thus shorter refining periods can be achieved.

Since the slag flows entirely back into the converter, large deposits of slag at the mouth of the converter are reliably avoided. Therefore, periodic ram or hammer cleaning operations, with the loss of operating time occasioned thereby, are avoided and it is possible to blow additional charges with the structure of the invention.

In addition, since whatever slag is thrown out entirely flows back into the interior of the converter, slag deposits in the interior of the waste-gas conduit means are avoided. Also in this case the conventional interruptions in the blowing operations for cleaning purposes are not required and therefore the production output can be increased.

Inasmuch as the interior cross section **15** of the waste-gas conduit means is smaller, the tremendous stress at the exposed surface in the region of the converter outlet is also smaller. Therefore, costs involved in eventual replacement of components are smaller. Also, the time required for disassembly and assembly purposes are thus rendered smaller for the same reasons.

Inasmuch as the waste gas flows into the waste-gas conduit means while air is excluded, the waste-gas conduit means is thermally stressed only by the sensible heat of the waste gas. The enormous streaming flames which otherwise occur as a result of combustion of the waste gas in the waste-gas conduit means will thus be prevented so that the waste-gas conduit means is not subjected to the stresses resulting from such flames, and the operating life of the structure is thus significantly increased.

The above advantages bring about an important and very substantial reduction in the possibility of damage when the structure of the invention is used, as compared with conventional waste-gas hoods, and this factor is of course of extremely great importance for the safety of the operations and for the production effectiveness.

Thus, the invention is particularly suitable for steel works where devices are used for increasing production without any significant changes in the structure, particularly in the structure for cooling and cleaning the waste gases.

A moving means is provided for moving the ring means **1** between the lower closed position thereof and the upper open position, and this moving means in the illustrated example takes the form of a pair of rods **4** which are operatively connected in any suitable way to any desired mechanical transmission or hydraulic assemblies which will bring about the required movement of the ring means **1** between its closed and open positions. These shifting rods **4** are tubular and are normally connected to a hydraulic apparatus which brings about the required movement of the ring means **1.** The

hydraulic cylinders operatively connected to the rods 4 are not illustrated. The upper end wall 6 of the annular means which defines the chamber 3 is formed with openings through which the rods 4 extend, and in order to seal these openings radially shiftable sealing means 5 are provided. The plurality of radially shiftable sealing means 5 which surround the rods 4 are situated therefore at the end wall 6 of the chamber 3.

Referring to FIG. 2, it will be seen that each of the sealing means 5 includes a sleeve 22 which fluid-tightly surrounds the tubular rod 4 so that the latter is axially shiftable in a fluid-tight manner in the sleeve 22. This sleeve 22 has fixed to its exterior surface a pair of sealing rings 24 and 26 which, for example, may be welded to the exterior surface of the sleeve 22. At the opening of the wall 6 through which the rod 4 extends, the thickness of the wall 6 is reduced so that an annular portion 28 of the wall 6 is received slidably but fluid-tightly between the pair of rings 24 and 26. If desired, the wall 6 may carry in the recess which receives the ring 26 a further ring 30 which may be welded to the wall 6 or threaded into the latter, for example. Therefore, with this construction the sealing means 5 is capable of shifting in the plane of the wall 6 while maintaining a fluid-tight closure at the region where the rod 4 extends from the chamber 3 to the outer atmosphere.

Furthermore, because of this, radial shiftability of each sealing means 5 with respect to the rod 4 which it surrounds enables the converter axis to deviate slightly from a precisely vertical attitude while still achieving the required seal. Thus any inaccuracies will be compensated for by way of the radial shifting of the sealing means 5. With this constructions it is possible for the axis of the vessel means 12 to deviate from a precisely vertical axis by approximately 5° while still achieving the required seal at the engagement between the top end surface of the vessel means 12 and the ring means 1. Between the lower header 8 and the top end surface of the vessel means 12 there forms, after a relatively short operating time, a seal resulting from deposits from the mouth of the vessel means 12 which stick to the inner surface of the header 8. As a result, a very narrow gap, if any, remains between the header 8 and the top end surface of the vessel means 12. In order to further reduce any possibility of inaccuracy in the seating of the ring means 1 on the top end surface of the vessel means 12, the ring means 1 is given a springy, yieldable construction. For this purpose the tubular components 9 are springy so that it is possible for the ring means 1 to yield between the headers 7 and 8 thereof in order to adapt itself to the top end surface of the vessel means 12. Thus, the rods 4 push downwardly with a predetermined pressure locating the header 8 against the top end surface of the vessel means 12, and the rods 9 are capable of resiliently yielding to assure a proper seating of the ring means 1 on the top end surface of the vessel means 12.

As was indicated above, the waste-gas conduit means 2 forms a laterally shiftable hood which can be moved by way of the hydraulic means 20. The inner surface of the waste-gas conduit means 2 is formed by the water tubes 17 through which cooling water flows as is well known.

As is shown schematically in FIG. 1, the installation includes a conventional low pressure cooling circuit, and this circuit communicates with the tubular rods 4 so as to provide through the latter the circulation of the cooling water through the tubular components 7–9 which form the ring means 1.

Also, as is schematically shown in FIG. 1, the waste-gases which do not burn within the conduit means 2, because of the exclusion of air therefrom, are delivered to a combustion chamber means 30 with which the tubular conduit means 2 communicates. This combustion means 30 itselt carries valve means 32 through which air is admitted for the purpose of achieving combustion of the waste gases only after the latter have travelled through the conduit means 2. Instead of conveying the unburned waste gases to an installation such as the combustion chamber 30, these unburned gases can instead be delivered to gas cooling and cleaning installations and can be stored for further use in suitable gas tanks, for example. Thus, the invention described above brings about an improvement in the environment providing an ecological protection in the case where steel works have been modified so as to bring about a higher output.

Of course the invention is not limited to any particular type of converter vessel or to an arrangement where a waste-heat boiler installation communicates with the vessel to receive the waste gas therefrom. It is possible to use the invention in all metallurgical operations where there is between the metallurgical furnace and the waste-gas flue a releasable connection through which it is possible for waste gas to escape undesirably. In accordance with the particular temperature of the waste gas which prevails in any given situation, it is possible to decide whether the hood which receives the waste gas and the sealing ring should have a construction which includes or does not include cooling surfaces.

What is claimed is:

1. In a metal-treating apparatus, tiltable vessel means having a hollow interior in which metal is treated as by being refined therein, said tiltable vessel means having a top open end through which waste gas issues during treatment of metal in said vessel means and said vessel means terminating at said top open end thereof in a top end surface, waste-gas conduit means aligned with and spaced from said top open end of said vessel means for receiving the waste gas issuing therefrom and for conducting the waste gas to an installation such as a gas-cooling and gas-cleaning installation, annular means surrounding said waste-gas conduit means at an end region of the latter which is adjacent said vessel means for defining a chamber which surrounds said waste-gas conduit means at said end region thereof, and ring means also surrounding said waste-gas conduit means at said end region thereof and having an upper open position situated within said chamber and spaced from said top end surface of said vessel means, said ring means having a lower closed position engaging said top end surface of said vessel means and extending between the latter and said waste-gas conduit means for closing the space between said vessel means and waste-gas conduit means, said ring means when in said lower closed position thereof having an upper end portion which extends into said chamber and which defines with said end region of said waste-gas conduit means and with said annular means a pair of gaps through which any escaping waste gas must flow while changing its direction at least twice.

2. The combination of claim 1 and wherein said annular means has an outer wall surrounding said ring

means when the latter is in its closed position for defining an outer one of said pair of gaps therewith while said ring means has a portion surrounding said waste-gas conduit means when said ring means is in said closed position thereof for defining an inner one of said pair of gaps.

3. The combination of claim **1** and wherein said annular means has a lower end region surrounding and spaced from said waste-gas conduit means for providing said chamber with an open end at that part of said chamber which is nearest to said vessel means.

4. The combination of claim **1** and wherein said waste-gas conduit means terminates at said end region thereof in a tapered portion which diverges toward said vessel means.

5. The combination of claim **1** and wherein said ring means has a tapered configuration which converges in the direction of waste-gas flow from said vessel means into said conduit means.

6. The combination of claim **1** and wherein said vessel means has at said top end thereof a discharge opening of a given size, and said waste-gas conduit means having an interior cross section which is of a smaller size than said discharge opening.

7. The combination of claim **6** and wherein the interior cross section of said waste-gas conduit means is approximately 20 percent smaller than the size of said discharge opening of said vessel means.

8. The combination of claim **1** and wherein said waste-gas conduit means has an inner surface defined by cooling tubes which form part of a gas-cooling installation.

9. The combination of claim **1** and wherein said ring means consists of tubular components through which a cooling fluid is adapted to flow.

10. The combination of claim **9** and wherein a low-pressure cooling circuit means communicates with said tubular components of said ring means for directing said cooling fluid therethrough.

11. The combination of claim **9** and wherein a moving means is operatively connected to said ring means for displacing the latter between said lower closed position thereof and said upper open position thereof, said moving means including shifting rods operatively connected to said ring means for shifting the latter between said positions thereof, and said shifting rods being tubular and communicating with said tubular components at the interior thereof for directing the cooling medium to and from the interior of said tubular components of said rings means.

12. The combination of claim **11** and wherein said annular means includes an annular end wall distant from said vessel means and formed with openings through which said shifting rods respectively extend, and a plurality of sealing means surrounding said shifting rods at said openings of said end wall of said annular means for sealing the interior of said chamber from the other atmosphere at the location where said rods extend through said openings of said end wall of said annular means.

13. The combination of claim **12** and wherein each of said sealing means includes a sealing member surrounding the shifting rod with which it coacts and connected to said end wall of said annular means for movement in the plane of said end wall while remaining in sealing engagement therewith.

14. The combination of claim **1** and wherein said ring means includes at opposed ends thereof a pair of tubular headers and between said tubular headers a plurality of elongated springy tubes situated one next to the other and each connected to and communicating with said headers.

15. The combination of claim **1** and wherein said annular means is fixed to said waste-gas conduit means and has an outer cylindrical wall consisting of a plurality of tubes.

16. The combination of claim **1** and wherein a shifting means is operatively connected to said waste-gas conduit means for shifting the latter with respect to said vessel means while said waste-gas conduit means coacts with said ring means for guiding the latter for movement between said open and closed positions thereof, and said ring means when in said closed position thereof coacting with said waste-gas conduit means for guiding waste gas issuing from said vessel means through said waste-gas conduit means without burning in the latter, and combustion chamber means communicating with said waste-gas conduit means for receiving waste gas therefrom, said combustion chamber means carrying a valve means through which combustion air is admitted for burning the waste gas when the latter reaches said combustion chambers means.

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