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[72] Inventor Walter Erman
1300 North Lake Shore Drive, Chicago, Ill. 60610

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[54] **APPARATUS AND METHOD FOR REMOVING OIL FROM METAL TURNINGS**
12 Claims, 5 Drawing Figs.

[52] U.S. Cl. .... **263/33 R,** 110/14, 134/15
[51] **Int. Cl.** **F27b 7/00**
[50] **Field of Search** 263/33, 34; 110/14; 134/10, 15

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Primary Examiner—John J. Camby
Attorneys—Roy E. Hofer and Raymond P. Niro

ABSTRACT: An apparatus and method are provided for use in removing oil from metal turnings. The apparatus includes a rotatable dryer equipped with an internal baffle arrangement used to suspend oily turnings in a stream of hot combustion gases which vaporize oil contained on the turnings, and a combustion chamber which generates hot combustion gases from a mixture of air and vaporized oil removed from the turnings and recirculates a portion of the combustion gases to the dryer. In addition, the apparatus is provided with a natural gas burner which generates secondary combustion gases for the combustion chamber when insufficient heat is generated by the combustion of the air-vaporized oil mixture alone, a blower which circulates air vaporized oil and secondary combustion gases to the combustion chamber and a control assembly to balance the flow of the air-vaporized oil mixture and secondary combustion gases.

The method for removing oil from oily turnings generally involves the use of heat of combustion of the removed oil to effect the removal of additional oil from the turnings.

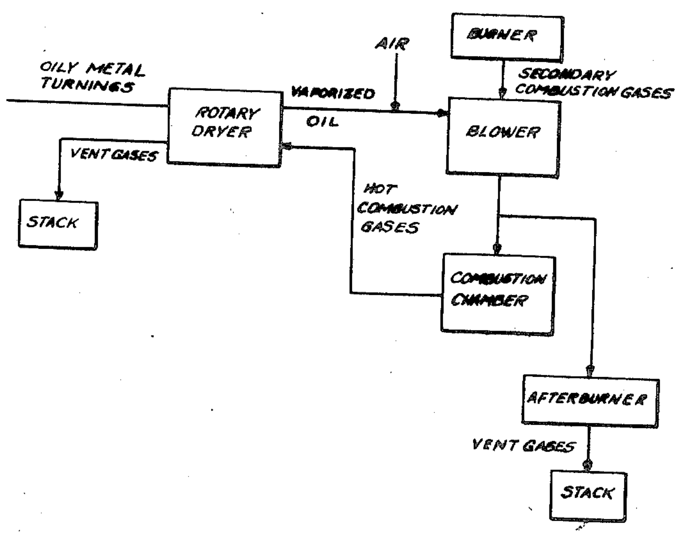


Fig. 1.

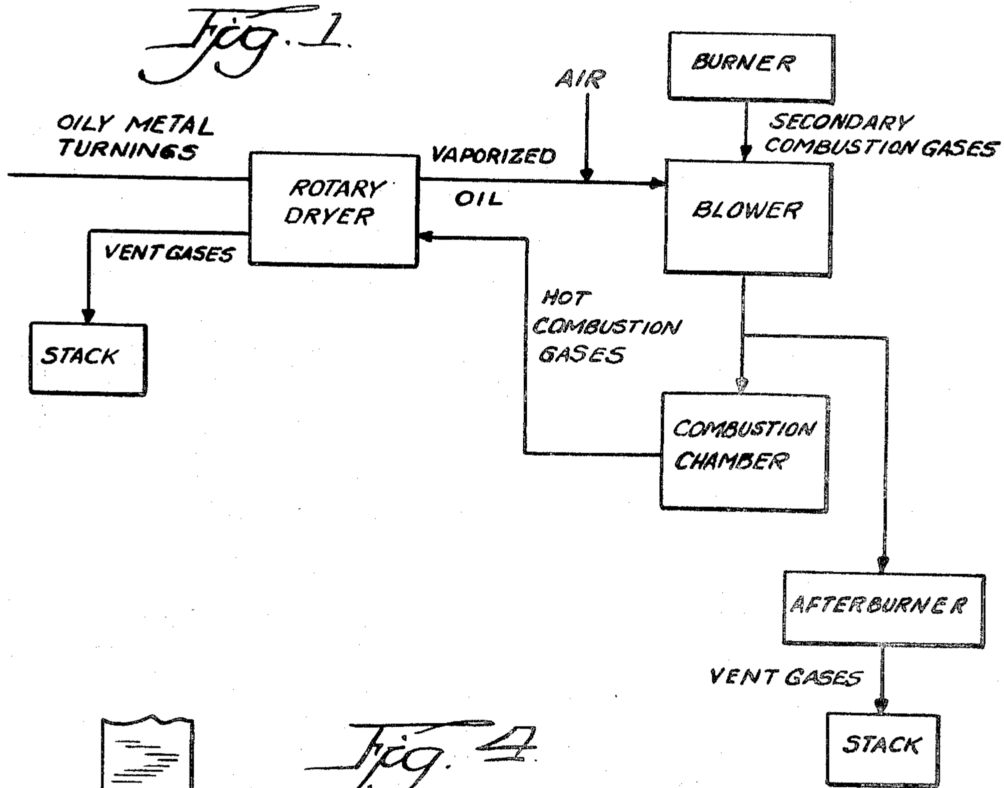
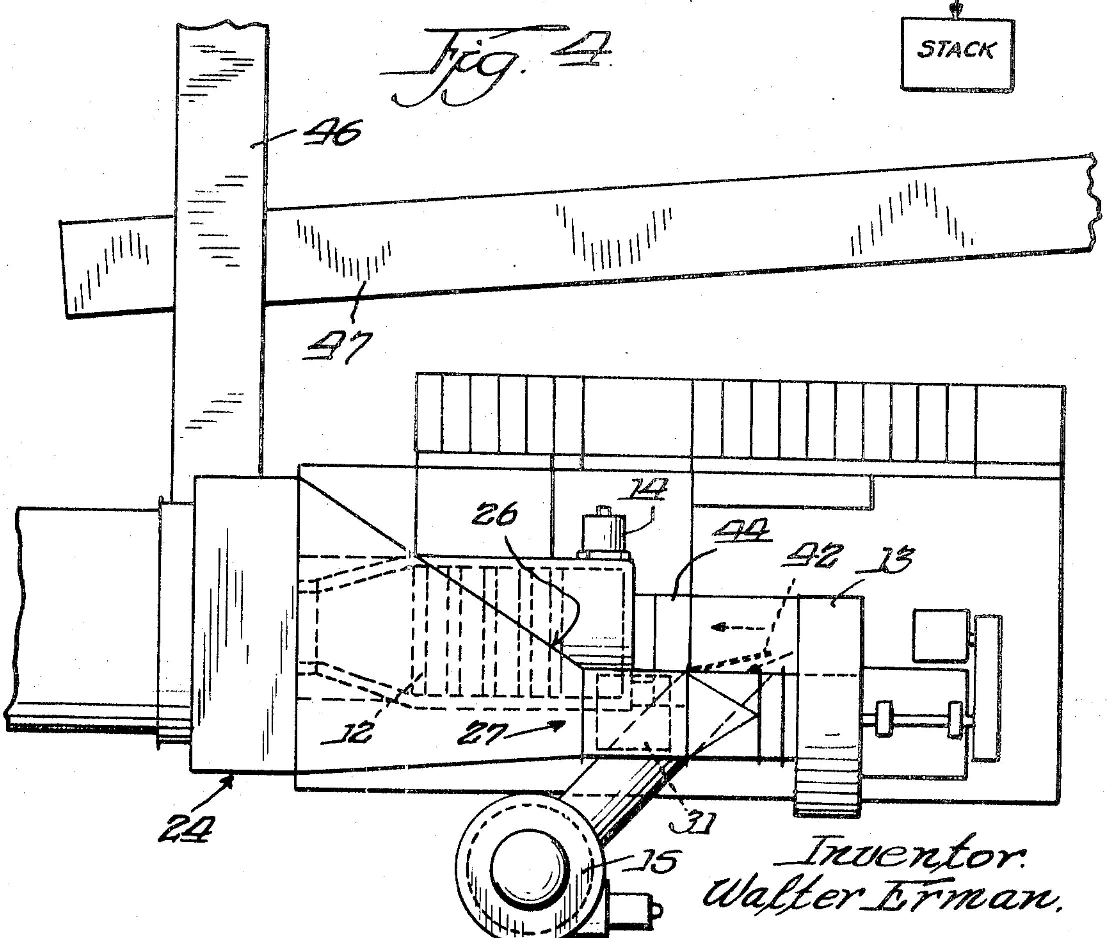


Fig. 4



Inventor:
Walter Erman,

By Roy E. Hofer & Raymond P. Niro Attys.

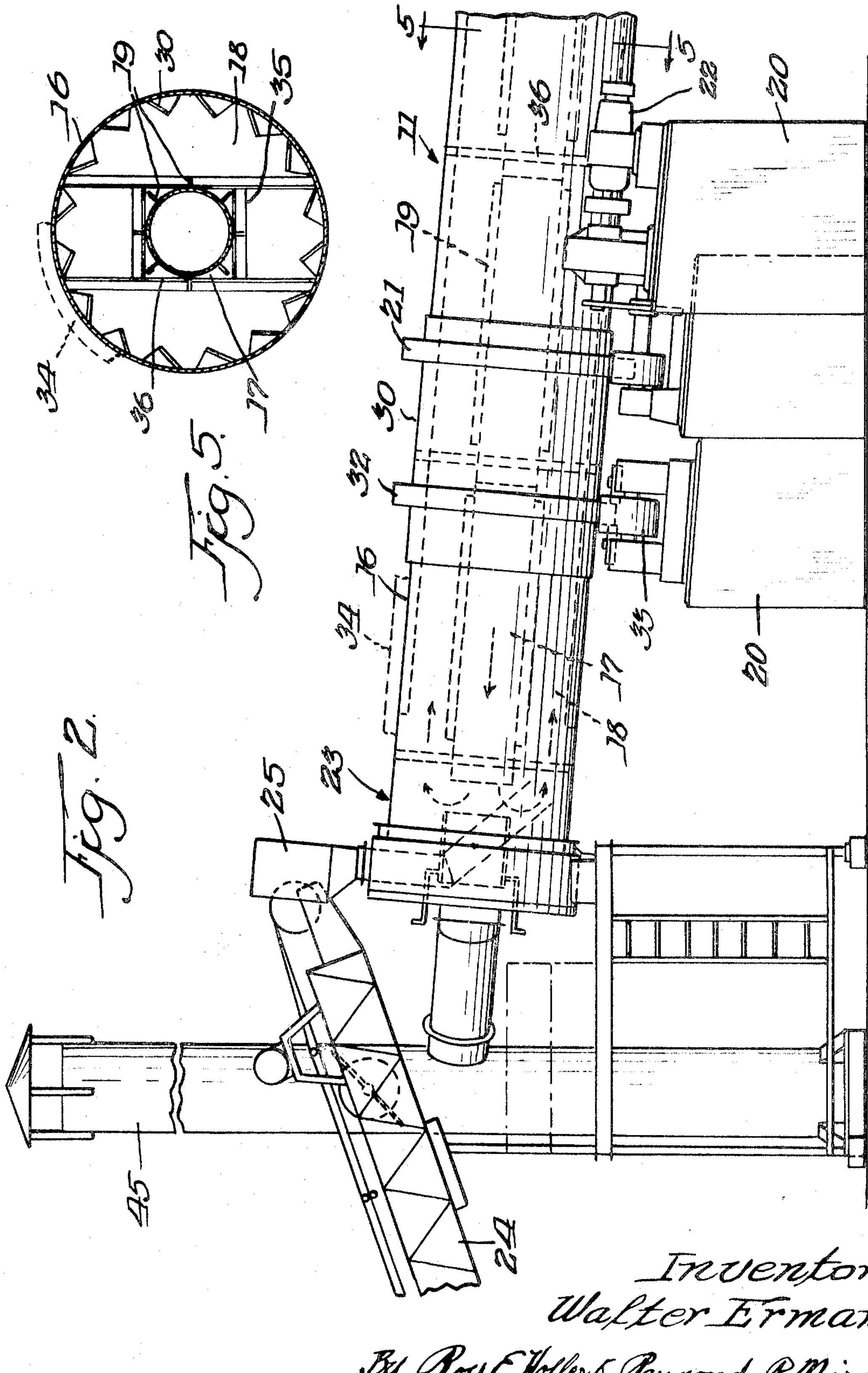


Fig. 5.

Fig. 2.

Inventor.
Walter Erman.
By. Roy E. Hoffer & Raymond P. Niro.
Attys.

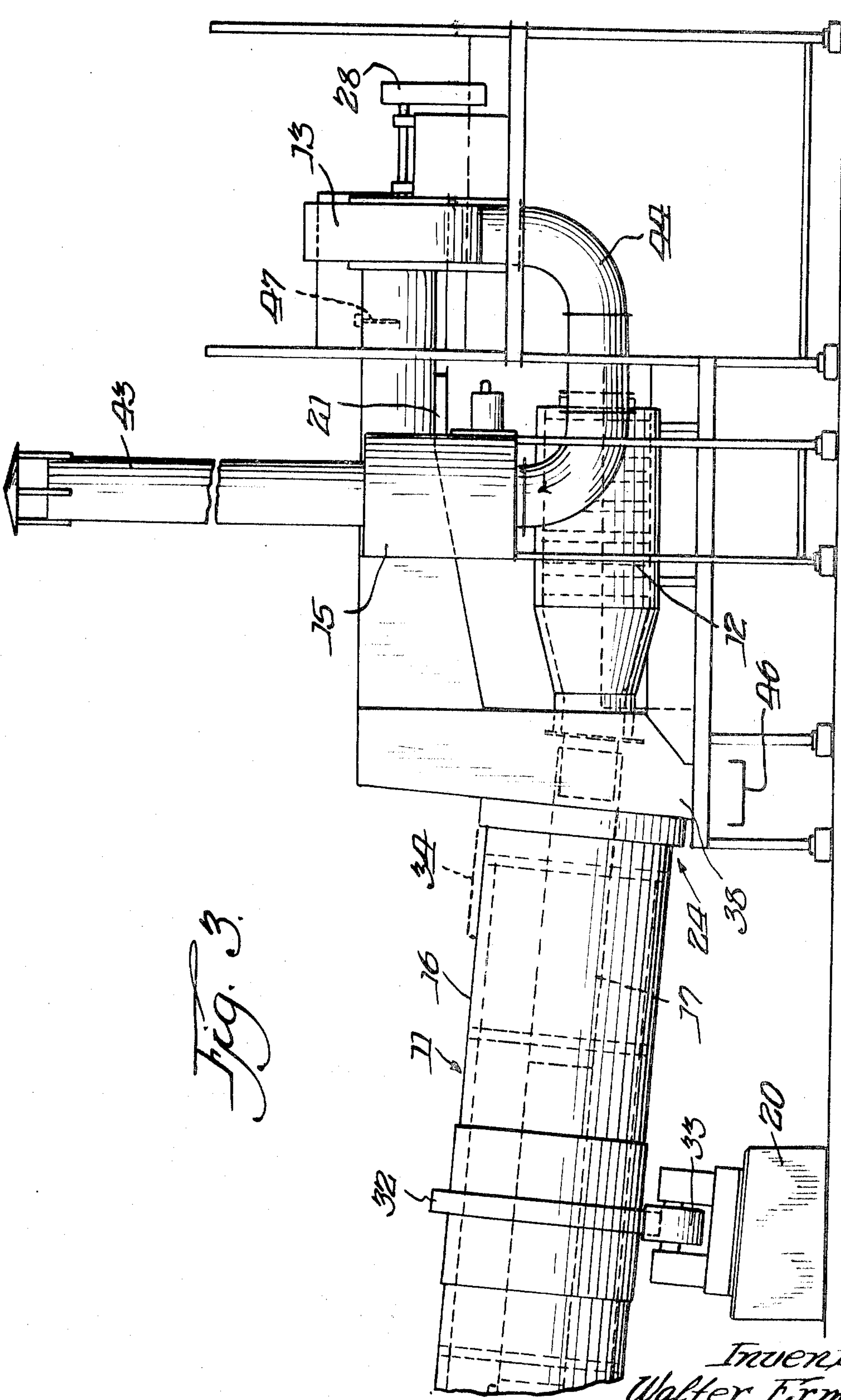


Fig. 3.

Inventor:
Walter Erman.
By Roy E. Hoffer & Raymond P. Niro.
Attys.

APPARATUS AND METHOD FOR REMOVING OIL FROM METAL TURNINGS

BACKGROUND OF THE INVENTION

This invention concerns an apparatus and method for treating metal turnings, and more specifically, deals with an apparatus and method for removing oil from metal turnings without generating excessive smoke or other air-contaminating materials.

It is well known that large quantities of oil are frequently applied to metals being processed on machine shop tools, such as lathes and the like, and that a variety of metal shavings, chips, and turnings are formed as a waste byproduct of such operations, Typically, the oil used in the metal processing adheres to the metal turnings making them ill-suited for direct reclamation operations.

It is known, for example, that the presence of large quantities of oil on steel or steel alloy turnings make such turnings unusable for direct steel recovery processes because only poor quality, high carbon steel can be obtained. Accordingly, a variety of techniques have evolved for removing oil from metal turnings.

One such method merely involves the burnings of oil from the turnings, with the consequent disadvantage of incomplete combustion and significant air pollutant emissions. In addition, the exposure of oil turnings to direct flames at the extremely high temperatures required for oil removal causes a high degree of oxidation to occur on the turnings.

Another oil removal technique which has proved equally unsuccessful involves: burning oil from the turnings in the presence of excess oxygen, mixing hot turnings with water, and then cooling and drying the turnings by evaporation of water therefrom. This technique, however, is still accompanied by incomplete removal of the oil, unsatisfactory air pollution rates, low operating throughput and extremely poor thermal efficiency for the overall oil removal process.

As a result of the many deficiencies in existing oil removal processes, an urgent need has developed for a new apparatus and method to efficiently remove oil from turnings while at the same time minimize the risk of discharge of air pollutants from the removal apparatus.

SUMMARY OF THE INVENTION

According to this invention, a new apparatus and method are provided for efficiently cleaning oily metallic turnings with minimal heat losses, high thermal efficiency, and vastly reduced potential of significant air pollution.

The oil removal apparatus of this invention generally includes: a rotatable dryer equipped with an internal baffle arrangement designed to permit intimate contact between oily turnings and a stream of hot combustion gases used to vaporize oil contained on the turnings; an assembly for transmitting oily turnings to the dryer; a device for mixing air with the vaporized oil discharging from the dryer; a combustion chamber used to burn vaporized oil and air to form hot combustion gases for the dryer; a natural gas burner for generating secondary combustion gases for the combustion chamber; a blower interconnecting the dryer, the burner, and the combustion chamber which receives air, vaporized oil, and secondary combustion gases and transmits them to the combustion chamber; and a control assembly to balance the quantity of secondary combustion gases and vaporized oil discharging from the dryer so as to maintain a constant temperature for the gases emitted from the combustion chamber.

The method of this invention for removing oil from oily turnings generally involves: the continuous suspension of oily turnings in a stream of hot combustion gases for a time sufficient to remove oil from the turnings, mixing vaporized oil with air, burning the air-vaporized oil mixture to form hot combustion gases recirculating sufficient hot combustion gases to effect removal of oil from the turnings and venting any excess combustion gases.

Although a number of significant advances are made by the apparatus and method of this invention, it should be noted that the practice of this invention provides minimal heat losses to the atmosphere since the heat of combustion from oil removed from the turnings is used to generate hot combustion gases needed to remove additional quantities of oil from the turnings. In addition, reduced quantities of additional fuel, e.g., secondary combustion gases, are required in the apparatus of this invention because the oil itself acts as a fuel.

It should also be noted that the invention provides: (1) suspension of the turnings in a stream of hot gases for a vastly improved oil removal efficiency, (2) high throughput rates, (3) automatic adjustment for excessive quantities of oil contained on the turnings by means of an afterburner which burns excess oil vapor rather than overheating the entire apparatus, (4) reduced likelihood of oxidation occurring on the turnings since the turnings are not subjected to a direct flame in an oxygen environment, (5) relatively smoke-free reclamation of the turnings because oil and other combustibles are burned to carbon dioxide and water, and (6) a concentric tube arrangement in the dryer which permits the turnings to be heated by conduction during an initial pass of the hot combustion gases and by convection and radiation during a subsequent pass.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more readily understood by reference to the accompanying drawings in which:

FIG. 1 is a block diagram of the oil removal process of this invention schematically representing the various steps involved in the process;

FIG. 2 is a side elevational view of the dryer end of the oil removal apparatus of this invention;

FIG. 3 is a side elevational view of the combustion chamber end of the oil removal apparatus of this invention;

FIG. 4 is a top elevational view of a portion of the combustion chamber end of the oil removal apparatus illustrated in FIG. 3; and

FIG. 5 is a cross-sectional view taken through line 5—5 in FIG. 2 illustrating the internal baffle arrangement of the rotatable dryer used to suspend oily turnings in a stream of hot combustion gases.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The steps performed in the oil removal process of this invention are diagrammatically represented in FIG. 1. Basically, the process is self-sustaining in the sense that oil removed from the turnings furnishes enough fuel to sustain additional vaporization of oil from the turnings. The removed oil is burned to essentially invisible products, such as carbon dioxide and water, to minimize potential air pollution hazards. In addition, the actual removal of oil from the turnings is uniquely effected by means of vaporization rather than burning with the consequent advantage that undesirable oxidation of the turnings is markedly reduced.

Briefly, therefore, the steps involved in the process include the suspension of oily turnings within a rotary dryer so that hot combustion gases can come in intimate contact with the turnings, mixing oil vaporized from the turnings with air and then burning the air-oil mixture to form additional hot combustion gases to effect the removal of oil from the turnings.

More specifically, however, as shown in FIG. 1, the oil removal process of this invention is initiated by first transferring metallic oily turnings into a suitable assembly for suspending the oily turnings in a stream of hot combustion gases. As shown in FIG. 1, one suitable apparatus for carrying out the suspension of turnings in a stream of hot combustion gases is a rotary dryer which, by means of rotation and a unique internal baffle arrangement, maintains the turnings in a suspended state and in intimate contact with a stream of hot combustion gases.

As the turnings are held in contact with the hot combustion gases, vaporization of the oils contained on the turnings occurs. Then the oil vaporized from the turnings is removed from the turnings suspension apparatus, e.g., rotary dryer, and mixed with a quantity of air sufficient to support combustion of the vaporized oil.

This air-vaporized oil mixture is then transmitted by means of a blower; or the like, to a combustion chamber where combustion or burning of the vaporized oil takes place. Since the oils contaminating the turnings are typically hydrocarbon compositions, combustion in the presence of air tends to create a stream of hot combustion gases composed primarily of carbon dioxide and water. It should be particularly noted that since combustion of the oil removed from the turnings occurs outside the presence of the turnings the likelihood of oxidizing the turnings is significantly diminished.

After the hot combustion gases have been generated in the combustion chamber, the gases are passed through the turnings suspension apparatus to effect the removal of oil contained on the turnings by vaporization. Preferably, the hot gases are first passed through the turnings suspension apparatus in a direction counter to the flow of the turnings without coming in contact with the oily turnings. In this way, the oily turnings are first preheated by means of conduction, the hot gases transferring heat through a centrally disposed conduit, or the like. Next, the hot combustion gases make a second pass through the turnings suspension apparatus, this time in contact with and in the same flow direction of the oily turnings. During this second pass, sufficient heat is transferred to the oily turnings by convection and radiation to cause the vaporization and ultimate removal of oil contained on the turnings.

In addition, during continuous operation of the oil removal process, a portion of the hot combustion gases generated in the combustion chamber are vented to an exhaust stack, as shown in FIG. 1, after making an initial pass through the turnings suspension apparatus.

It is contemplated that sufficient quantities of oil will be removed from the turnings to provide the complete fuel requirements for the process. However, in some instances, excessive amounts of oil may be contained on the turnings while, in other instances, insufficient amounts of oil may be present on the turnings. In either event, the process, shown generally in FIG. 1, can readily adapt to such changing situations.

More specifically, when excessive amounts of oil are contained on the turnings, a portion of the vaporized oil removed from the turnings suspension apparatus are diverted from the combustion chamber and, instead, are burned in an afterburner, or the like, and vented to an exhaust stack. In the case where insufficient amounts of oil are contained on the turnings or where an initial startup of the process takes place, a stream of secondary combustion gases is provided to maintain sufficient quantities of hot gases to effect the vaporization of oil from the turnings. By automatically controlling the quantity of vaporized oil diverted from the combustion chamber and the quantity of secondary combustion gases provided to the combustion chamber, the oil removal process of this invention can be efficiently operated to provide a sufficient, but not excessive, quantity of hot combustion gases for use in removing oil from the turnings.

One embodiment of the oil removal apparatus of this invention is illustrated in FIGS. 2, 3, and 4 and generally comprises a rotatable dryer 11 designed to suspend oily turnings in a stream of hot combustion gases, a combustion chamber 12 which provides hot combustion gases to the dryer, a blower 13 used to circulate gases through the apparatus, a natural gas burner 14 to generate secondary combustion gases and an afterburner oriented in a parallel flow arrangement with the combustion chamber.

More specifically, dryer 11 is rotatably mounted on a series of cradles or pillars 20. These pillars 20, in turn, are disposed along the length of the dryer 11 to permit the dryer to be inclined at some predetermined angle sufficient to allow oily turnings to move forward in the direction of combustion chamber 12. The assembly used to rotate dryer 11 includes a gear ring 21 secured to the outer circumference of the dryer which is driven by means of gear motor assembly 22.

Steel tires 32, mounted on trunnion rollers 33, are disposed along the length of dryer 11. These tires are not driven by gear motor assembly 22 but rather merely serve to sustain the rotational effect of dryer 11 caused by gear ring 21 and gear motor assembly 22.

The upper inclined inlet end 23 of dryer 11 is adapted to receive oily turnings transferred by conveyor 24. As the turnings move along conveyor 24, they fall by gravity flow through vertical chute 25 into dryer 11.

Externally, dryer 11 is provided with a relatively thick layer of insulation 34 sufficient to maintain the outer surfaces of the dryer 11 at temperatures of about 250° F. or less. Internally, dryer 11 is provided with an outer shell 16, normally in the shape of a cylinder, and inner conduit 17 which is concentrically disposed within the outer shell and is adapted to receive hot combustion gases discharging from combustion chamber 12.

As shown in FIG. 5, a plurality of baffles or lifters 30 are spaced about the inside surface of outer shell 16. These baffles are designed both to suspend oily turnings within the annular space 18 formed between inner conduit 17 and outer shell 16 and to transfer turnings along the length of the annular space as the dryer is rotated. Fins 19 are disposed along the outer surface of inner conduit 17 to improve the conductive heat transfer capability of conduit 17 and to allow heat to be transferred to the oil turnings by conduction through conduit 17 as well as by convection and radiation from hot combustion gases passing through annular space 18. Support bars 35 and 36 are provided to support conduit 17 within outer shell 16 of dryer 11. In practice, hot combustion gases at temperatures of about 1,200° F. are discharged from combustion chamber 12 within and along the length of inner conduit 17 until they reach the upper inlet end 23 of the dryer. This first pass of hot gases through dryer 11 is in a flow direction counter to that of the oily turnings. Then the hot combustion gases make a second pass within and along annular space 18 of dryer 11 in the same flow direction as the turnings. As the hot gases pass through annular space 18, the combined action of rotating dryer 11 and baffles 30 tend to suspend the oily turnings in the hot gases for a time sufficient to permit oil contained on the turnings to be vaporized as the oily turnings pass through the dryer.

Preferably dryer 11 is rotated at a rate within the range of 1.25 to 2.50 revolutions per minute. At this rotation rate, the oily turnings are suspended in the hot gases for a sufficient time to permit complete vaporization of oil.

Vaporized oil discharging from the outlet end 24 of dryer 11 is mixed with sufficient air to support combustion in combustion chamber 12. Air is drawn into the blower 13 through bleed air damper 31. The air-vaporized oil mixture then passes through blower 13 which is driven by motor assembly 28 and then into combustion chamber 12 where combustion of the air-oil mixture takes place.

As shown in FIG. 4, blower 13 is interconnected through inlet duct 26 and the outlet end 24 of dryer 11 which narrows somewhat at 27 to accommodate the inlet of blower 13. As such blower 13 receives vaporized oil emitted from the dryer 11, air drawn through bleed air damper 31 discharges through outlet duct 44 to combustion chamber 12 or through gate valve 42 to afterburner 15. The purpose of natural gas burner 14 is to provide secondary combustion gases during the startup of the overall oil removal apparatus. In addition, when insufficient vaporized oil is discharged from dryer 11, burner 14 acts to supplement hot combustion gases generated in combustion chamber 12 from the combustion of the air-vaporized oil mixture for use in removing oil from the turnings moving through dryer 11.

After the oil removal apparatus of this invention has been properly heated by means of natural gas burner 14, the heat of combustion (and hot combustion gases) produced by the burning of vaporized oil removed from the turnings permits a reduction in the amount of heat (and secondary combustion gases) required from burner 14. A control assembly is, therefore, provided to balance the quantity of secondary combustion gases generated in burner 14 with the quantity of vaporized oil discharging from the outlet of dryer 11 so that the temperature and amount of combined combustion gases emitted from combustion chamber 12 is maintained at some predetermined level. Ideally, this temperature level is maintained sufficiently high to allow the discharge of a stream of hot combustion gases to dryer 11 capable of vaporizing oil from the oily turnings.

When oily turnings processed in the apparatus of this invention contain an excessive amount of oil, heat generated in the combustion chamber 12 may exceed that required for efficient oil removal in the dryer 11. Accordingly, a control assembly which includes thermocouple 41 located near the inlet of blower 13 automatically turns down burner 14, lights a gas flame in afterburner 15, and opens motor operated blast gate valve 42 in front of the combustion chamber to divert a portion of the air-vaporized oil mixture into the afterburner. Excess air-vaporized oil mixture diverted to afterburner 15 is completely burned to carbon dioxide and water vapor and allowed to vent through stack 43. Gate valve 42 then opens and closes as required to reduce the quantity of combustion gases generated in combustion chamber 12.

Combustion chamber 12 can be constructed from various refractory materials sufficiently to withstand a temperature in excess of 1,200° F. A burner 14 housed outside the combustion chamber 12 is used to burn the air-vaporized oil mixture to carbon dioxide and water vapor which comprise the essential ingredients of the hot combustion gases used to vaporize oil from oily turnings. During continuous operation of the oil removing apparatus, a portion of combustion gases are vented through main stack 45 as shown in FIG. 2 while the remaining portion circulates through dryer 11. After oil has been removed from the turnings, they are removed from the outlet end 24 of dryer 11 by means of apron conveyors 46 and 47 which receive turnings dropping through opening 38 in dryer 11. Accordingly, as dryer 11 is rotated, turnings pass opening 38 while vaporized oil removed from the turnings pass directly into the inlet end of blower 13.

It should be understood that the various modifications of the apparatus and invention discussed herein can be constructed without departing from the spirit and scope of the invention.

I claim:

1. An apparatus for cleaning oily turnings comprising:

means for suspending said oily turnings in a stream of hot combustion gases for a time sufficient to permit vaporization of oil therefrom;

means for transmitting said oily turnings to said turnings suspension means;

means for introducing air into the vaporized oil discharging from said turnings suspension means;

primary combustion means, communicating with said turnings suspension means, for burning said vaporized oil with air to form hot combustion gases therefrom, and for discharging a stream of said combustion gases to said turnings suspension means; and

secondary combustion means for generating additional hot combustion gases for said turnings suspension means when the quantity of hot gases generated from said primary combustion means is insufficient to effect substantially complete vaporization of oil from said turnings;

whereby oil contained on said turnings is removed therefrom and vaporized substantially by means of hot combustion gases generated by said primary and secondary combustion means.

2. The apparatus of claim 1 wherein said means for suspending oily turnings is a rotatable dryer comprising an outer shell, an inner conduit disposed concentrically within said outer shell, whereby said oily turnings are transmitted in the annular space formed between said outer shell and said inner conduit, and said stream of hot combustion gases discharging from said combustion means first flows within and along the length of said inner conduit counter to the flow of said oily turnings and then flows within and along the length of said annular space in a direction of flow of said oily turnings so as to come in intimate contact with said turnings and effect the removal of oil therefrom.

3. An apparatus for cleaning oily metallic turnings comprising:

a rotatable dryer means having an inlet adapted to receive said oily turnings, baffle means to suspend said turnings within said dryer for intimate contact with a stream of hot combustion gases, and an outlet adapted to discharge vaporized oil removed from said turnings by said stream of hot gases;

means for transmitting said oily turnings to the inlet of said dryer means;

means for mixing air with said vaporized oil discharged from the outlet of said dryer means;

a combustion chamber communicating with said dryer means and adapted to burn said vaporized oil with air to form hot combustion gases and to discharge a stream of said combustion gases into said dryer means;

a burner for generating secondary combustion gases for said combustion chamber;

blower means interconnecting said burner and the outlet of said dryer means with said combustion chamber, said blower means being adapted to receive air, vaporized oil discharging from the outlet of said dryer means, and combustion gases generated in said burner and to transmit said combustion gases, air and vaporized oil into said combustion chamber; and

control means for balancing the quantity of secondary combustion gases generated in said burner with the quantity of vaporized oil discharging from the outlet of said dryer means whereby the temperature of the combined combustion gases emitted from said chamber is maintained at some predetermined value.

4. The apparatus of claim 3 wherein said rotatable dryer means comprises an outer shell and an inner conduit disposed concentrically within said outer shell and wherein said oily turnings are discharged into the annular space formed between said outer shell and said inner conduit, whereby the stream of hot combustion gases discharging from said combustion chamber first flows within and along the length of said inner conduit counter to the flow of said oily turnings to provide conductive heat transfer to said oily turnings and then flows within and along the length of said annular space in an opposite direction so as to come in intimate contact with said oily turnings and effect the removal of oil therefrom.

5. The apparatus of claim 4 wherein said inner conduit is provided with a plurality of fin members disposed along the outer surface of said conduit to provide a conductive heat transfer surface for said oily turnings.

6. The apparatus of claim 4 wherein said rotatable dryer means has a plurality of perforated baffles spaced about the inside surface of said outer shell, said baffles being adapted simultaneously to suspend said oily turnings in said stream of hot combustion gases allowing said gases to vaporize said oil and to transmit said turnings along the annular space between said inner conduit and said outer shell upon rotation of said dryer means.

7. The apparatus of claim 6 wherein said rotatable dryer means is capable of controlled rotation at rates in the range of about 1.25 to 2.5 revolutions per minute.

8. THe apparatus of claim 3 wherein said rotatable dryer means comprises an outer shell having a plurality of spaced baffles disposed about the inside surface of said shell, said baffles being adapted to suspend said oily turnings in said stream of hot combustion gases;

an inner conduit disposed concentrically within said outer shell and having a plurality of fin members spaced along the outer surface of said conduit;

whereby the stream of hot combustion gases discharging from said combustion chamber first flows within and along the length of said inner conduit counter to the flow of said oily turnings to provide conductive heat transfer to said oily turnings and then flows within and along the length of the annular space formed between said outer shell and said inner conduit in the direction of flow of said oily turnings so as to come in intimate contact with said turnings and effect the removal of oil therefrom.

9. The apparatus of claim **3** wherein said control means terminates the flow of secondary combustion gases from said burner when the quantity of combustible gases generated by the combustion of air and said vaporized oil discharging from the outlet of said dryer means is sufficient to provide a stream of hot combustion gases to said dryer capable of vaporizing oil from said turnings.

10. An apparatus for cleaning oily metallic turnings as defined in claim **3** which is further characterized in that:

an afterburner means adapted to receive an air vaporized oil mixture from said blower means is positioned in a parallel flow arrangement with said combustion chamber;

a control valve is provided to automatically divert from said combustion chamber into said afterburner a portion of the air-vaporized oil mixture discharging from said blower; and

whereby said control means for the apparatus reduces the flow of secondary combustion gases from said burner as the heat generated in said combustion chamber from the combustion of said air-vaporized oil mixture increases and whereby said control means terminates the flow of secondary combustion gases, activates said afterburner and diverts a portion of the flow of air-vaporized oil from said combustion chamber to said afterburner when the heat generated in said combustion chamber exceeds the requirements for vaporization of oil in said dryer means and prevents overheating of the recirculating apparatus.

11. A method for removing oil from oily metallic turnings which comprises:

continuously suspending said oil turnings within a turnings suspension means in a stream of hot combustion gases for a time sufficient to vaporize oil from said turnings;

mixing said vaporized oil removed from said oily turnings with air;

burning said air and vaporized oil to form a stream of hot combustion gases; and

recirculating a quantity of said hot combustion gases to said turnings suspension means sufficient to vaporize oil contained on said turning.

12. A method for removing oil from oily metallic turnings which comprises:

continuously suspending said oily turnings within a rotatable dryer in a stream of hot combustion gases for a time sufficient to vaporize oil from said turnings:

mixing said vaporized oil removed from said oily turnings with air;

burning said air and vaporized oil in a combustion chamber to form hot combustion gases;

providing secondary combustion gases to said combustion chamber when said burning of air and vaporized oil in said combustion chamber generates insufficient hot combustion gases to remove oil from said turnings;

balancing the flow of secondary combustion gases and air-vaporized oil mixture to said combustion chamber to provide sufficient hot combustion gases to remove oil from said turnings; and

circulating hot combustion gases from said combustion chamber to said dryer.

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