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[54] **OIL SOOT HANDLING SYSTEM**

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[52] **U.S. Cl.** **75/24,** 75/25, 75/84

[51] **Int. Cl.** **C21b 3/04**

[58] **Field of Search** 75/24, 25, 1, 84

[56] **References Cited**

UNITED STATES PATENTS

3,579,328 5/1971 Aas 75/24

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[57] **ABSTRACT**

Valuable metals, particularly vanadium, may be recovered from oil soot by firing crude oil to produce oil soot, collecting the soot, and recycling the collected soot for refiring until substantially all of the soot is converted to slag. The recycling of the collected soot is accomplished by the use of at least one air eductor to provide the motive power for pneumatically recycling the collected soot. During the recycling, the soot must be maintained at a temperature above its dew point, and wetting of the oil soot must be avoided.

9 Claims, 2 Drawing Figures

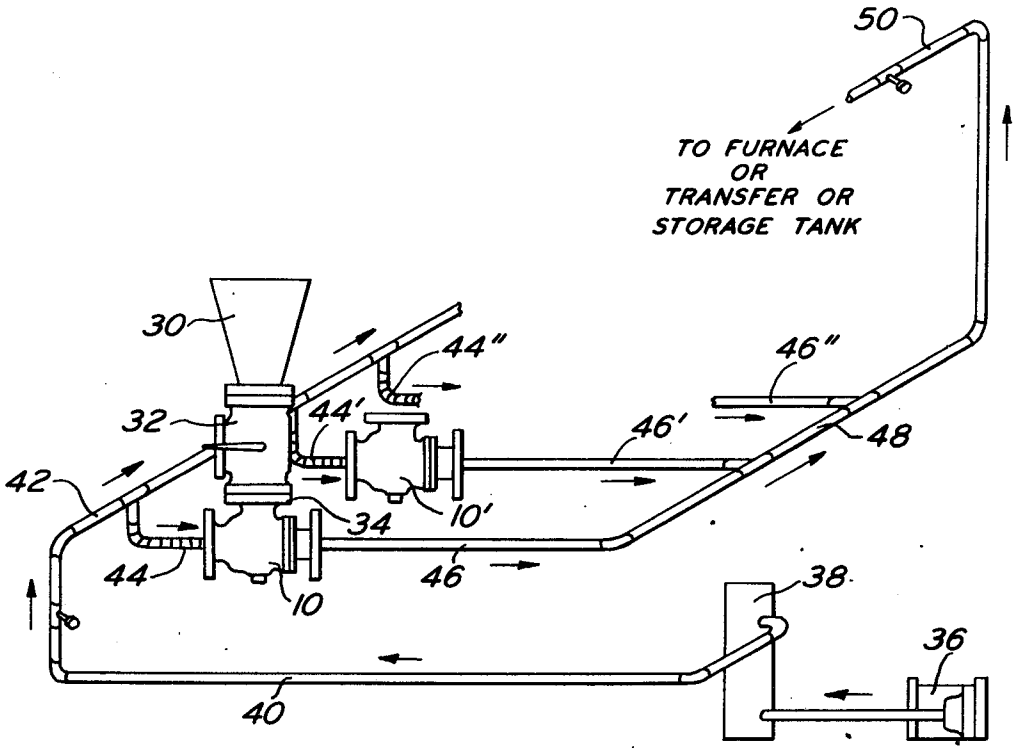


FIG. 1

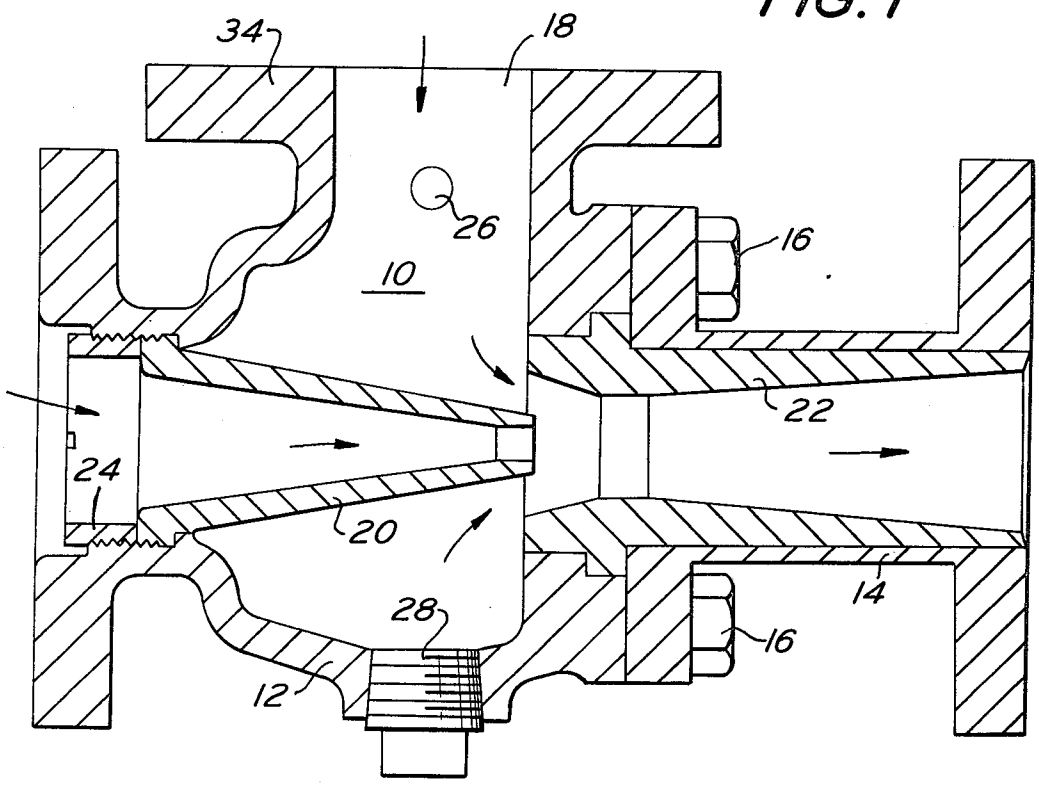
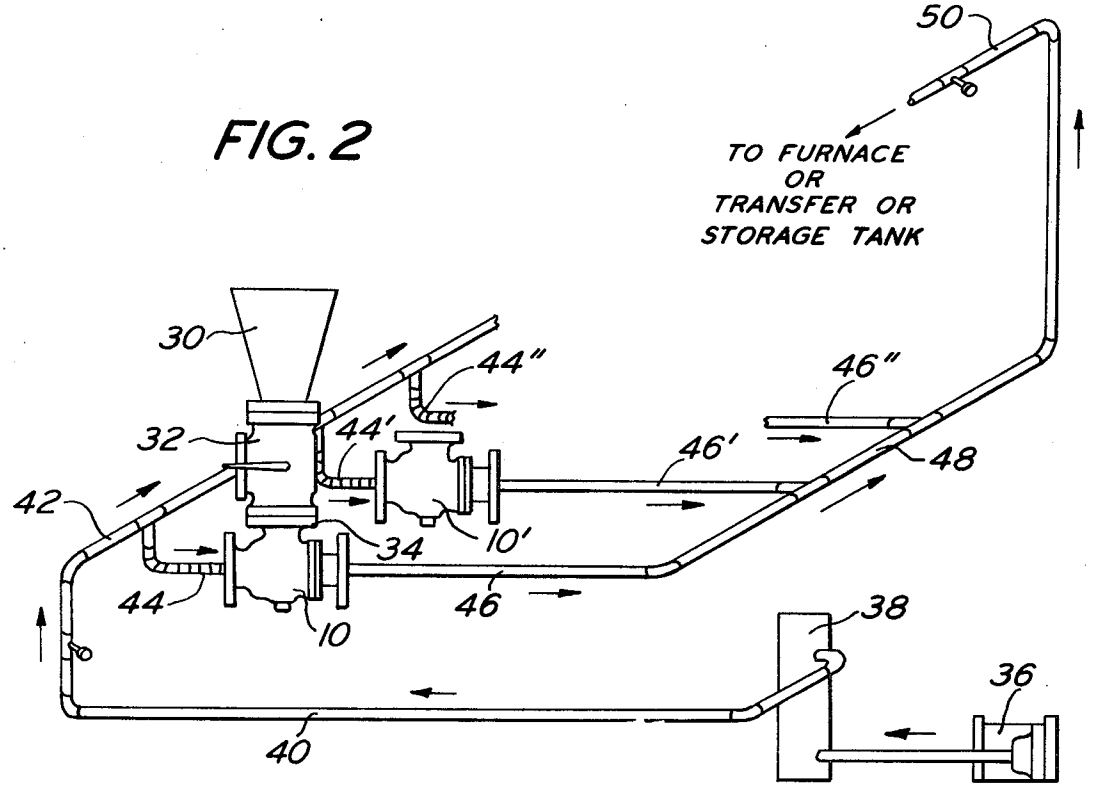

34
18
26
16
10
22
24
20
14
28
16
12

FIG. 2


50
TO FURNACE
OR
TRANSFER OR
STORAGE TANK
30
44"
46"
32
44'
46'
48
42
34
10'
44
46
10
38
36
40

OIL SOOT HANDLING SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to an oil soot handling system. More particularly, the present invention is directed to an improved method for recycling oil soot in the process for recovering valuable metals, particularly of vanadium, from the oil soot.

The large utilities burn low grade oils, such as refinery residues and non-treated crude oils. They have discovered that many South American crudes, notably oils originating in Venezuela, have a very high content of vanadium. If the oil ash from Venezuelan crude oil is recycled through the burner to burn off all of the carbon, so that the remainder of the ash forms a slag, the resulting slag contains about 13 to 15 weight percent of vanadium which can then be recovered quite profitably.

Unfortunately, up until the present time there have been considerable problems with the handling of vanadium bearing oil soot. Oil soot, which is the ash obtained from the flue of an oil burner, is far more difficult to handle than fly ash, which is the ash obtained from burning coal. Thus, the oil soot or ash is much finer in particle size and much stickier, so that it tends to compact and aggregate when handled. Attempts have been made to wet the oil soot with water so as to facilitate its handling. However, the presence of water has been found fatal to the recovery of vanadium from the oil soot. Furthermore, the oil soot is highly hygroscopic, and as it is cooled it rapidly absorbs water, which again is fatal to the recovery of vanadium.

A typical chemical analysis of oil ash from Venezuelan crude oil with magnesium salt additives is as follows:

		Percent	
Carbon	C	12.0	(may be higher)
Silica	SiO_2	3.0	
Iron oxide	Fe_2O_3	3.0	
Vanadium pentoxide	Va_2O_5	21.0	
Vanadium	Va	12.0	
Calcium oxide	CaO	2.0	
Magnesium oxide	MgO	27.0	
Sulphate	SO_3		
		100.0	

A typical breakdown of the sizes of the dust particles from the oil burner as they enter the collector is as follows:

Micron Size	Average Size	% in Stream by Weight
Above 30	30	31.5
29 to 26.1	27.55	4.0
26.1 to 21.4	23.75	10.0
21.4 to 13.1	17.25	23.5
13.1 to 10.57	10.57	14.5
8.05 to 4.73	6.39	6.0
4.73 to 2.13	3.43	5.2
2.13 to 1.24	1.685	3.3
Below 1.24	0.62	2.0

As can be seen from the table of typical chemical properties above, the oil soot obtained directly from the oil burner contains a high percentage of carbon black, which may range from about 10 to 30 percent of the soot, and which must be removed to concentrate and recover the vanadium. Also, due to the small particle sizes of the oil ash, as shown in the above physical analysis, it is apparent that the stream of fine oil soot particles is highly abrasive.

In the past, a number of systems have been proposed for the pneumatic handling of oil soot for conveying between the oil soot collector and the re-entry to the burner or storage facilities. However, such systems have had a number of serious disadvantages. For example, vacuum systems using conventional materials handling valves, while simple, low in cost and suitable for wet disposal methods, generally require major systems modifications and elaborate collecting and filtering protections for the vacuum producers, and are not generally suitable for continuous operation.

Pressure systems using rotary (star) feeders require special precautions to avoid oil soot sticking in rotor pockets and tight seals between the rotors and seats. Also, system pressures are generally limited to 3 psig. Pressure systems using air locks have a number of advantages but are high in cost due to complex controls, high maintenance costs and high initial equipment cost. Finally, combination vacuum-pressure systems, using centrifugal fans, while simple in operation and low in initial cost, have extremely high maintenance problems in most cases due to the abrasive material passing through the fan blades. Such systems also require a careful balance between the vacuum side and the pressure side.

BRIEF SUMMARY OF THE INVENTION

The above and other disadvantages of the prior art are overcome by the method of the present invention in which at least one air eductor is used to provide the motive power for pneumatically recycling the collected soot in a process for recovering metals from oil soot. The soot is collected and recycled for refiring. This method is particularly directed to processes in which vanadium is the metal to be recovered from the soot after the soot is refired and substantially converted to slag.

According to the method of the present invention, it is necessary that the oil soot be maintained at a temperature above its dew point, both during recycling and storage (in the case where the soot is not directly recycled to the oil burner). It is also necessary that wetting of the oil soot with water be avoided.

BRIEF DESCRIPTION OF DRAWINGS

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a sectional side elevation view of an air eductor for use in the method of the present invention;

FIG. 2 is a fragmented schematic view in perspective of a suitable system for employing air eductors according to the method of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, there is shown an air eductor, generally designated **10**, suitable for use in the present invention. Air eductor **10** consists of two main parts, a body **12** and a tail casing **14**, which are fastened

together, such as by bolts or machine screws **16,** for ease in disassembling.

The body **12** of the air eductor **10** comprises a suction inlet **18** through which the material to be conveyed, in this case oil soot, enters the air eductor. The body **12** is also provided with a nozzle **20** which serves to direct the stream of air or other conveying fluid into the throat **22** of the air eductor. The nozzle **20** is held in the body **12** by a nozzle retaining ring **24.** Pipe plugs **26** and **28** are also provided in the body **12** in the wall of the suction inlet **18** and at the bottom of the body portion. These pipe plugs allow easy access to the interior of the air eductor body for cleaning or clearing blockages of oil soot in the air eductor.

The throat **22** of the air eductor comprises a venturi shaped orifice which begins in the body **12** of the eductor at about the apex of the nozzle **20** and is primarily held in place by the tail casing **14.** Due to the contact of the interior of the throat with high velocity abrasive particles of oil soot, the throat is easily replaceable and is manufactured of a high abrasion resistant material, such as Ni-hard, a trademark for an abrasion resistant cast iron containing 4.5 percent nickel, 1.5 percent chromium and 1.5 percent manganese.

Although the air eductor may be provided in various sizes, suitable representative dimensions for the air eductor **10** shown in FIG. **1** may be: overall length — 10¼ inches, diameter of throat exit — 2 inches, and distance from center line of nozzle to be beginning of suction inlet — 3⅛ inch. Other dimensions in FIG. **1** are roughly to scale.

The air pressure of the motive air supplied to the air eductor will depend on how far it is desired to convey the oil soot. For the air eductor whose dimensions are given above, it is contemplated to use 110 SCFM air at 18 lbs. per square inch gauge and 300° F. Generally, in order to maintain the oil soot above its dew point during the recycling, the air supplied to the nozzle of the eductor must be heated to at least 300° F. Also, the air should be provided at a pressure of at least 15 psig and a velocity of at least 3,000 feet per minute.

Referring now to FIG. **2,** the operation of the air eductor in the process of the present invention, will now be described. The crude oil, particularly Venezuelan crude, is fired or burned in a conventional furnace or burner (not shown). The oil ash or soot is then collected or retrieved by anyone of a number of conventional means (not shown), which may suitably include Cottrell-type electrostatic precipitators, cyclone separators, filter bags, or combinations of the foregoing. From any of these collectors, the oil soot then passes into dust hoppers, one of which is indicated at **30** in FIG. **2.**

Each dust hopper **30** may be suitably connected to an air eductor **10** by means of a lever operated three-way knife gate valve **32,** which is used for draining or washing down the dust hopper **30.** The three-way valve is connected to the upper flange **34** which surrounds the suction inlet **18** of the eductor. The oil soot is sucked from the dust hopper **30** through the three-way valve **32** into the suction inlet **18** of the eductor by the rapidly moving stream of air which is provided through the eductor nozzle **20** and directed into the eductor throat **22.** Where the oil soot is supplied from economizer or preheater hoppers, it is preferred to provide a cinder feeder (not shown) between each hopper and air eductor for the purpose of sizing the oil soot prior to entry into eductor.

Motive air for the eductor is supplied by a suitable blower **36,** such as a positive displacement rotary compressor. The air from the blower is passed through electric or steam heaters **38** to raise the temperature of the air to a sufficient degree to maintain the oil soot above its dew point during the recycling. The heated air then passes from the heaters **38** through suitable valved piping **40** into a common supply header **42,** from which it is provided through suitable conduits **44, 44'** and **44''** to a series of air eductors **10, 10',** etc. The use of a plurality of oil soot hoppers and air eductors, arranged in parallel, has the advantage that if one air eductor should require maintenance, material can still be removed by the remaining eductors, thus reducing the possibility of a boiler outage. Such an arrangement is also specially suitable where oil soot must be removed from numerous points of collection and discharged into a transfer tank and storage silo.

The motive air and entrained oil soot leave the eductors **10, 10',** etc. through conduits **46, 46'** and **46''** and enter manifold **48.** The oil soot and motive air then pass through valved recycling line **50,** either for direct re-injection to the oil burner or furnace (not shown) or for temporary storage in a transfer tank (not shown). Where the oil soot is recycled to a transfer tank, it may be intermittently rapidly removed to a storage silo, from which the oil soot may be subsequently reinjected directly into the furnace for reburning or refiring. It is usually necessary to recycle the oil soot to the furnace at least twice for refiring in order to burn off as much of the carbon black as possible and substantially convert all of the oil soot to slag, from which the valuable metal such as vanadium may be recovered.

It will be understood that all pipe lines and eductors in the above-described system should be well insulated to reduce heat losses and thereby lessen the chances of the temperature of the oil soot falling below the dew point. Similarly, any transfer tanks or storage silos must be similarly insulated, and may even need to be heated if more than momentary storage is contemplated. This is necessary to prevent agglomeration and sticking of the oil soot while in the pipes or tanks. It is also preferred that all parts which come in contact with the high velocity abrasive oil soot particles be manufactured of a high abrasion resistant material, such as Ni-hard, and be easily replaceable.

It will be seen from the above description that the use of air eductors according to the method of the present invention for pneumatically conveying small volumes of abrasive oil soot particles from dust hoppers for relatively short distances has a number of important advantages over systems of the prior art. Thus, since the air eductors are static devices having no moving parts, they are ideally adapted for continuous operation with a minimum of maintenance problems and costs. Secondly, air eductors are relatively low in initial cost compared to conventional materials handling valves, star feeders or air locks. Thirdly, with air eductors the temperature of compression is usually sufficient to convey the oil soot without introduction of additional heat from outside sources. Moreover, satisfactory operation of an eductor system does not depend on the exact tolerance and balance required by other conveying media.

Furthermore, air eductors pull oil soot and flue gas from hoppers so that there is no leakage of air into the hoppers which will upset precipitator efficiency. The latter is a serious problem in most systems using precipitators due to the low grain loading of flue gas. Probably the only significant disadvantage of air eductor systems is the high power requirement compared to some other conventional systems. Continuous operation is also mandatory unless metering equipment is added to each eductor.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. In a method for handling oil soot in the recovery of metals therefrom comprising firing crude oil to produce oil soot, collecting the soot, and recycling the collected soot to means for refiring the soot, the improvement comprising providing a stream of motive air for recycling the oil soot, passing said stream through a nozzle in at least one air eductor to create a suction which sucks the soot into the air eductor whereby the soot becomes entrained in the stream of air, and pneumatically conveying the entrained soot in the stream of air to means for refiring the soot, said soot being maintained at a temperature above its dew point during the recycling.

2. A method according to claim **1** wherein the soot is refired until substantially all of the soot is converted to slag.

3. A method according to claim **2** wherein the primary metal to be recovered from the slag is vanadium.

4. A method according to claim **1** wherein the motive air supplied to the air eductor is preheated to a degree sufficient to maintain the soot above its dew point during the recycling.

5. A method according to claim **1** wherein wetting of the oil soot is avoided.

6. A method according to claim **2** wherein the soot is recycled at least twice to a furnace which is used for firing and refiring the soot.

7. A method according to claim **1** wherein the collected soot is first conveyed to storage means prior to refiring.

8. A method according to claim **4** wherein the heated air is supplied to the air eductor at a pressure of at least **15** psig and a velocity of at least 3,000 feet per minute.

9. A method according to claim **1** wherein the collected oil soot is fed to a plurality of air eductors arranged in parallel and provided with a common source of motive air for recycling the collected soot.

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