OIL PUMPING METHOD

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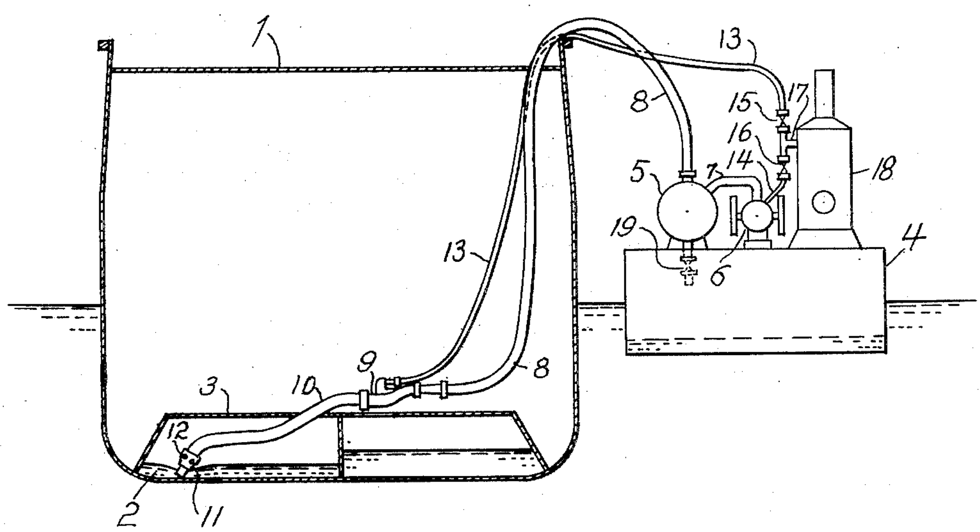

Fig-1

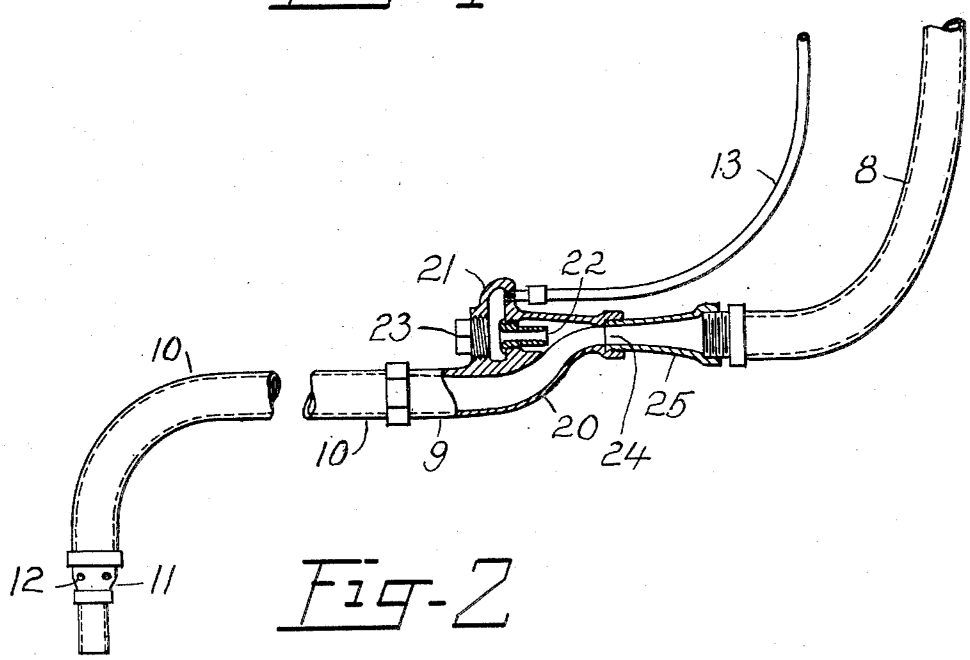

Fig-2

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OIL PUMPING METHOD

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My invention relates to an apparatus and method whereby stubborn and viscous oils and oily sludges may be pumped through a transmission line of considerable length and elevation, and it is especially adapted for the removal of such material from the inner bottoms and cargo holds of tankers and oil burning vessels.

The extreme viscosity of such material precludes its handling by ordinary pumping means and methods, and I am well aware of the existence of special devices and methods for this purpose. Some of these methods are exemplified by the Wheeler Patent No. 1,405,173, which employs air as a blasting or emulsification agent while other methods employ steam for the same purpose, see Engstrand Patent No. 1,952,061.

Other methods depend for their operation upon a rapid and intermittent slug formation, as is the case with the Engstrand Patent No. 1,967,231.

Specifically referring to the Wheeler patent above quoted, I find the drawback of this pioneer invention to be the elaborate and costly high vacuum creating plant with which each individual transmission line must be provided.

Referring to the Engstrand Patent No. 1,952,061 you will note that the transmission herein disclosed is a true steam spray transfer and therefore, excellent as the device may be for large refining tanks, the long and slender high pressure steam hoses which are directly connected to long and unwieldy steam jet pumps will preclude its use in such close quarters, as an inner bottom tank of a vessel, and besides its use in such inaccessible quarters cannot be allowed by the responsible ship operator, as the workers are always subject to the very real danger of accidental scalding by steam escaping from a bursted high pressure steam hose.

A thorough study of the sundry intermittent slug transmission methods show that, when the actual tank cleaning is undertaken, the pumping rate is comparatively slow for the semifluid sludges, which so often are encountered in ship bottoms and refining tanks, and which circumstance I have found depends upon the fact that the intake suction, besides being intermittent, is entirely too feeble for the rapid intake feeding of aforesaid heavy and viscous residues.

The ideal sludge handling system must at all times possess a high vacuum suction where the transmission line is brought in contact with the material to be pumped and I have discovered that such high and uninterrupted intake suction can be obtained for several transmission lines discharging in a common vacuum receptacle if slug formation higher up in the transmission lines is substantially prevented. It is readily seen that when a slug of material is allowed to form inside a transmission line its sealing action will be similar to that of a pellet in a rifle bore, and when a too great acceleration resistance occurs in the line a vacuum break and blow back is bound to occur at the intake end of the transmission line, with a resultant interruption of pumping.

I have discovered, and this is my invention, that it is possible to substantially prevent any slug formation inside an air transmission line and create a high and continuous intake suction at the end of a cold intake hose by means of inserting a specially constructed steam jet pump in the line at a point spaced well apart from the intake end of the line, and also by placing a spray separator at the end of the line from which separator all of the admitted air and steam are by-passed out of the system by a powerful vacuum suction action.

I have also discovered that heavy and viscous oil sludges passing through my pumping device are so changed in nature that they can be readily pumped through long transfer lines and burned in the regular burners under the boilers, as the pumped mass is very rich in heat units and is returned into an oily and heterogene condition, although the water content of the mass may be as high as 50 per cent.

Now therefore, inasmuch as the nature of the material is changed and a new and useful result is obtained by means of my new combination of old elements, I do not only claim the apparatus used but also the several related steps necessary for my pumping method as part of my invention.

In the drawing:

Figure 1 shows my preferred apparatus installed on board a slop barge with the transmission hose slung over the ship's side removing heavy viscous material from the inner bottom of an oil carrying ship.

Figure 2 is a plan view of my apparatus and shows the detail of construction thereof on an enlarged scale.

In the drawing where like reference characters designate corresponding parts, **1** denotes the vessel from which the heavy oil sludge **2** is being removed out of the inner bottom **3** in which the sludge has accumulated.

At the side of the vessel the slop barge **4** is moored. On the deck of the barge the vacuum tank 5 is installed and the high vacuum pump 6 is shown connected thereto by the pipe line 7.

To the vacuum tank 5 the transmission line 8 is attached, which flexible hose line is adapted to be slung over a ship's side and led into the hold of the vessel.

At a point in close proximity to the tank top and preferably reclining thereon, the special high vacuum steam jet pump 9 is connected to the line 8 so as to discharge therethrough. Into the suction end of the jet pump 9 the end of the flexible intake hose 10 is secured and this hose line, devoid of any high pressure steam line, is shown led into the inner bottom tank through a conventional manhole.

The intake end of the hose line 10 is preferably supplied with the reducer fitting 11 through the side wall of which several air holes 12 are drilled.

Steam for the operation of this jet pump 9 and the high vacuum pump is furnished through the steam hose 13 and the pipe connection 14, which steam lines are provided with the valves 15 and 16 respectively, and directly connected with the manifold 17, with which the boiler 18 is provided. The vacuum tank 5 is also provided with the drain valve 19 through which the tank may be conveniently emptied into the hold of the slop barge.

My special steam jet pump 9 is preferably of the solid injection jet type, but this type may be replaced with the annular type which, of course, must also possess the special proportions required for my pumping method. I have found the former type to be more powerful than the latter, although it is heavier and more difficult to handle.

The steam jet pump has preferably a cast iron body 20 with a lateral steam jacket 21, into which the expanding nozzle piece 22 is screwed. The clean out plug 23 allows for the insertion and the removal of the nozzle piece and provides also for the easy insertion of an iron pounding bar if the throat opening should become plugged during pumping.

The throat opening 24 of my preferred jet pump has a cross sectional area of approximately one quarter that of the transmission line 8, which is shown connected to the pump body proper by means of the tapered Venturi fitting 25.

The operation is as follows:

The transmission hose having been positioned as shown in the drawing, the valves 15 and 16 are opened and the intake nipple dipped into the material to be pumped, care being taken not to submerge the air holes 12.

An intake vacuum of as high as 20 inches mercury is created by the combined action of the jet and the vacuum pump and the air will therefore rush in with a super-cyclonic velocity of several hundred feet per second through the openings 12.

In the meantime a column of viscous material is rising relatively slowly through the reduction nipple as it is held back therein by a considerable friction resistance.

The inrushing air in striking this relatively slowly moving column will disintegrate the same into a spray which becomes suspended in the ensuing air stream and is carried into and through the throat opening of the high vacuum steam jet pump 9.

The high pressure steam jet, which in the pump throat attains a super-velocity of more than 2,700 feet per second, will still further blast the relatively slow moving spray of material, which from here on will be still further subdivided and suspended in a mixed air and steam jet stream which is sucked through the transmission line proper by the high vacuum pump 6. Any slug formation will be prevented inside the line as any tendency to seal the line will be counteracted by an accelerated flow of the steam and air through any momentarily restricted place in the line as the propelling vacuum in the discharge portion of the line will immediately increase.

The material will therefore enter the separator tank 5 in the form of a spray. Now, therefore, this separator fitting must be a spray separator and I prefer the relatively large spray separator employed by Wheeler above quoted for a floating marine equipment, inasmuch as I can discharge several hose lines into the same vacuum tank.

When the separator tank is filled, the operation is discontinued and the material is allowed to drain out through the valve 19 into the hold of the slop barge.

For refinery service I prefer a small individual separator where the spray is allowed to impinge upon a cylindrical wall of the separator tank, and the centrifugal force is utilized for separation in the conventional manner. I also connect for this kind of service a reciprocating pump to the separator, which pump will withdraw the pumped material from the separator during the pumping operation.

I have also discovered that in order to obtain a spray transmission through the entire transmission hose, the throat opening of the high vacuum steam jet pump shall neither be too small nor too large.

If the throat opening is smaller than 20% of the transmission hose area, the material will pass through the intake portion of the line in the form of a slug while the transmission from the jet pump on will substantially be a spray transmission.

I have also discovered that, if the pump throat opening is more than half that of the transmission line, slug formation occurs beyond the point of the steam admission, and a sluggish and relatively slow pumping will result.

The intensity of the steam jet has also to be confined between relatively narrow limits. The steam supply cannot be excessive because an excessive steam admission will overload the vacuum pump, and an insufficient intake vacuum accompanied with blow back is bound to result.

The steam supply cannot, on the other hand, be too small as an effective spray blasting in the pump throat requires a certain minimum amount of high pressure steam.

I have found that when the high pressure steam jet nozzle is at its narrowest portion, less than 20% but more than 10% of the throat opening of the pump body, the best results are obtained.

I have also discovered, and therein my invention also resides, that when the temperature at all times inside all parts of the transmission line is kept below 180° Fahrenheit, the transmission is a true spray transmission, which is from 200 to 300 percent faster for heavy oils and sludges than any other existing pumping method.

That the pumping temperature existing inside the transmission hose 8 is the true criterion for a spray transmission is evident when we consider the Dalton law, which is one of the fundamental laws for the interaction between mixed gases, where no chemical reaction occurs.

The Dalton law states that in a mixture of different gases each gas behaves as a vacuum to all the rest, and if one or more liquids are introduced into a space at given volume, the amount of vapor given off by each depends only upon its temperature and pressure, and is independent of any other gas or vapor present, and therefore the total pressure of the gases and vapors, contained in the space, is the sum of the separate pressures, which each would exert if it were the only one present.

The high pressure steam which emits at the high velocity of 2700 feet per second from the narrow high pressure steam nozzle will expand into the space of the transmission line and there mix with the sucked in air.

Now, from the above consideration of the Dalton law we know, that the air will behave as a vacuum for the steam and vice versa. The high pressure steam escaping into this seeming vacuum will expand and a certain percentage thereof will condense leaving the steam at all times in a saturated condition.

I have discovered that in order to create an air spray transmission through the relatively short intake hose of the transmission line, an air velocity of more than 100 feet per second is required through the hose. As the cross section of a 4 inch diameter hose is approximately 12 square inches, approximately 10 cubic feet of attenuated air will pass into and through the line during each second. As a partial vacuum exists inside the intake line when the intake nozzle is submerged as shown, the amount of atmospheric air passing therethrough will be approximately 4 cubic feet per second.

As the air stream velocity will increase considerably, say 50 percent, when struck by the high velocity steam and subjected to the powerful suction of the high vacuum pump, the resulting steam and air stream will possess a velocity of approximately 150 feet per second.

As I have found a 4" hose to be the size most suitable for sludge pumping, a velocity of 150 feet per second means that the volume of the combined air and steam stream passing through the hose during one second approximates 12 cubic feet.

At 180 degrees Fahrenheit a quarter of a pound of steam occupies 12 cubic feet with a pressure of about 7½ pounds per square inch. Also 4 cubic feet of atmospheric air will expand into some 12 cubic feet of air at a temperature of 180° Fahrenheit, and a pressure of about 7½ pounds per square inch.

As I use a half pound of steam per second for the operation of my high vacuum jet pump and the pumped material approximates 5 pounds per second, half of this jet steam will condense leaving a quarter of a pound of saturated steam per second inside the transmission line.

It is also to be noted that sludges on shipboard most often contain large deposits of scale and water and that such deposits are thoroughly pulverized and mixed when passing through my high velocity steam jet in the manner described, which renders the mass pumpable by ordinary pumping means and burnable in the conventional burners.

In this connection I wish to point out that an individual reciprocating vacuum pump cannot be conveniently shifted from tank to tank in a refinery, and therefore I prefer to use a steam jet exhauster in conjunction with the individual separator for refinery service, but in a permanent floating equipment for ship service a large reciprocating vacuum pump, common for several transmission lines, is by far more economical in steam consumption than a number of individual steam jet air exhausters.

It is to be noted that in all prior art patents when steam is used as a pumping agent, the temperature is at times higher than 180° Fahrenheit inside the transmission line.

In the true steam spray transmission of Engstrand above quoted a steam pressure of more than atmospheric pressure must exist inside the line and therefore the temperature must be above 212° Fahrenheit.

Also in the slug transmissions of Engstrand No. 1,967,231 the operation is dependent on an intermittent steam pressure sufficient to overcome the acceleration resistance of the slug as well as the atmospheric pressure against which the slug is being discharged, and there I have found that a temperature much higher than 212° Fahrenheit exists inside the transmission line during the slug discharge.

I do not wish to be understood as limiting myself to the apparatus shown, as it is evident that modification and alterations may be made in my device without departing from the spirit and scope of my invention.

It is finally to be noted that in both my preferred pumping systems, i. e. that for ship service as well as that for refinery service, the spray of pumped viscous material is being separated from the gases previous to their discharge into the atmosphere.

I claim:

1. The method of pumping viscous material characterized by admitting a high pressure steam jet into a transmission line at a point spaced well apart from the intake end in the direction of flow to thereby create a high and uninterrupted intake vacuum and suck a stream of air and viscous material through the intake portion of the line and cause a spray transmission therein and deliver the spray into the steam jet and creating a vacuum at the end of the transmission line so as to prevent the temperature from ever rising above 180 degrees Fahrenheit at any place inside the transmission line.

2. The method of pumping viscous material characterized by admitting a high pressure steam jet into a transmission line at a point well spaced apart from the intake end in the direction of flow to thereby create a high and uninterrupted intake vacuum and suck a stream of air and viscous material through the intake portion of the line and cause a spray transmission therethrough, creating a continuous vacuum at the end of the transmission line so as to at all times prevent a temperature rise above 180° Fahrenheit at any place in the line and separating the spray from the suspending gases previous to their discharge into the atmosphere.

LESTER W. PARKER.