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[54] CLEANING OIL-LADEN METAL WASTE TO RECOVER THE METAL AND RECLAIM THE OIL

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[51] Int. Cl. **B08b 7/04**

[58] Field of Search 134/2, 10, 13, 25–26, 134/32–34, 36, 40, 109; 29/403

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[57] **ABSTRACT**

Oil-laden metal waste such as turnings, chips and the like are cleaned to remove oil and other impurities from the metal waste enabling recovery of the metal and reclaiming of the oil. The cleaning is achieved through counterflow of a detergent solution in a wash bath, removing the cleaned metal waste from the bath and separating a substantial quantity of the remaining moisture therefrom, and removing the detergent solution from the wash bath and running it through a rehabilitation circuit where it is subjected to centrifugal force to separate sludge and oil from the solution. Then concentrated makeup detergent solution is added, the makeup and restored detergent solution heated and returned from the rehabilitation circuit to the wash bath.

5 Claims, 2 Drawing Figures

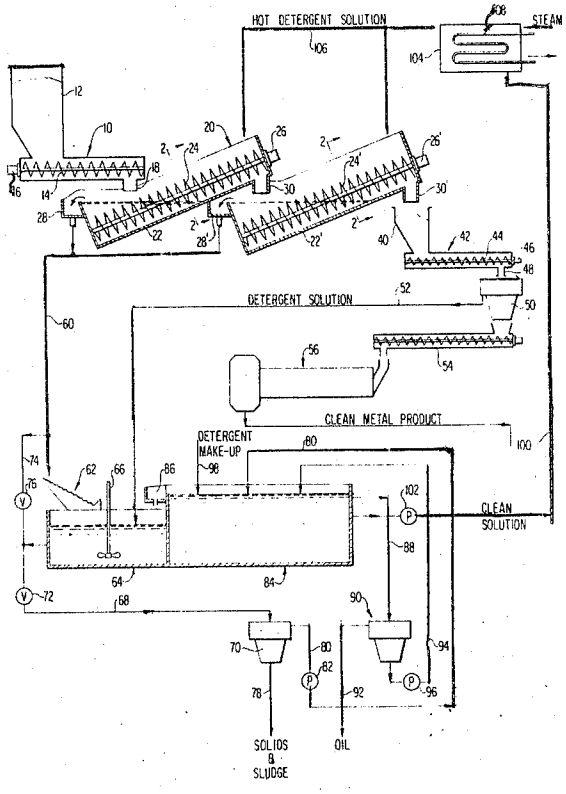


FIG. 1

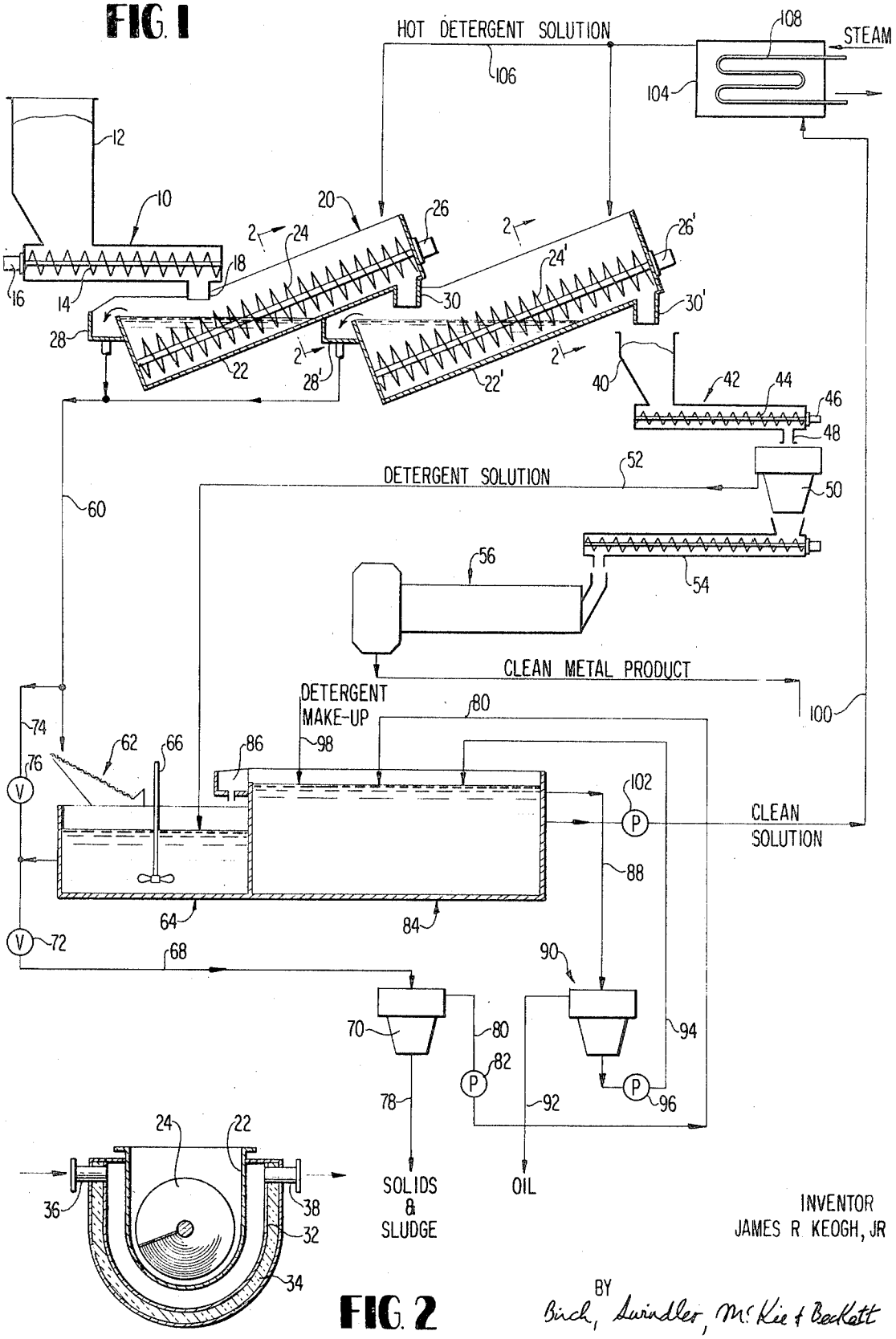


FIG. 2

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CLEANING OIL-LADEN METAL WASTE TO RECOVER THE METAL AND RECLAIM THE OIL

RELATED APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 693,298 filed Dec. 26, 1967, now U.S. Pat. No. 3,544,369 dated Dec. 1, 1970.

BACKGROUND OF THE INVENTION

This invention relates to the art of cleaning metal waste such as metal chips, turnings and the like, and reclaiming oil from such waste. More particularly, the invention is directed to washing such metal waste in a detergent solution to remove the oil and other impurities from the metal waste, reclaiming the oil from the detergent solution and separating sludge picked up by the detergent solution to restore the cleaning capability of the solution to be reused while the cleaned metal waste has excess moisture separated therefrom to provide a commercially acceptable metal product of sufficiently low moisture and oil content such that it may be fed direct to melting furnaces or compressed into briquettes suitable for use in metalurgical reclaiming processes.

Manufacturing industries create vast quantities of metal waste in their day to day operations, such waste being in the form of chips, turnings, borings and the like. Not only is the metal constituent of this so-called waste of recoverable value but also the lubricating oils coating the metal particles or pieces consequent from the manner in which the metal waste is produced are of value to be reclaimed. In addition to the desired components of the metal and oil, impurities of the type normally attendant operation of industrial facilities are mixed with the metal waste. In handling industrial waste of this nature, it is desirable to be able to compress the metal constituent of the waste into briquettes or directly feed the metal to a melting furnace. In order to accomplish this, it has been found essential that a high percentage of the oil content of the waste be removed preferably to leave the metal constituent at a level of less than approximately 2 percent by weight with respect to the residual oil and moisture content on the recovered metal constituent of the waste.

Prior art proposals have not provided the capability of recovering both the metal and the oil from metal waste on an economically profitable basis where the metal constituent in the resulting product has sufficiently low moisture and oil content to enable direct feeding to melting furnaces or compression into briquettes which will possess the desired compressive strength for handling and subsequent use in metalurgical reclaiming processes. Many prior art reclaiming operations for metal waste are directed solely to reclaiming either the metal constituent or the oil constituent and do not provide a combined operation from which overall profitable operation is possible. Other prior art attempts to remove moisture, oil and other impurities from metal chips and the like have been unsuccessful in producing an end product with sufficiently low moisture and oil content that the waste can be formed into briquettes of the high compressive strength of around 10,000 lbs. per square inch deemed necessary for practical handling and use in metalurgical reclaiming processes. Other attempts in the prior art to provide commercially useable end products from metal waste have been so complicated as to substantially increase both the required capital investment and the operating and maintenance expenses in carrying out the process.

SUMMARY OF THE INVENTION

This invention encompasses automatic and continuous cleaning and drying of metal waste such as metal chips, turnings and the like together with the reclamation of oil from such waste. The oil characteristicly associated with the metal component of the waste and other impurities is that used both for cooling and lubrication incident production of the metal chips and turnings. The oil may be of various forms including oils and emulsions and varieties commonly used in metal boring, cutting and like operations.

The invention broadly contemplates crushing the metal waste to achieve a reasonably consistent size of metal particles for handling in the cleaning operation. The waste is washed with a detergent solution of sufficient strength to dissolve the oil carried by the waste thereafter the waste is removed from the wash bath and a substantial quantity of the remaining moisture separated therefrom. The detergent solution is removed from the wash bath after it is exposed to the metal waste and this solution, carrying sludge and oil therewith, passed through a rehabilitation circuit to restore the cleaning capability of the solution before returning the solution to the wash bath for reuse.

The washing is accomplished by providing a flow of detergent solution in a first direction while agitating and removing the metal waste through the flowing detergent solution in a generally opposite direction giving a counterflow of waste and solution. In the rehabilitation circuit, the detergent solution carrying the sludge and oil therewith is subjected to centrifugal force such that the sludge is separated from the solution and then the oil is separated from the solution. Thereafter, the restored detergent solution has concentrated makeup added thereto, is heated, and the makeup and restored detergent solution returned from the rehabilitation circuit to the wash bath.

It is a principal object of this invention to overcome the aforementioned problems in the prior art by providing a new and novel cleaning approach for metal waste such as chips, turnings and the like to enable recovering the metal constituent in a form useable in metalurgical processes and to reclaim the oil carried by such waste.

It is another important object of this invention to provide combined recovery of metal and reclamation of oil in a metal waste cleaning operation accomplished in a simple and relatively inexpensive manner requiring minimum capital investment with low operating and maintenance expenses.

A further object of the invention to achieve metal waste cleaning wherein the metal component is recovered at a sufficiently low moisture and oil content as to permit direct feeding of the metal to a melting furnace or allow the metal to be formed into commercially acceptable briquettes.

It is also an object of this invention to provide waste cleaning wherein the optimum of oil is recovered from the washing detergent solution in a relatively simple and inexpensive manner while the solution is passing through a rehabilitation circuit to restore its cleaning capability and enable its repeated use in the metal waste washing.

It is also an object of this invention to achieve metal waste cleaning employing a detergent solution of strength sufficient to dissolve the oil carried by the metal waste and thereafter upon the application of centrifugal force to the detergent solution, carrying oil and sludge, obtain rapid separation of the sludge and oil independently of each other leaving the detergent solution in a restored condition to be returned from the rehabilitation circuit to the wash bath.

Other objects and advantages, particularly with respect to more specific features, of this invention will become apparent from the following description taken in connection with the accompanying drawing wherein the illustrated embodiment of this invention is set forth by way of illustration and example.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic view with certain components in section, showing the overall interrelationship between components of a metal waste cleaning system in accordance with this invention.

FIG. 2 is a sectional view of each of the metal waste washers taken on lines 2—2 of FIG. 1.

DETAILED DESCRIPTION

In the previously filed application Ser. No. 693,298 filed Dec. 26, 1967, as to which this application is a continuation in part, there is contained certain specific description of process

steps and apparatus developed for the cleaning of metal wastes by washing in a detergent solution for its repeated use in the washing operation by removing sludge and oil from the spent detergent solution. This prior parent application described and explained in some detail the types of detergents deemed appropriate for making up the detergent solution. It was there recognized that the particular detergent used in the waste-cleaning operation may vary widely dependent on the type of chip, cutting or form of metal waste; the particular metal constituent such as aluminum, cast iron, brass, etc.; the type of soil or other impurities contained in the particular waste being cleaned; the type of oil incorporated in the metal waste to be cleaned; etc. Actually, any number of a wide variety of dry or liquid detergents may be suitable for use with the system disclosed. The above-mentioned aspects, fully discussed in the above identified parent application, are not repeated herein but reference is made to their being discussed in the prior copending application and they are to be considered incorporated in this application as if repeated in their entirety. Hereinafter, more specific description of the particular embodiment shown in the drawing accompanying this continuation in part application will be set forth along with discussion pointing out the particular advantages deemed to reside in this embodiment of the invention.

FIG. 1 shows the overall layout, in diagrammatic form, of a metal waste cleaning system showing the flow and treatment of the constituents handled in the process of cleaning metal waste.

The system shown in the embodiment of FIG. 1 commences with the provision of a feeder **10** having a hopper **12** in which the metal waste, which is to be cleaned and have the oil and metal constituents separated for reuse, is retained. The feeder **10** may take anyone of a variety of conventional forms with a screw-type feeder having a feed screw **14** driven by a motor **16** being diagrammatically illustrated to control feed of the metal waste from hopper **12** and discharge it from the feeder outlet **18** into the metal waste washer **20**.

The metal waste washer **20** specifically illustrated in the embodiment of FIG. **1** is made up of two similar wash sections connected in series. However, it is to be understood that depending upon the conditions of the metal waste, detergent solution, desired retention time in the detergent solution for the metal waste and other variables involved in carrying out the waste-washing operation, the washer **20** may be constructed of a single section or even constructed of a plurality of sections greater than two.

Where adequate exposure time of the metal waste to the detergent solution to obtain the desired waste cleaning cannot be achieved by a single washer section, it is beneficial to employ a plurality of sections in series like the two illustrated in FIG. **1**. The alternative of simply increasing the length of one section of the washer has the drawback that such would entail the undesirable addition of screw-supporting hanger bearings intermediate the ends of the feed screw with such bearings being exposed to the abrasive material of the metal waste. Thus, in washing particularly dirty or oily waste, increase in the washing time by using a multiple section washer such as illustrated is desirable.

As heretofore mentioned, the sections of the metal waste washer **20** are similar and accordingly, description of only one section should suffice for understanding of the contemplated construction for washer **20**. The washer has a longitudinally extending and upwardly inclined tank **22** with a spiral ribbon conveyor **24** operatively mounted longitudinally within the tank to be driven by motor **26** in propelling the metal waste through the flow of detergent solution and agitating such waste so that maximum exposure of the surfaces of the metal waste particles to the cleaning by the detergent solution will occur.

Referring to FIG. **2**, it will be seen that the tank **22** is generally U-shaped in cross section having a semicylindrical bottom conforming generally to the exterior of spiral ribbon conveyor **24**. The tank **22** retains a wash bath of the detergent solution into which the metal waste is discharged from outlet **18** of feeder **10**. The lower rear end of the tank **22** provides a wier over which the spent detergent solution flows into a trough **28** from which such solution is led to the rehabilitation circuit wherein the cleaning capability of the solution is restored as will be described.

Where a multiple section washer **20** such as illustrated in FIG. **1** is to be used the sections are mounted in series. As so disposed, the spiral ribbon conveyor **24** in the first section is driven by motor **26** to propel and agitate the metal waste within the wash bath of detergent solution to be moved upwardly along the inclined bottom of the tank **22** and finally discharged at the upper end of the tank through outlet **30**. This outlet is positioned to overlie the lower end of the next succeeding washer section so that the metal waste is discharged into such next section and there exposed to a second portion of the tank bath.

In this next section, a similarly formed tank **22'** provided with a spiral ribbon conveyor **24'** driven by a motor **26'** acts to propel the metal waste and agitate it within the second portion of the wash bath moving it up along the inclined wall of tank **22'** out of the wash bath to be finally discharged through outlet **30'** of the second washer section. The lower end of the tank **22'** also provides a wier over which the spent detergent solution flows into a trough **28'** to be led to the rehabilitation circuit.

It should be understood that washer **20** may well be constructed so that the detergent solution from tank **22'** will be discharged directly into the upper end of the first section tank **22** of washer **20** and used therein to be finally discharged over the wier of tank **22** into trough **28** rather than being led separately from tank **22'** to the rehabilitation circuit. Also, although the washer sections are illustrated as being similar in length, in some cases it may be desirable to have the sections of different lengths for best cleaning action on the waste in the screw washer.

Reference may now be made to the sectional showing of FIG. **2** which illustrates the cross section of each of the sections of the metal waste washer **20**. From FIG. **2**, it will be seen that the generally U-shaped tank **22** is preferably intended to be enclosed along its length by suitable heating means to insure retention of the detergent solution at the desired temperature level for most effective cleaning of the metal waste. In the embodiment illustrated, the exterior of tank **22** has a casing **32** spaced from the exterior of tank **22**. This casing is provided with suitable insulation **34** and an inlet **36** and an outlet **38** for flow of steam through the casing **32** so that heating of the washer **20** may be carried out. As a preferred embodiment, the space between casing **32** and tank **22** may contain a plate-type internal tube heat exchanger, the tube being connected with inlet **36** and outlet **38**.

When the cleaned metal waste is propelled by spiral ribbon conveyor **24'** upwardly within the second section of the metal waste washer **20**, it is discharged through outlet **30'** from the washer into the surge hopper **40** of a feeder **42**. The feeder **42** may be a conventional screw feeder similar to feeder **10** wherein a feed screw **44** driven by motor **46** withdraws cleaned metal waste from surge hopper **40** and feeds it through outlet **48** to a spinner extractor **50**.

A quantity of cleaned metal waste is discharged from feeder **42** into the bowl of extractor **50**. As characteristic of such devices, the bowl is rotated at a high speed whereupon the centrifugal forces exerted upon the cleaned metal waste tend to throw off a substantial quantity of the moisture remaining on the cleaned waste after its exposure to the washing action in washer **20**. This separated moisture is detergent solution which is conducted away from extractor **50** through line **52** and led to the rehabilitation circuit for the detergent solution as will be described in more detail hereinafter.

The now substantially dried metal waste in clean form is discharged from extractor **50** into a screw feeder **54** which transports the cleaned waste by rotation of the motor driven screw of such feeder to the intake of a drier **56**. In the drier,

the already partially dried and cleaned waste coming from the extractor **50** is subjected to drying conditions to drive off further of the remaining moisture contained within the cleaned waste.

As used herein, it will be understood that moisture contemplates primarily the detergent solution which is separated from the cleaned waste first in the extractor **50** and subsequently in the drier **56**. However, it is to be recognized that this moisture in both cases would contemplate separation of remaining oil that may be a part of the detergent solution entrapped within the metal waste in the detergent solution as the metal waste is discharged from outlet **30'** of washer **20**.

Whereas feeder **42** provided with surge hopper **40** is advantageous where a batch-type extractor **50** is employed, it should be understood that the feeder and surge hopper may be omitted where the extractor **50** is one of the so-called continuous discharge-type extractors. However, such a continuous discharge extractor may not always be justified from a cost and operational standpoint and thus, a batch-type extractor where the cake of cleaned waste is removed from the extractor bowl at intervals and passed to feeder **54** may be most economically practical. In such event, when the extractor **50** is shut down and the bowl of the extractor is being cleaned, the feeder **42** will be inoperative and the cleaned waste coming from outlet **30'** of the washer **20** can conveniently build up in surge hopper **40**.

Also, although the combination of extractor **50** and dryer **56** in series is shown in the illustrated embodiment, with certain types of metal waste and with certain contemplated further uses for the clean dry metal end product, the provision of the dryer **56** may not be necessary. Of course, the saving in the initial cost of the dryer and the saving in the energy required for its operation would be beneficial if sufficiently dry metal product can be obtained by solely using the extractor **50**. Likewise, it will be recognized that moisture removal may be achieved solely by use of a dryer **56** without use of an extractor such as **50**.

The clean dry metal product leaving the dryer **56**, or if the dryer be omitted, leaving the extractor **50**, is in a condition of low moisture and low oil content with the sludge or other impurities that originally existed in the metal waste before cleaning removed therefrom. This product is in condition to be fed to a metal-melting furnace or to be briquetted for use in other metalurgical processes.

The rehabilitation circuit to restore the detergent solution to its cleaning capability will now be described.

The detergent solution which has been used in cleaning the metal waste in washer **20** overflows into troughs **28** and **28'** of the two sections of the washer and is led away from such troughs through line **60**. This solution, of course, carries with it the oil that has been dissolved from the surfaces of the particles of the metal waste together with sludge or other impurities which may have been present in the metal waste prior to its being cleaned.

The contaminated detergent solution is normally discharged from line **60** unto a coarse screen **62**. Of course, the liquid and smaller particles consisting of the detergent solution, oil and sludge will pass through the screen **62** and be accumulated in surge tank **64**. The coarse screen **62** is only needed where the type of the metal waste being cleaned and consequently the flow of liquid from the washer **20** into line **60** is such that coarse or other undesirably large particles flow along with the liquid. Removal of such coarse or undesirably large particles before further rehabilitation of the detergent solution is desirable in connection with obtaining good action in the application of the centrifugal force used in rehabilitating the detergent solution. Where such coarse or large particles are not present in the flow through line **60** from washer **20**, then the coarse screen **62** may be omitted and the liquid from line **60** sent directly to surge tank **64**.

To maintain the detergent solution carrying oil and sludge in suspension, the surge tank **64** may be provided with means to agitate the liquid therein. Such agitation may be obtained by a propeller immersed in the liquid detergent driven through shaft **66** by a suitable motor means (not shown).

The detergent solution carrying sludge and oil is conducted from surge tank **64** through line **68** to a centrifuge **70**. The control of flow to the centrifuge **70** through line **68** is obtained by manipulation of valve **72** in line **68**. Also it will be noted that a bypass line **74** containing a control valve **76** is provided communicating with line **60** so that liquid flow therethrough may be directed either to surge tank **64** or through line **74** when valve **76** is open to feed the liquid material directly through line **68** to centrifuge **70**.

The operation of centrifuge **70** is conventional in that high rotative speed imparted to the liquid material fed to the centrifuge imparts centrifugal forces to such material such that the liquid portion is separated from the solids and sludge. The solids and sludge are then removed through line **78** from the centrifuge while the remaining solution, constituted by detergent and oil, is drawn from the centrifuge through line **80** by means of pump **82**.

The centrifuge **70** may be of the type wherein continuous discharge of the solids and sludge is carried out during centrifuge operation. However, the economics of initial cost and reliability of operation may make the use of more conventional batch-type centrifuge advisable. In a batch-type centrifuge, a cake of the solids and sludge is accumulated during operation of the centrifuge and the centrifuge must be stopped and cleaned at intervals varying in time depending upon the rate of accumulation of the solids and sludge in the centrifuge bowl. Where the batch-type centrifuge is used, the feed to the centrifuge through line **68** will, of course, be terminated by closing valve **72** when the centrifuge is being cleaned and at such time, the surge tank **64** will serve to accumulate the contaminated detergent solution leaving washer **20** and flowing through line **60**.

The pump **82** draws the liquid portion through line **80** and feeds it to a settling basin **84**. Preferably, the settling basin **84** is associated with the surge tank **64** such that overflow from the basin through trough **86** may be returned to the surge tank **64**. The importance of this relationship arises where a batch-type centrifuge **70** is employed in the system. When the liquid is withdrawn from surge tank **64** to centrifuge **70**, the level in tank **64** will be lowered while the level in settling basin **84** may increase to overflow through trough **86** to maintain a minimum supply in tank **64**. However, when the centrifuge **70** is shut down for cleaning, the liquid from line **60** will tend to accumulate in surge tank **64** and restored clean detergent solution will continuously be drawn from settling basin **84** requiring adequate volume in such basin.

The liquid portion consisting of detergent solution and oil both with the sludge removed enters basin **84** through line **80**. The oil tends to rise to the surface in this basin with the detergent solution tending to settle beneath the upper strata.

Line **88** is connected to withdraw liquid from basin **24** adjacent the normal surface level of the liquid in such basin. This upper strata will be mostly oil although a portion of the detergent solution will be present. The liquid flowing in line **88** is led to a centrifuge **90**. This centrifuge operates to apply centrifugal force to the liquid entering from line **88** to separate the oil from the detergent solution. The separated oil is drawn from centrifuge **90** through line **92**, whereas the detergent solution leaves the centrifuge **90** through line **94** and is pumped back to settling basin **84** by pump **96**.

The operation of centrifuge **90** and pump **96** may be carried out on a timed period. Since only a portion of the overall detergent washing solution is passed through centrifuge **90** and this portion is drawn from the more concentrated oil layer within settling basin **84**, most effective separation of the oil can be achieved by the operation of centrifuge **90**.

The restored and clean detergent solution is present in basin **84**. Concentrated makeup detergent solution will be added to basin **84** through line **98**. The restored detergent solution, having its desired cleaning capabilities, is withdrawn from basin **84** through line **100** by the action of pump **102** disposed in

such line. This clean detergent solution of proper concentration for the desired cleaning effectiveness enters a heat exchanger **104** wherein the temperature of the detergent solution is raised to the desired level to effect best cleaning of the waste material. Heat exchanger **104** may take a conventional form with the detergent solution entering the bottom of the heat exchanger chamber and the desired hot solution withdrawn from the top through line **106**. The heat exchanger casing may appropriately contain a steam coil **108** through which steam is passed to achieve the rise in temperature of the detergent solution.

From line **106**, the hot detergent solution is discharged into the upper ends of the sections of washer **20** in the two-section washer embodiment illustrated in FIG. **1**. This solution flows downwardly in a direction opposite to the movement of the waste material caused by the spiral ribbon conveyors **24** and **24'**. Thus, most effective counterflow cleaning exposure of the surfaces of metal particles in the waste material to the hot detergent solution is achieved. As noted hereinabove, the temperature of the washer **20** is itself maintained by the heating jacket encasing it so that the detergent solution is maintained at the desired temperature for cleaning.

Although two separate centrifuges **70** and **90**, one for sludge removal and the other for oil removal, have been illustrated in the preferred embodiment, it is to be understood that a single centrifuge-type separator may be employed to receive the contaminated detergent solution and separate, in a single operation, the sludge and oil as two constituents then passing on the cleaned detergent solution. It is even possible that such a centrifuge-type separator wherein centrifugal forces are applied to the contaminated detergent solution to separate sludge and oil as two constituents apart from the detergent solution could have continuous removal of sludge wherein it is not necessary to shut the centrifuge down to clean the bowl of accumulated sludge.

As a further alternative, rather than utilize a centrifuge **70** of the type wherein intermittent cleaning of the bowl is necessary, duplicate solids removing centrifuges could be used in parallel wherein the contaminated detergent solution would be supplied to one centrifuge while it was in operation while the other centrifuge was being cleaned and vice versa. However, it generally would be more economical to provide the simple surge tank **64** rather than involve the added expense of providing and maintaining two separate solids removing centrifuges.

Also, the oil centrifuge **90** can be sufficiently large to take the full flow from the solids removing centrifuge **70**. In such alternative, centrifuge **90** would be disposed to receive the liquid flowing in line **80**. However, the use of a smaller centrifuge handling partial flow from and to the basin **84** is preferred. If desired, a float-level control for pump **96**, sensitive to the level of liquid in basin **84**, may be provided to start and stop operation of pump **96**. This level control could respond within limits to the contemplated depth of the upper oil strata in basin **84**. Thus, in most cases, the liquid going to the oil separator **90** would be largely oil and also only a small part of the flow which is handled through the sludge-removing centrifuge **70**.

It is to be understood that the form of this invention herein shown and described is to be taken as a preferred example of the invention and various changes and modifications in the arrangement of parts and the interconnection of components may be resorted to without departing from the spirit of the invention or the scope of the appended claims. All such variations and modifications which come within the spirit and scope of the appended claims are intended to be included herein as fully and as completely as if they had been specifically illustrated, described and claimed. Thus, the modification specifically disclosed is exempliary only and not intended to be limiting on the scope of the invention. The scope of the invention is defined by the following claims.

I claim:

1. A continuous nonbatch type process for cleaning oil-laden metal waste, such as turnings and chips, to recover the metal and reclaim the oil carried by said waste comprising the steps of:

a. providing a flow of detergent solution in a first direction to form a wash bath for cleaning said metal waste by submersion in said detergent solution and dissolve the oil carried by said waste;

b. propelling said metal waste through the flow of detergent solution in a direction generally opposite to the direction of flow of said solution to provide counterflow of waste and solution, the propelling of said waste through said bath serving to agitate said waste and thereby give maximum exposure of the surfaces of the metal waste particles to cleaning by said solution;

c. removing the cleaned metal waste from said wash bath;

d. separating a substantial quantity of the remaining moisture from said cleaned metal waste;

e. removing the detergent solution from the bath after its exposure to the metal waste and passing the detergent solution, carrying sludge and oil therewith, through a rehabilitation circuit to restore the solution cleaning capability before returning the solution to said wash bath for reuse;

f. subjecting all of said detergent solution in said rehabilitation circuit to centrifugal force to separate sludge, acquired by said solution in cleaning said metal waste, from the detergent solution and oil;

g. accumulating the separated detergent solution and oil in a settling basin;

h. withdrawing a portion of the accumulated liquid from adjacent the top of the settling basin and subjecting the withdrawn portion to centrifugal force to separate the oil from the detergent solution to restore the solution, the remainder of said withdrawn portion from which the oil has been separated being returned to the settling basin;

i. adding concentrated makeup detergent solution to the restored solution in the rehabilitation circuit;

j. heating said makeup and restored solution in said rehabilitation circuit; and

k. returning the heated makeup and restored detergent solution from said rehabilitation circuit to the wash bath.

2. A process for cleaning oil-laden metal waste as recited in claim **1** wherein the substantial quantity of remaining moisture is separated by subjecting the cleaned metal waste to centrifugal force, and the separated remaining moisture is returned to said rehabilitation circuit for reuse in the wash bath.

3. A process for cleaning oil-laden metal waste as recited in claim **1** wherein the substantial quantity of remaining moisture is separated from the removed cleaned metal waste by subjecting the cleaned metal waste to drying conditions.

4. A process for cleaning oil-laden metal waste as recited in claim **1** wherein the makeup and restored solution are withdrawn and subjected to said heating before return to the wash bath.

5. A process for cleaning oil-laden metal waste as recited in claim **1** wherein surge accumulation of the cleaned metal waste is provided; the accumulated cleaned metal waste is intermittently subjected to centrifugal force; the substantial remaining moisture of the cleaned metal waste is removed by subjecting the cleaned metal waste to centrifugal force; and the separated remaining moisture is returned to said rehabilitation circuit.

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