

Jan. 10, 1961

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METHOD OF AND APPARATUS FOR DISINTEGRATING
AND DISPERSING A MOLTEN SMELT STREAM
 Original Filed Jan. 8, 1952

2,967,758

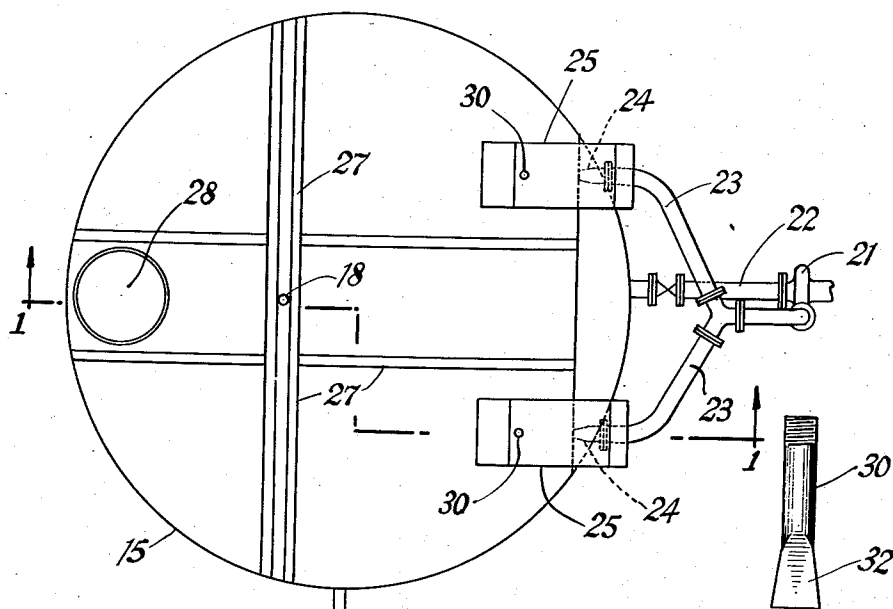


FIG. 2

FIG. 3

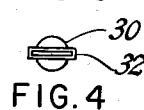


FIG. 4

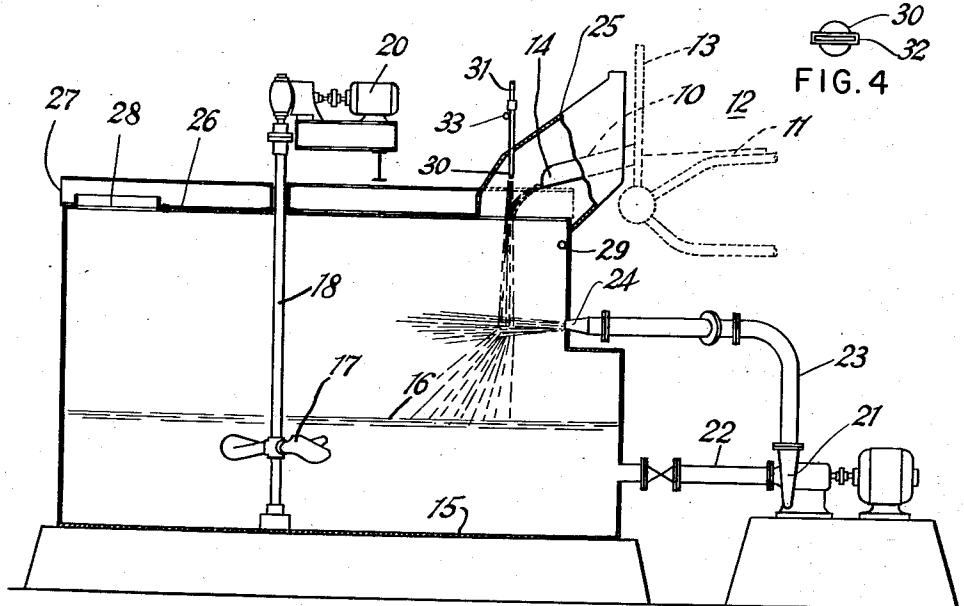


FIG. 1

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METHOD OF AND APPARATUS FOR DISINTEGRATING AND DISPERSING A MOLTEN SMELT STREAM

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Continuation of application Ser. No. 265,433, Jan. 8, 1952. This application June 21, 1956, Ser. No. 592,987

8 Claims. (Cl. 23—48)

The present invention relates to the recovery of chemicals by the incineration of a pulp residual liquor, and more particularly to a method of and apparatus for disintegrating and dispersing a stream of molten smelt prior to its delivery to a pool of liquid in a dissolving tank so as to avoid or at least minimize violent chemical reactions in the dissolving tank. This application is a continuation of my copending application Serial No. 265,433, filed January 8, 1952, now abandoned.

In the sulphate and soda processes for the digestion of cellulosic fibrous materials, the residual liquor from the digestors is incinerated with the recovery of the sodium salts in the form of a molten smelt withdrawn from the incinerating zone and discharged into a dissolving tank, which is partly filled with a pool of "weak" liquor obtained from the causticizing portion of the process. In the sulphate process, the smelt is mainly composed of sodium carbonate and sodium sulphide, the latter resulting from the reduction of sodium sulphate in the char bed. In the soda process, the smelt is mainly sodium carbonate. The aqueous liquor in the dissolving tank is highly reactive chemically to these molten sodium compounds, particularly when they are allowed to accumulate in masses. Discharging the molten smelt as a continuous stream into the liquid within the dissolving tank has been accompanied by noise in the nature of a continuous roar at a high sound level, and occasionally by violent and destructive explosions. Many attempts have been made to eliminate or reduce this noise, but such attempts have not heretofore been successful.

According to my present invention, dissolving tank noise has been largely eliminated by the use of a high velocity gaseous fluid jet, preferably steam under a substantial pressure, which is directed downwardly to intercept the stream of molten smelt entering the dissolving tank so as to shatter the stream and disperse the smelt particles before the molten smelt encounters the pool of weak liquor in the tank. The downward direction of the smelt disintegrating jet drives the smelt particles towards the pool and during this travel the smelt particles are preferably quenched by a spray of weak liquor recirculated from the pool. Within certain definite limits as to gaseous fluid flow, and jet nozzle location, my invention has been found to practically eliminate the dissolving tank noise and explosions heretofore common in the industry.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described an embodiment of my invention.

Of the drawings:

Fig. 1 is a sectional elevation taken on the line 1—1 of Fig. 2 of apparatus incorporating the invention;

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Fig. 2 is a plan of the apparatus shown in Fig. 1; and Figs. 3 and 4 are side and end views, respectively, of the nozzle shown in Fig. 1.

In the drawings, the invention is illustrated as applied to disintegrating and dispersing the stream of molten smelt discharged from a chemical recovery furnace of the general type illustrated in U.S. Patent No. 2,161,110, before the molten smelt enters a pool of dissolving liquor. In the process of chemical recovery disclosed in the patent the molten smelt is obtained by the incineration of residual liquor resulting from the soda or sulphate processes of paper pulp manufacture, so that the smelt contains mainly sodium carbonate and/or sodium sulphide.

As shown, a pair of discharge spouts 10 from the hearth 11 of the recovery furnace 12 extend outwardly with a downward inclination from corresponding ports in the front wall 13 of the furnace. From the end 14 of each discharge spout 10, the molten chemical smelt tends to fall continuously in a substantially solid stream through a downward trajectory into a pool of weak liquor maintained in a dissolving tank 15. In the processes described, the molten smelt leaving the furnace 12 will be at a temperature between 1500 and 1700° F. The smelt is dissolved in the weak liquor within the tank 15, with the concentrated liquor continuously withdrawn, and make-up weak liquor continuously added to maintain the level of the liquor pool in the tank substantially constant as, for example, at 16. The temperature of the liquor pool within the tank 15 will ordinarily be of the order of 150–200° F.

Customarily the tank is provided with an agitator 17 mounted on a vertical shaft 18 and driven by a motor 20. In addition, liquor is withdrawn from the lower portion of the tank 15 by a pump 21 through the valved connection 22 and returned through pipes 23 and nozzles 24 to the upper portion of the tank above the normal pool level indicated at 16. The recirculated liquor is customarily discharged in a horizontal direction, and beneath the smelt stream discharging from the end 14 of each spout 10.

As shown in Fig. 2, the nozzles 24 discharge recirculated liquor streams generally in vertical alignment with the smelt discharged from the corresponding discharge spouts 10. Only one spout and one recirculated liquor nozzle is used in small capacity recovery units while a pair of spouts are used in high capacity recovery units. Whatever the capacity of the recovery unit, each spout 10 is provided with an enclosing hood 25 which extends upwardly from an opening in the tank cover 26 toward the furnace wall 13. The cover 26 is reinforced by structural steel members 27 which also support the motor 20 and drive mechanism for the agitator 17. A vent port 28 is provided in the cover of the tank and is usually connected with a vent duct (not shown) to convey fumes and vapor developed in the tank to a discharge point located outside of the enclosure of the chemical recovery unit.

In the usual operation of a chemical recovery unit of the type described, the stream of molten smelt discharging from the end of a spout 10 describes a downwardly curved trajectory in falling to the subjacent liquor pool. The stream of liquor discharged from the nozzle 24 strikes against the falling smelt stream and tends to deflect and break up the smelt stream. However, the effect of the recirculated liquor stream is insufficient to effectively disperse the smelt stream and to thereby eliminate the noise of the hot smelt contacting and quenched by the weak dissolving liquor. The insufficiency of the recirculated liquor stream to shatter and disperse the smelt stream is apparently due to the relatively low velocity and direction thereof, and the prohibitive pump-

ing costs necessary to recirculate the liquor through the nozzles 24 at an adequate velocity to accomplish the smelt stream shattering effect, as hereinafter described, for noise elimination.

In accordance with the present invention, I have found that the usual noise and explosions associated with dissolving tank operations in the chemical recovery process described can be substantially eliminated by the use of a gaseous fluid jet impacting the smelt stream at sufficient velocity to disintegrate or shatter the smelt stream and to disperse or scatter the smelt particles over a relatively large horizontal area of contact with the liquor stream from nozzle 24 or with the upper surface of the pool within the tank 15. I prefer to use steam for this purpose because in its expansion to atmospheric pressure the desired high jet velocity is readily attainable. Steam is economically available in chemical recovery installations of the type described, since the quantity of steam required is less than one percent of the steam generated in the heat recovery portion of the residual liquor incinerating process.

Some reduction in noise can be attained by the use of a disintegrating and dispersing jet striking the smelt stream from almost any direction, providing large quantities of high velocity fluid is used. When a jet of water or weak liquor is horizontally directed against the smelt stream with sufficiently high velocity and in sufficient quantity to reduce the noise by disintegration and dispersion of the smelt stream, the added liquor dilutes the liquor pool in the tank 15 to an excessive extent. When an air jet is used in this position, the vent discharge through the outlet 28 is greatly increased. The power necessary to supply the necessary high velocity jet of water, liquor or air is also excessive, under these conditions. However, for best results, with a reasonable quantity of gaseous fluid the direction of jet flow and the point of contact between the jet and the smelt stream must be selected within closely defined limits.

In Figs. 1 and 2, a nozzle 30 is positioned beyond the end 14 of each spout 10 with the longitudinal axis of the nozzle lying in a vertical plane common with the longitudinal axis of the spout 10 and spaced from the end of the spout so that an extension of the nozzle axis intersects the smelt stream where the trajectory is downward. I prefer that the minimum dimension between the axis of the nozzle 30 and the end 14 of the spout should be approximately 12 inches, and that the discharge end of the nozzle be substantially in horizontal alignment with the end 14 of the spout. When the nozzle is used with the customary commercial sized chemical recovery units the axis of the nozzle 30 will be substantially vertical, although under conditions of a relatively low or unusually high smelt flow rate the adjustable nozzle may be tilted a few degrees about the pivot 33 from the vertical to obtain best results.

With the nozzle 30 located as described, the steam jet issuing therefrom will strike the smelt stream about 6 or 7 inches from the nozzle tip. With proper steam flow, as hereinafter described, the jet will shatter the smelt stream so that the smelt is dispersed into minute particles which are quenched and further distributed upon contacting the liquor stream from the corresponding nozzle 24 and dissolved upon entering the pool of dissolving liquor in the lower portion of the tank 15. Any smelt splattered upon the wall of the tank is removed by liquor washing obtained by low pressure jets supplied from the pipe 29.

The theoretical reasons for the outstanding noise eliminating success of the described jet are obscure, but are probably due to several factors, such as the cooling effect upon the smelt in contact with the steam, the small size of the smelt particles entering the liquor pool and their distribution over a wide area of the liquor pool surface, and the downward impetus given the smelt particles by the jet.

It has been observed that a minimum dimension of 3 feet, and preferably 4 or 5 feet, should be provided between the zone of jet contact with the smelt stream and the stream of recirculated liquor discharged by the corresponding nozzle 24. Under these conditions the recirculated liquor from each nozzle 24 will intercept at least some of the smelt particles and cause them to deposit over an increased area of the liquor pool.

The steam jet discharged through each nozzle 30 receives steam from any convenient source, such as from the steam generating equipment (not shown) associated with the furnace 12, through a valved pipe 31. In the embodiment shown, the steam is delivered to the nozzle 30 at a pressure of the order of 50 to 150 p.s.i.g. (pounds per square inch gauge) depending upon the valve adjustment in the pipe 31. At this pressure, adequate steam flow is obtained by the use of a $\frac{3}{8}$ " diameter pipe, and the corresponding nozzle shown in Figs. 3 and 4, is fabricated by flattening a $\frac{1}{2}$ " pipe to an elongated tip 32, 1" by $\frac{1}{8}$ ", and having an area of approximately .06 square inch. Under these conditions, the jet steam flow will be of the order of 300 to 500 pounds per hour, and the steam velocity will approach the acoustical velocity, i.e. of the order of 1200 feet per second. When higher pressure steam is available, the pipe sizes and nozzle dimensions will be correspondingly reduced to retain the equivalent jet velocity.

It will be noted that the dissolving tank noise customarily present in chemical recovery units of the type described, is effectively reduced or eliminated by the use of jets positioned as described so as to disintegrate and disperse the molten chemical stream before contacting the pool of dissolving liquid. Steam is particularly effective due to its high velocity, compared to other fluid mediums even though the mass flows of all the mediums are substantially equal.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form of the invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by the claims.

What is claimed is:

1. A process for the recovery of chemicals from pulp residual liquor comprising the steps of incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals in an incinerating zone and reducing the inorganic chemicals to a molten metal smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, gravitationally discharging the molten smelt as a substantially continuous stream from said incinerating zone in a downward trajectory towards a pool of aqueous dissolving liquor chemically reactive to said smelt, and disintegrating and dispersing said stream of smelt while above the level of said pool of dissolving liquor by discharging a downwardly directed jet of gaseous fluid intersecting said smelt stream at a position of substantial vertical tangency while at a high jet velocity and driving said disintegrated and dispersed smelt into said pool of dissolving liquor.

2. A process for the recovery of chemicals from pulp residual liquor comprising the steps of incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals in an incinerating zone and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, gravitationally discharging the molten smelt as a substantially continuous stream from said incinerating zone in a downward trajectory towards a pool of aqueous dissolving liquor chemically reactive to said smelt, and disintegrating and dispersing said stream of smelt while above the level of said pool of dissolving liquor by discharging a downwardly directed jet of steam inter-

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secting said smelt stream at a position of substantial vertical tangency while at a high jet velocity approaching 1200 feet per second and driving said disintegrated and dispersed smelt into said pool of dissolving liquor.

3. A process for the recovery of chemicals from pulp residual liquor comprising the steps of incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals in an incinerating zone and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, gravitationally discharging the molten smelt as a substantially continuous stream from said incinerating zone in a downward trajectory towards a pool of aqueous dissolving liquor chemically reactive to said smelt, disintegrating and dispersing said stream of smelt while above the level of said pool of dissolving liquor by discharging a downwardly directed jet of gaseous fluid intersecting said smelt stream at a position of substantial vertical tangency while at a high jet velocity and driving said disintegrated and dispersed smelt into said pool of dissolving liquor, and withdrawing aqueous liquor from said pool and spraying the withdrawn liquor in a generally horizontal direction into contact with the disintegrated and dispersed smelt stream while above the level of said pool.

4. Chemical recovery apparatus comprising in combination a chemical recovery furnace having means for incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, and a smelt spout opening from said furnace for a gravitational discharge of a substantially continuous stream of molten smelt from said furnace, a smelt dissolving tank positioned to receive the smelt stream discharging from said spout, means for maintaining in said dissolving tank a pool of aqueous liquor chemically reactive to said smelt, and means for disintegrating and dispersing said stream of smelt while above the level of said pool of aqueous liquor including a gaseous fluid jet nozzle positioned above and spaced from the discharge end of said smelt spout to direct a high velocity jet of gaseous fluid downwardly in substantially vertically tangential merging relationship with said smelt stream above the level of said pool of aqueous liquor.

5. Chemical recovery apparatus comprising in combination a chemical recovery furnace having means for incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, and a smelt spout opening from said furnace for a gravitational discharge of a substantially continuous stream of molten smelt from said furnace, a smelt dissolving tank positioned to receive the smelt stream discharging from said spout, means for maintaining in said dissolving tank a pool of aqueous liquor chemically reactive to said smelt, and means for disintegrating and dispersing said stream of smelt while above the level of said pool of aqueous liquor including a downwardly directed gaseous fluid jet nozzle having its axis of discharge lying in a vertical plane common with the axis of said smelt spout and positioned superjacent to the downward trajectory of said smelt stream to project a high velocity jet of gaseous fluid in vertically tangential relation and intersecting said smelt stream above the level of said pool of aqueous liquor.

6. Chemical recovery apparatus comprising in combination a chemical recovery furnace having means for incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals and reducing the inorganic chemicals to a molten smelt containing one or both compounds from

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the group of sodium carbonate and sodium sulphide, and a smelt spout opening from said furnace for a gravitational discharge of a substantially continuous stream of molten smelt from said furnace, a smelt dissolving tank positioned to receive the smelt stream discharging from said spout, means for maintaining in said dissolving tank a pool of aqueous liquor chemically reactive to said smelt, and means for disintegrating and dispersing said stream of smelt while above the level of said pool of aqueous liquor including a downwardly directed steam nozzle having its axis of discharge lying in a vertical plane common with the axis of said smelt spout and positioned superjacent to the downward trajectory of said smelt stream to project a high velocity jet of steam substantially vertically tangentially intersecting said smelt stream above the level of said pool of aqueous liquor.

7. Chemical recovery apparatus comprising in combination a chemical recovery furnace having means for incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, and a smelt spout opening from said furnace for a gravitational discharge of a substantially continuous stream of molten smelt from said furnace, a smelt dissolving tank positioned to receive the smelt stream discharging from said spout, means for maintaining in said dissolving tank a pool of aqueous liquor chemically reactive to said smelt, and means for disintegrating and dispersing said stream of smelt while above the level of said pool of aqueous liquor including means for horizontally projecting a spray of cooling liquid above the level of said pool of aqueous liquor, a downwardly directed nozzle having its axis of discharge horizontally spaced from the discharge end of said smelt spout and lying in a vertical plane common with the axis of said smelt spout and positioned to project a high velocity jet of gaseous fluid substantially vertically tangentially intersecting said smelt stream at least three feet above the level of said spray of cooling liquid.

8. Chemical recovery apparatus comprising in combination a chemical recovery furnace having means for incinerating a sodium base pulp residual liquor containing combustible organic and non-combustible inorganic chemicals and reducing the inorganic chemicals to a molten smelt containing one or both compounds from the group of sodium carbonate and sodium sulphide, and a smelt spout opening from said furnace for a gravitational discharge of a substantially continuous stream of molten smelt from said furnace, a smelt dissolving tank positioned to receive the smelt stream discharging from said spout, means for maintaining in said dissolving tank a pool of aqueous liquor chemically reactive to said smelt, and means for disintegrating and dispersing said stream of smelt while above the level of said pool of aqueous liquor including a downwardly directed nozzle positioned superjacent to the downward trajectory of said smelt stream and arranged to project a high velocity jet of gaseous fluid in vertically tangential intersecting relationship with said smelt stream above the level of said pool of aqueous liquor, and means for withdrawing aqueous liquor from said dissolving tank and spraying the withdrawn liquor into contact with the gaseous fluid jet disintegrated and dispersed smelt stream while above the level of said pool.

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