Apr. 17, 1923. 1,451,904

C. FIELD

HEAT TRANSFERRING APPARATUS

Filed May 16, 1921 2 Sheets-Sheet 2

Fig. 5.

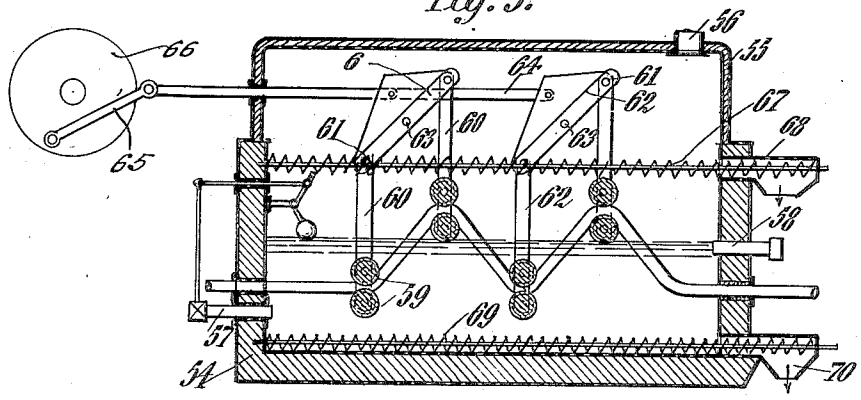


Fig. 6.

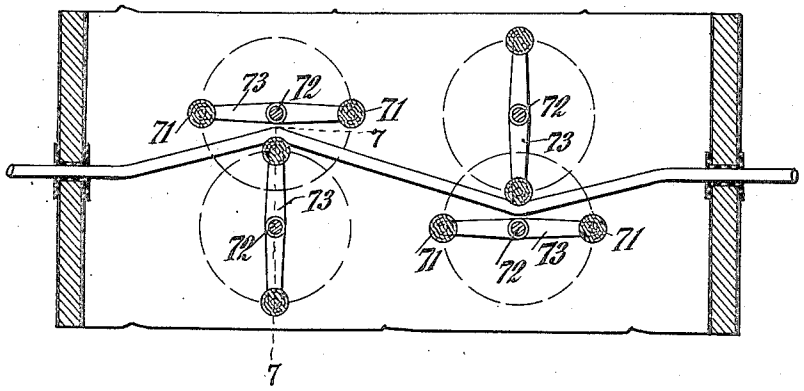
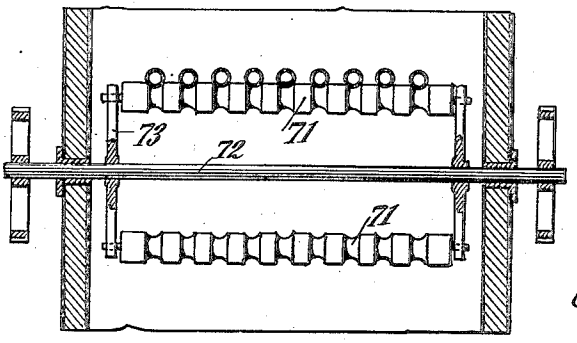


Fig. 7.



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HEAT TRANSFERRING APPARATUS

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Fig:1.

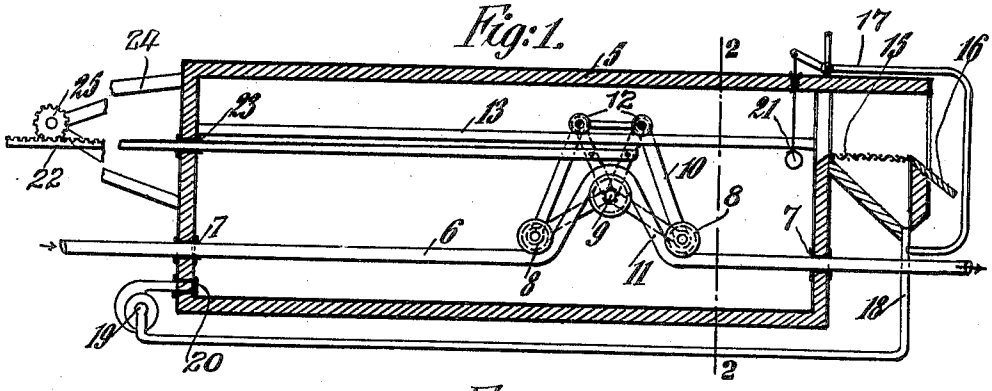


Fig:3.

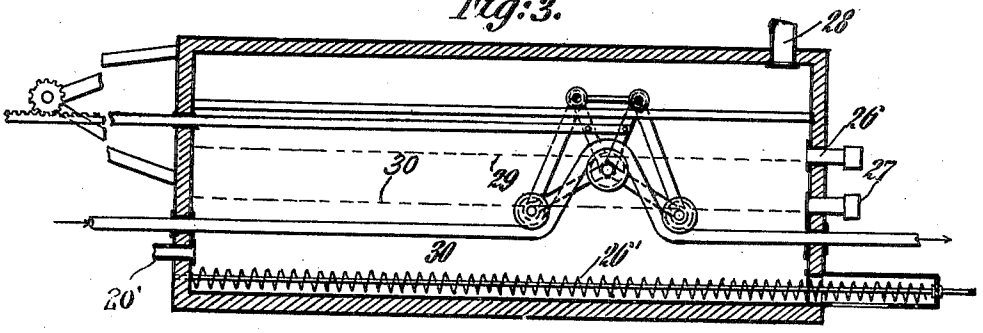


Fig:4.

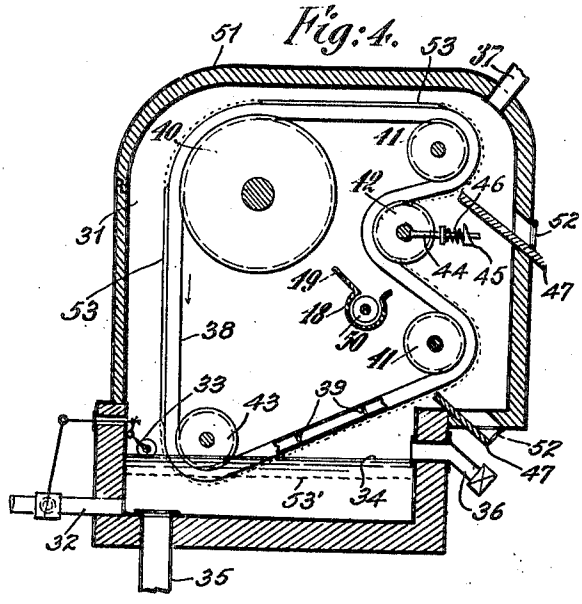
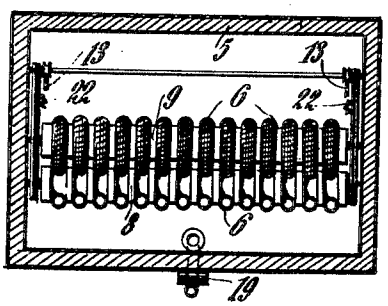


Fig:2.



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Patented Apr. 17, 1923. 1,451,904

UNITED STATES PATENT OFFICE.

CROSBY FIELD, OF YONKERS, NEW YORK, ASSIGNOR TO CHEMICAL MACHINERY CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

HEAT-TRANSFERRING APPARATUS.

Application filed May 16, 1921. Serial No. 469,798.

To all whom it may concern:

Be it known that I, CROSBY FIELD, a citizen of the United States, and resident of the city of Yonkers, county of Westchester, and State of New York, am the inventor of certain new and useful Improvements in Heat-Transferring Apparatus, of which the following is a specification.

This invention relates to an improved heat transferring apparatus and has for its primary object to provide simple and effective means for recovering solids from fluid materials with the expenditure of comparatively little power and at relatively small cost.

More particularly it is the purpose of my present invention to provide apparatus for recovering solids from liquid or gaseous materials wherein I have incorporated the fundamental principle involved in the utilization of a flexible heat transfer medium, whereby the solid deposit may be readily separated from such medium and recovered by temporarily altering the normal conformation of the flexible medium. This principle I have in a general way disclosed in my prior application for patent, Serial No. 247,365 filed July 30, 1918, of which the subject matter of this application is in part a continuation.

The present invention contemplates the provision of certain types of heat transference apparatus, other than those described in the application just referred to and which I have found to be very efficient and reliable in practical use.

With the above and other objects in view my invention consists in the several embodiments of apparatus to be hereinafter more fully described, illustrated in the accompanying drawings and subsequently incorporated in the subjoined claims.

In the drawings, wherein I have illustrated several satisfactory and desirable forms of the apparatus and in which similar reference characters designate corresponding parts throughout the several views:

Figure 1 is a longitudinal sectional view of one form of apparatus for use when the recoverable solids are lighter than the liquid or gas;

Figure 2 is a section taken on the line 2—2 of Figure 1;

Figure 3 is a view similar to Figure 1 of a slightly different construction which is employed when the solids are heavier than the liquid or gas;

Figure 4 is a vertical sectional view illustrating another alternative embodiment of the invention;

Figure 5 is a sectional view showing another modified construction;

Figure 6 is a fragmentary section of a still further alternative embodiment of the apparatus, and

Figure 7 is a sectional view taken on the line 7—7 of Figure 6.

Referring in detail to the drawings and more particularly to Figure 1 thereof, 5 designates a tank or container of suitable dimensions, the walls of which are preferably covered with a heat insulating lagging. A plurality of flexible tubes 6 extend longitudinally through this tank in spaced relation to the bottom wall thereof, said tubes being securely fixed in stuffing boxes or glands 7 in the end walls of the tank. Any desired number of these flexible tubes arranged in the same horizontal plane may be employed, in accordance with the capacity of the tank. The portions of the tubes extending through the tank 5 are of greater length than the length of the tank so that a portion of each tube may be extended around a series of peripherally grooved rollers 8 and 9 respectively, which are mounted in a travelling frame 10. The rollers 8 are spaced apart a suitable distance and have their axes in the same horizontal line, while the roller 9 is arranged intermediate of the rollers 8 and above the plane thereof. Thus, an upward loop or bend 11 is formed in each of the tubes 6. The frame 10 is provided at each side thereof and at its upper end with wheels 12 to travel along the track rails 13, which are suitably secured to the side walls of the tank.

Brine, or any other heat transferring agent, is continuously circulated through the tubes 6 in the operation of the machine.

The tank 5 at one end thereof is provided with an outlet hopper 14 for the overflow from the tank and over the upper end of this hopper a wire mesh screen 15 is arranged. The solid material passes over this screen and beyond the hopper and is discharged over an inclined directing plate 16.

The water feed pipe 17 is connected at one end to a pipe 18 which extends from the

lower end of the hopper 14 and receives the overflow water. This pipe 18 is connected to the inlet side of a pump 19 which delivers the water at 20 into the opposite end of the tank, adjacent the bottom thereof. Thus, a continuous circulation of the water or other liquid is maintained through the tank.

The pipe 17 is provided with a cut off valve automatically actuated by the float 21 disposed in the tank adjacent its outlet end.

Any suitable means may be provided for actuating the travelling frame 10, but for this purpose, I have herein shown a rack bar 22 fixed at one of its ends to said frame and extending through a stuffing box 23 in the end wall of the casing 5. In a frame 24 fixed to the exterior of the tank, a pinion 25 is mounted and has meshing engagement with the teeth of the rack bar 22. This pinion may be driven from any suitable source of power.

In the operation of the machine above described, assuming that it is desired to convert water into ice or to recover a solid from fluid materials which is lighter than the fluid, a continuous circulation of the fluid is maintained through the tank by the operation of the pump 20, while the brine or other heat transferring agent is circulated through the flexible tube 6. Thus, the heat will be transferred from the fluid in immediate contact with the outer sides of the tubes and absorbed by the transfer agent so that a film of solid material will deposit on the exterior surfaces of the tubes. As fast as this film forms it is removed by the reciprocation of the frame 10 carrying the rollers 8—9, which results in the progressive formation of the loop or bend in each of the tubes from one end to the other of the tank. As the tubes are bent they pass around the rollers 8—9 and the film of solid thereon will be fractured and caused to flake off into the tank. This solid being lighter than the water or other fluid will rise to the surface thereof and will be carried with the overflow upon the screen 15. Here the small particles of ice or other solid material accumulate while the water or other fluid is precipitated through the screen into the hopper 14 and returned to the tank through the pipe 18. The accumulating solid material is finally forced outwardly and downwardly over the directing plate 16 into a suitable receptacle or conveyance. In this manner the process of recovering the solidified material goes on continuously.

In Figure 3 I have shown a slightly different form of the machine, which is adapted for use in those cases where the recoverable solids are heavier than the liquid or gas. In this case the tank is not provided with the outlet hopper and screen at its end, as above referred to, but a screw conveyor 26′ is arranged in the bottom of the tank which carries off the solid material settling therein. The tank is provided at one of its ends with the inlet connection 20′ for the material to be treated. The tank is provided with upper and lower horizontal outlets 26, 27 at one of its ends and in addition thereto a vertically disposed outlet 28 is provided in the top wall of the tank. When it is desired to have all parts of the flexible tubes wholly submerged in the fluid, the fluid level is maintained on the line indicated at 29 and overflows through the upper outlet 26. When the tubes are to be only partially submerged, the fluid level is at 30 and the overflow is through the lower outlet 27. When gas or other vaporous fluid is used, the level is the top wall of the tank and the out-flow is through the passage 28. The means for flexing the series of tubes is identically the same as that above described.

In Figure 4 of the drawings, there is illustrated a somewhat different form of apparatus, wherein the vertically disposed tank 31 is provided to receive the liquid or gas which is susceptible of either partial or entire conversion into a solid. When the liquid is entirely convertible it enters the tank from the inlet pipe 32, at the lower end thereof said pipe having a valve actuated through the medium of the float mechanism 33 to maintain the level of liquid in the tank at 34. When the material to be converted is a gas or vapor it enters the lower end of the tank through the separate inlet 35 and may find an exit through either of the outlets 36 or 37. When a liquid is used the exit is through the outlet 36.

Within the tank 31 a series of flexible tubes 38 are arranged, said tubes in this instance being endless and each containing a heat transfer medium, such as mercury, water or other suitable plastic or other liquid filler. Each of these tubes is provided with spaced interior partitions 39 so that the heat transfer medium therein is separated into several distinct portions. These tubes pass over a plane or peripherally grooved drum 40 mounted within the tank. This drum is hollow, to receive a secondary heat transfer medium which is maintained in continuous circulation and makes its entrance and exit through hollow shafts in a manner well known in the art, although if desired other means might be provided for supplying the drum with the heat transfer medium. This drum is rotated by any suitable means to impart movement to the tubes 38.

In addition to the drum 40, vertically spaced peripherally grooved idler pulleys or rollers 41 are mounted within the tank at one side thereof and after passing over the upper pulleys 41 the tubes 38 extend around the intermediate spring pressed idler pulleys 42

which act to maintain a constant tension on the flexible tubes. After passing outwardly over the lower pulleys 41 the tubes extend around additional grooved idler pulleys 43 at the opposite side of the tank and then upwardly to the drum 40. Any preferred means may be employed for tensioning the tubes, but I have illustrated for this purpose a yoke rod 44 in which the pulley 42 is mounted, said rod being movable through the fixed bracket 45. A coil spring 46 surrounding this rod constantly urges the idler pulley 42 against the tube. Immediately below each of the pulleys 41 an inclined shelf or directing plate 47 extends through the wall of the tank. Upon the shelf particles of solid matter flaking off from the flexible tubes fall and are directed outwardly through openings in the tank wall. At the inner side of the series of tubes and below the idler pulleys 42, a transverselv disposed trough 48 is arranged, said trough having an angularly extending flange 49 which directs the particles of solid matter flaking off of the belt portions passing around the pulleys 42 in the trough. A conveyor 50 of suitable construction is mounted on this trough and discharges the particles of solid material through one side of the tank.

In operating upon gas or other vaporous materials, the tank 31 is closed at its upper side by a cover 51, and when this cover is used the openings through which the shelves or plates 47 extend are closed by means of doors or gates 52.

Under certain conditions the series of flexible tubes 38 may be connected by means of a flexible belt 53 of canvas, rubber, metal or other suitable material. This belt is suitably secured to the outer sides of the flexible tubes and ties the same together. It will be understood that the plate 53 is continuous with the tubes 38, though in the drawing I have indicated only spaced portions of the plate, the remainder thereof being cut away In this case in order to prevent solidification of the material on the surface of the drum body, the liquid level in the tank should be maintained at 53′ or below the inner surfaces of the tubes 38.

In Figure 5 I have disclosed another means for flexing a series of tubes through which the heat transferring medium is conducted and in this instance I have shown a form of the apparatus which may be employed when the recoverable solids are either lighter or heavier than the liquid or gas. In this construction, the tank or container 54, when necessary, is provided with a cover 55 having an outlet 56 for gas or vapor. At one end of the tank the liquid to be treated is admitted through the pipe 57 having a float controlled valve maintaining a constant liquid level in the tank. At the opposite end of the tank the outlet 58 for the non-converted liquid is provided. The flexible conducting tubes for the heat transfer medium extend through the tank or container, as shown in Figure 1 and at spaced points these tubes extend between the pairs of grooved rollers 59 which are mounted on the lower ends of the bars 60. These bars at their upper ends are operatively connected as at 61 to opposite ends of a pair of triangular shaped heads 62, which are pivoted as at 63 intermediate of their ends. As shown in the drawings the adjacent bars 60, each carrying a pair of the rollers 59 are pivotally connected to the head plates 62. These plates 62 are, in turn, pivotally connected to a horizontally reciprocable rod 64 which extends through one end of the cover 55 and is eccentrically connected by means of a link 65 to the operating wheel or disc 66. Thus, it will be apparent that when the rod 64 is reciprocated, the adjacent bars 60 are alternately raised and lowered as the head plates 62 are oscillated. Thus, different portions of the series of flexible tubes will be correspondingly raised or lowered and in the movement of the pairs of rollers 29 in each direction, the tube parts engaged with said rollers and extending between the spaced pairs of rollers are flexed. Therefore, the solid deposit collecting on the surfaces of said tubes will be fractured and caused to scale off into the fluid or liquid. The particles of solid material pass off with the overflow liquid through the outlet 58. When the liquid is wholly convertible into solid form, as in the case of ice, the liquid level is maintained in the tank at a higher elevation at which point a screw conveyor 67 is arranged and carries all the solid particles of ice through the outlet 68. When the recoverable solids are heavier than the fluid and are precipitated to the bottom of the tank, they are carried off by a screw conveyor 69 and delivered through the outlet 70.

In figures 6 and 7 of the drawings I have illustrated still another alternative form of the apparatus wherein the flexible conducting tubes for the heat transferring agent extend through the tank between vertically spaced pairs of peripherally grooved rollers 71. The rollers in each pair are disposed at opposite sides of a rotatable shaft 72 and are mounted for independent rotation between radially extending arms 72 fixed on said shaft. Gearing or other suitable means is provided for rotating the shafts 72 whereby each pair of rollers 70 is bodily moved or revolved in a circular path. Two or more sets of these rollers may be arranged in the tank, two pairs of the rollers constituting each set and it will be observed from reference to the drawings that when the rollers of one pair in each set are disposed in horizontal alignment with each other, the rollers in the other pair are in

vertical alignment with each other and with the shaft 72. Thus, as these pairs of rollers are rotated relative to each other, the flexible tubes are moved upwardly and downwardly at spaced points in their length, alternately above and below a central horizontal plane. In this manner the desired flexing action is obtained so as to cause the deposit of solid material on the tubes to be fractured and loosened so that it will flake off into the tank.

From the foregoing description considered in connection with the accompanying drawings, the several described embodiments of the invention will be clearly understood. Insofar as I am aware I am the first in the art to utilize the principle of transferring heat through the medium of flexible elements to convert a fluid into solid form and then separating and recovering the solids by flexing the conducting elements. This process of recovering solids from fluid materials is fully described and claimed in an independent application for patent, the present application covering only certain desirable embodiments of the apparatus for carrying out the improved method or process. I have found in practice that the several constructions to which I have above referred, are productive of very satisfactory results in practical use and may be serviceably employed not only for the manufacture of flake ice, but likewise in the recovery of other solids, vapors or gas. For instance, in the manufacture of chemicals it frequently becomes necessary to purify them by distilling or subliming. Such distillation is usually carried out by converting the material into vapor by the application of heat, the temperature being so controlled that only the pure material is converted into vapor. This vapor is then condensed. In the ordinary condensing equipment commonly used the vapor upon cooling is re-converted into the solid phase in the form of large cakes or masses of material which must be subsequently ground, crushed, or otherwise worked in order to reduce the same to such form as is necessary for further operations. If, however, the condensing apparatus consists of one of the above described forms of my present invention, then the material will be recovered in the form of small cakes or minute sheets or flakes and in such form can be readily utilized without further treatment.

As an example of one specific application of my present improvements to such use, the manufacture of coal tar products and particularly beta naphthol may be considered. Crude beta naphthol is placed in an ordinary still and the vapors resulting from the properly controlled application of heat thereto are delivered to the apparatus such as shown in Figure 3 of the drawings, the outlet 28 being connected to a vacuum pump, while the outlets 26 and 27 are closed. Owing to the presence of the heat transfer medium flowing through the flexible conduits 30, the beta naphthol vapors are condensed upon these conduits in the form of a thin shell or tube exteriorly covering the surfaces of the conduits. As the tubes are progressively flexed by means of the longitudinally travelling device engaged therewith, this shell of solid beta naphthol is broken off from the tubes in the form of small sheets or flakes and falls to the bottom of the tank where said flakes are collected by the screw conveyor 26′ and carried off. This screw forms a seal between the tank and the exterior atmosphere. The operation of the apparatus is so controlled that the solid flakes will remain in contact with the vapors from which they have been condensed for a minimum period of time. During such operation the condensation of the vapors on other parts of the equipment is prevented by pre-heating, proper lagging or the excess temperature of the vapors, or by different combinations of such well known methods.

When the apparatus shown in Figure 4 is used for the conversion of beta naphthol vapors, the inlet 32 and outlet 37 are closed. The vapors are introduced through inlet 35 and upon emergence therefrom they impact against the relatively cool lower portion of the conduit 38 so that such vapors are converted into solid form upon the surfaces of the conduit to be broken up into a multitude of small flakes or particles as said conduit passes around the several flexing rollers 41 and 42 and fall into the collectors 47 from which they may be removed through the opening 52.

When such vapors are converted into solid form by the apparatus shown in Figures 5 and 6, the float valve is removed and the solid vapors freely enter the tank through the entrance 57, such vapors as are not converted into solid form finding an exit through the outlet 56. The conveyor 67 is removed or rendered inoperative and the outlet 58 is closed. The hot vapors condense upon the flexible tubes and the thin sheets or flakes falling from these tubes when they are flexed are removed by the conveyor 69 through the outlet 70. It will likewise be apparent that the essential feature of my present invention might also be embodied in various other alternative forms of apparatus. Accordingly I reserve the privilege of adopting all such legitimate changes in the form, preparation and relative arrangement of the several parts as may be fairly embodied within the spirit and scope of the appended claims.

I claim:

1. In a heat transferring apparatus, a hollow non-rotatable heat transferring mem-

ber adapted to contain a heat transferring medium, means for contacting the material to be treated with said member, and means for progressively flexing said member throughout its length to thereby effect a separation of the solidified material from the surfaces of said member.

2. In a heat transferring apparatus, a hollow heat transferring member adapted to contain a heat transferring medium, means for contacting the material to be treated with said member, and mechanically operated means exteriorly co-acting with said member to flex all portions of the member throughout its entire length and thereby effect a separation of the solidified material from the surfaces of said member.

3. In a heat transferring apparatus, a hollow heat transferring member adapted to contain a heat transferring medium, means for contacting the material to be treated with said member, a plurality of relatively spaced mechanical elements engaging said member at spaced points in its length, and means for actuating said mechanical elements to flex all portions of said member substantially throughout its entire length to thereby effect a separation of the solidified material from the surfaces of said member.

4. In a heat transferring apparatus, a hollow heat transferring member adapted to contain a heat transferring medium, means for contacting the material to be treated with said member whereby the material is solidified by heat transference upon the surfaces of said member, spaced mechanical elements engaging said flexible member at spaced points along its length, and means for actuating said spaced elements to flex different portions of the flexible member alternately in opposite directions and thereby effect a separation of the solidified material from the surfaces of said member.

5. In a heat transferring apparatus, a tank to contain the material to be treated, a plurality of hollow heat transferring members extending longitudinally through the tank and submerged in the material, said hollow members being of greater length than the length of the tank, and means for flexing said hollow members substantially throughout their entire length, said means including spaced mechanical elements arranged within the tank and in constant supporting engagement with the heat transferring members.

6. In a heat transferring apparatus, a tank to contain the material to be treated, a plurality of hollow heat transferring members extending through the tank and submerged in the material, said members adapted to receive a heat transferring medium whereby the material in immediate contact with said members is solidified upon the surfaces thereof, means within said tank and engaging said members and means for reciprocating the latter means to flex said members substantially throughout their entire length and thereby effect a separation of the solidified material from the surfaces of said members.

In testimony that I claim the foregoing as my invention, I have signed my name hereunder.

CROSBY FIELD.