Dec. 15, 1959 J. D. CHRISTIAN 2,917,284

HEAT EXCHANGE APPARATUS

Filed May 4, 1956 4 Sheets-Sheet 1

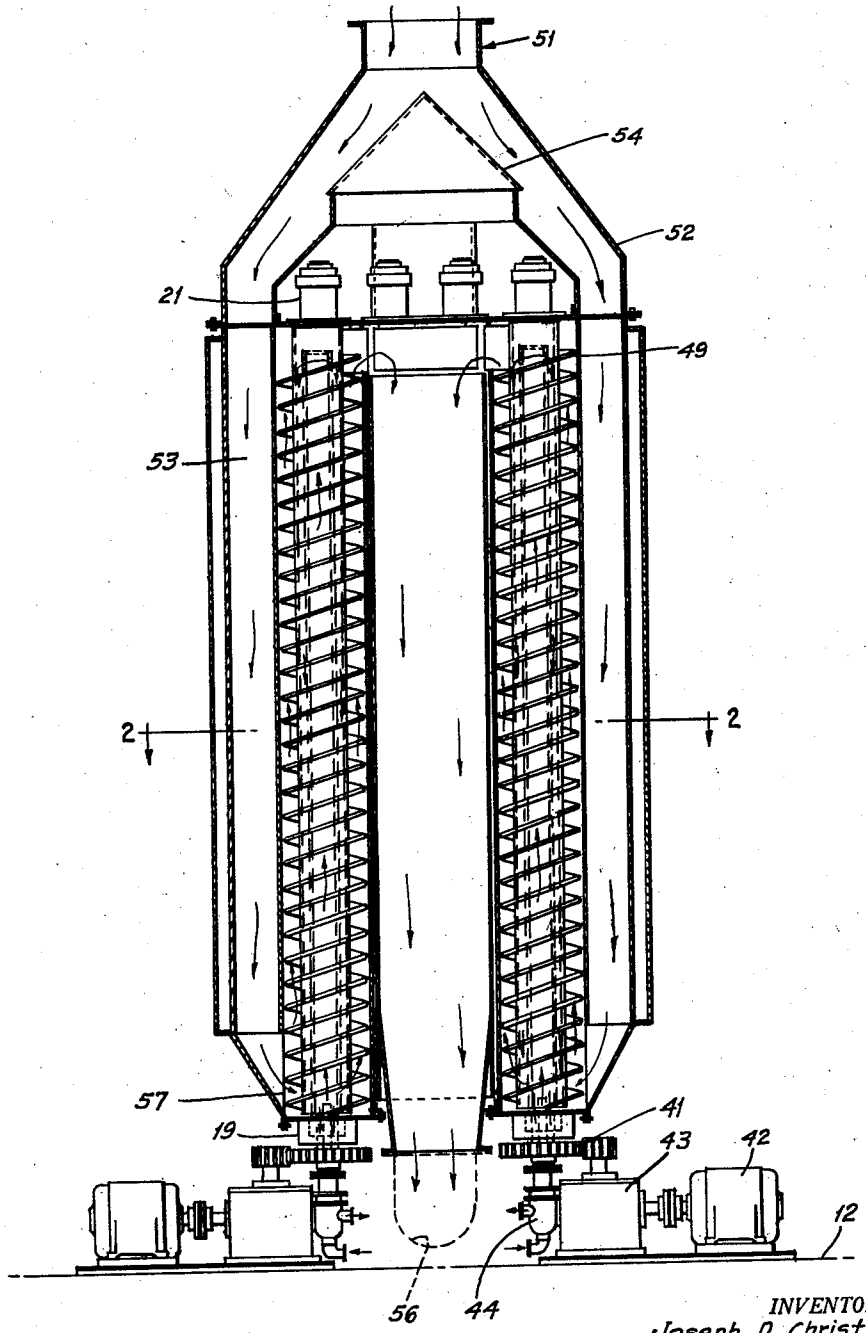


Fig. 1

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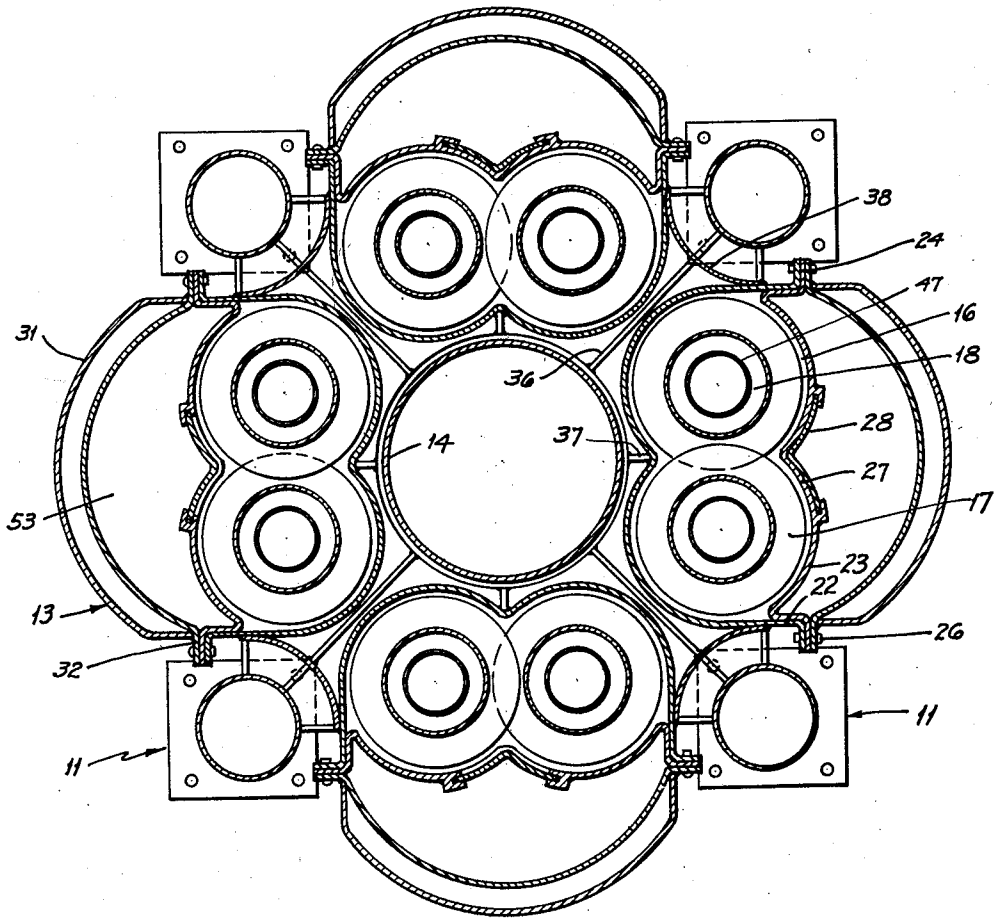


Fig. 2

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HEAT EXCHANGE APPARATUS

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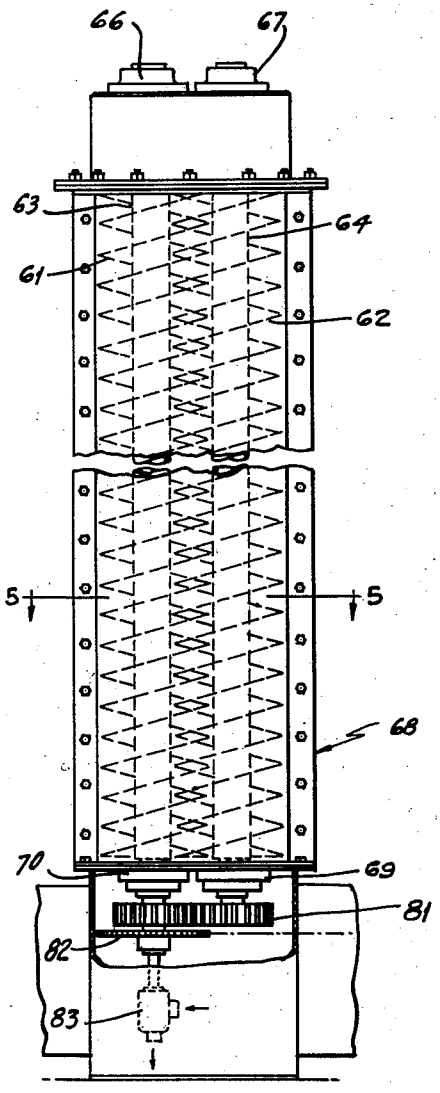


Fig. 3

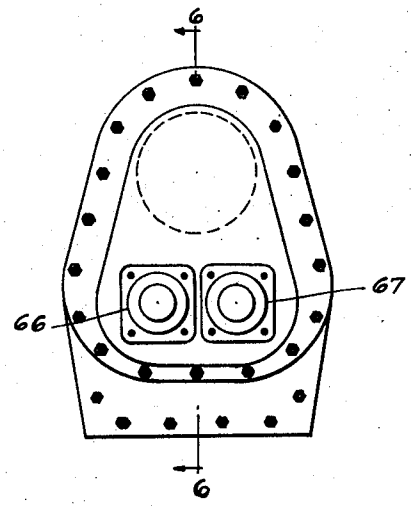


Fig. 4

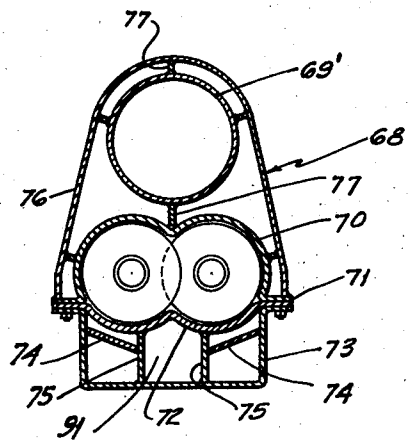


Fig. 5

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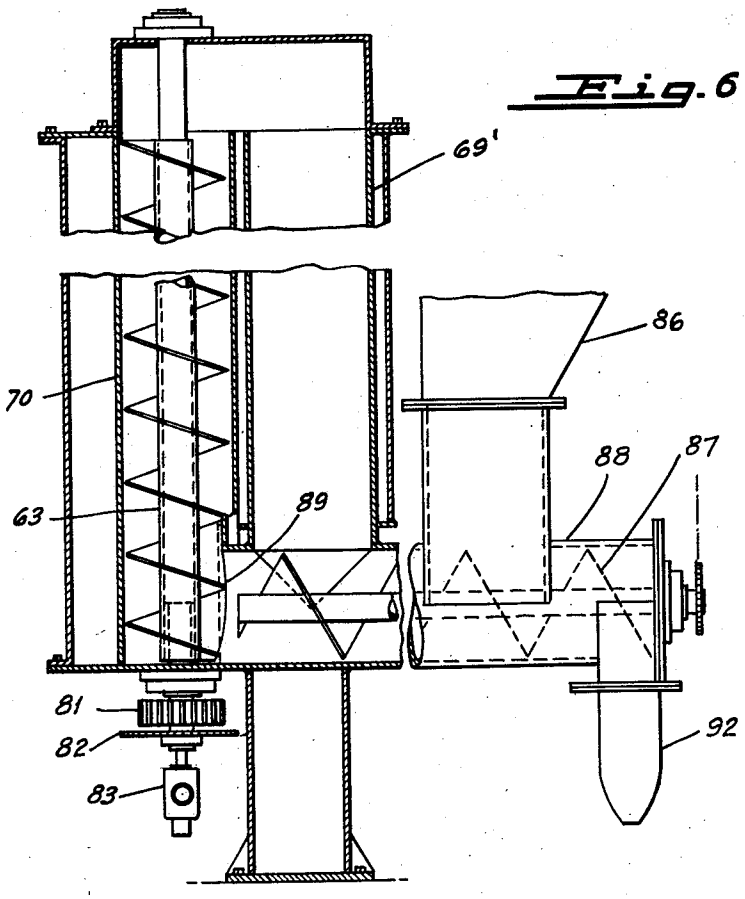
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Fig. 6



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2,917,284

HEAT EXCHANGE APPARATUS

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Application May 4, 1956, Serial No. 582,742

2 Claims. (Cl. 257—112)

This invention relates to heat exchange and particularly to a novel form of apparatus which can be utilized to impart to or remove heat from a material, to the end that the temperature of the material is desirably altered. The apparatus is also capable of other uses and some of these will be related in further detail.

It is in general the broad object of the present invention to provide a novel form of device for controllably altering the temperature of a material.

Another object of the present invention is to provide an apparatus for cooling cement.

An additional object of the present invention is to provide a novel apparatus for the handling of meat scraps for production of tallow.

The invention includes other objects and features of advantage, some of which, together with the foregoing, will appear hereinafter wherein the present preferred embodiment of the invention is disclosed. In the drawings accompanying and forming a part hereof, Figure 1 is a side elevation, partly in section, taken through a form of the apparatus embodying the invention and which is particularly suited to the cooling of cement.

Figure 2 is a section taken along the line 2—2 in Figure 1, and showing the construction of the apparatus.

Figure 3 is a side elevation, partly in section, of an apparatus particularly suited to the handling of tallow and the like.

Figure 4 is a top view of a portion of the apparatus shown in Figure 3.

Figure 5 is a section taken along the line 5—5 in Figure 3.

Figure 6 is a side elevation, partly in section, of the apparatus shown in Figure 3.

Referring to Figure 2, the apparatus there shown includes four spaced vertical columns 11, extending upwardly from a suitable base 12, and providing a support for a casing structure, generally indicated at 13. The casing structure includes a central vertical tube 14 about which are clustered four pairs of intermeshing vertical screws or helical bladed rotors 16 and 17. Each rotor includes a relatively large diameter hollow central shaft 18 having relatively narrow helical fins fastened thereto, the rotor shafts being supported in bearings 19 and 21 provided, respectively, at the bottom and the top of the casing. The helical fins in each pair preferably have the periphery of one closely approaching but not in wiping contact with the shaft of the other.

Each screw pair is closely confined within an arcuate housing made up of an inner arcuate portion 22 and an outer cover portion 23. Each of the portions are flanged along their peripheral edges, as indicated at 24, the flanges being secured together by bolts 26. Each of the covers 23 includes an opening 27, over which is mounted a movable door 28 to permit of regulation and control of recirculation of material, as will be described. Also mounted over each cover is an outer cover 31, flanged as at 32 and secured by the bolts 26 in position over the cover 23. The outer cover 31 is hollow to permit of fluid

circulation. It is to be noted that the width of the inner arcuate portion between its projecting sidewalls is such that by removing the cover portion, the screws are totally exposed. Further, this enables the screws to be removed for inspection, testing and repair.

Stay bars 36 and 37 extend from the tube 14; stay bars 36 pass to each of columns 11 through arcuate braces 38, which join adjacent pairs of housing members 22; stay bolts 37 extend between tube 14 and each of the housing members 22.

Suitable gearing, generally indicated at 41, is mounted upon each of the rotor shafts to permit of their drive from the prime mover 42 through gear reduction 43. Suitable rotary unions 44 are provided upon each of the shafts for ingress and egress of a heat exchange fluid to each of the rotors, the fluid being admitted to the interior of a baffle tube 47 provided within each shaft 18, the fluid issuing through an outlet 49 (Figure 1) at the top of each baffle tube and then passing downwardly through the hollow center of the rotor and discharging via a rotary union 44. Fluid is also admitted to circulate through the hollow covers 31 and in the space between tube 14 and each of the surrounding screw conveyor housing members 22. In this connection, it is to be noted that all joints and welding that retain the heat exchange medium are located so that fluid circulating in the areas exterior to the housing for the rotors cannot gain access through any joint and, further, all such joints are exposed so that any leak can be readily observed. Also, all fluid connections are beneath the casing as is the power equipment, thus ensuring that any fluid or lubricant leaks cannot contaminate the material being processed.

At the top of the structure, a header, generally indicated at 51, is provided, having down spouts 52 each leading to a passage 53 provided between an outer cover 31 and a rotor cover member 23. Immediately beneath the header 51 is provided a distributing cone 54; this can be arranged with a gate portion, permitting by-pass of a desired quantity of the material entering header 51 into tube 14, if this is desired. Material at the bottom of tube 14 is taken off by a suitable conveyor (not shown) in passage 56.

In using this apparatus, the material is introduced through the header 51 and unless by-passed, falls down through the several passages 53, the material entering between the screw pairs through an inlet 57 provided in the bottom of housing members 22 and 23. The material is moved upwardly by the helical rotors in rubbing contact with the heat exchange surfaces provided by the housing members 22 and 23 and with the hollow shaft and helical fins of the rotors themselves, issuing from the top of the rotors and falling downwardly through the tube 14, to be removed through the outlet 56. If desired, one or more of gates 28 can be opened to permit of partial or complete recirculation.

It is obvious that with this feature of recirculation the processor can be operated on a continuous, semi-continuous or batch cycle basis. If part of the material is recirculated, by blending with other material, increased heat exchange is facilitated. If complete recirculation is practical, the unit functions as a batch processor, retaining the batch for the proper time to accomplish the full heat exchange desired, then by closing the recirculating door the material can be discharged through tube 14 to the discharge conveyor provided at 56.

The equipment described is particularly useful in the cooling of cement. However, it is not limited to handling of only this material, since it can be used successfully upon salt, grain, flour, starches and the like, and upon such diverse materials as meat scraps, tomatoes, baby foods, and various slurries. The action of the screws is

to move the material with a scrubbing action over the heat exchange surfaces. When desired, as in the case of handling meat scrap, particle degradation can be emphasized by the clearances between the interfolded helices. Likewise when handling materials where particle degradation is desired to be at a minimum, such as sugar, the clearances are increased.

The action of the screw conveyor flights is to spread the material over the area of the heat exchange surfaces, promote particle relocation and intimate contact. Thus, highly efficient heat exchange is obtained. The rotors are turned at as slow a speed as is possible to secure upward movement of material. Also, the space between the rotors and the casing, the free space about the rotors, is preferably filled with materials. Further, the rotors preferably fit the casing as snugly as possible to maintain fall-back of material to a minimum.

In that form of the invention shown in Figures 3–6, I have illustrated a somewhat simpler form of apparatus. In this, a single pair of helical rotors or screw conveyor flights **61** and **62** are mounted upon hollow shafts **63** and **64**, the latter being supported by bearings **66** and **67**, provided at the top of a casing structure, generally indicated at **68**; the lower ends of the shafts are supported by bearings **69** and **70**. The casing structure **68** includes a down pipe **69** and a first arcuate housing member **70** fitting the interfolded screw conveyor flights; housing member **70** is flanged at **71**, as is an outer cover member **72**. Mounted upon the outer cover **72** is a shell **73**, having a plurality of interior dividers **74** and **75** on each side thereof to provide a plurality of heat exchange passages in conjunction with the screw conveyor cover member **72**. An outer shell **76** is also provided about the pipe **69** and about a portion of screw conveyor housing member **70**. Vertical dividers **77** are provided between the shell **76**, pipe **69**, and the screw conveyor housing member **70**, to provide a plurality of passages for heat exchange fluid.

The screw conveyor flights are driven by suitable gearing **81** from a prime mover, not shown, which drives a sprocket **82** mounted upon shaft **63**. Heat exchange fluid is introduced through the rotary union **83** mounted upon each of the shafts.

Material to be processed is fed into the hopper **86** and is then moved by a horizontal screw conveyor flight **87** through casing **88** into inlet **89** of casing **68**. The material is circulated through the equipment, being returned through the down pipe **69** to the feeder screw **87**. When it is desired to remove the material and empty the apparatus, the direction of rotation of the feed screw is reversed, and the material is discharged through the outlet pipe **92**. If it is desired to operate the apparatus continuously, then down spout **69** can be so provided as to lead all or a portion of the material away.

In processing tallow and like material, a portion of the area of the cover member **72** is provided with a plurality of small holes, e.g., ⅛" holes on ¼" centers, so that the tallow will drain off of the meat scrap and so can be led away through passage **91**, and moisture vapors may rise through passage **91**.

In a typical installation, the meat scrap is introduced in "hogged" form from a hog to the double helical rotors rotating intermeshed at 50 r.p.m. These rotors are 9" in diameter and 20' high. The meat scrap, weighing about 60 pounds per cubic foot, will be recirculated at the rate of twenty-one tons per hour and this recirculation tends to homogenize the product. Steam passing through the heat exchange ducts raises the temperature of the material, usually to about 216° F. This causes a break-down of cells and a release of the tallow, which exudes through the perforated area of the cover **72** and falls to the bottom of passage **91**, while the water vapor passes off through the top of said passage. This action of the screws is such that it keeps the small holes clean. As the meat scrap is reduced in volume, additional cold material is added. When the tallow is completely rendered from the mass, the remaining "cracklings" are discharged, as herebefore described. The apparatus shown is not only useful in treating materials such as tallow and other materials, but in the precrushing or scalping of wine grapes, in which stems, seeds and skins are separated from the juice.

From the foregoing, I believe it will be apparent that I have provided a novel, simple and improved form of heat exchange device, which will meet with many diverse uses.

I claim:

1. A device of the character described comprising a vertical tube having an inlet at its upper end and an outlet at its lower end, a plurality of pairs of interleaved screw conveyor flights extending parallel and closely adjacent to said tube, a casing closely fitting each screw pair, means joining adjacent casings and the tube to provide heat exchange passages, a cover on each casing providing a passage for material, means for introducing material into each passage, an inlet from each passage into each casing at the lower end thereof, each screw pair discharging into the inlet of said tube, each screw flight being mounted on a hollow shaft, and means for circulating a heat exchange fluid through each shaft and through the heat exchange passages between the casings and the tube.

2. A device as in claim 1 wherein each casing includes an outer cover and an inner cover having outwardly extending sidewalls spaced apart a distance slightly greater than the width of the interleaved screws to permit removal of the screws upon removal of the outer cover.

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