April 7, 1959 L. G. SIMJIAN 2,880,663

APPARATUS FOR TREATING ARTICLES

Filed Dec. 20, 1957 3 Sheets-Sheet 1

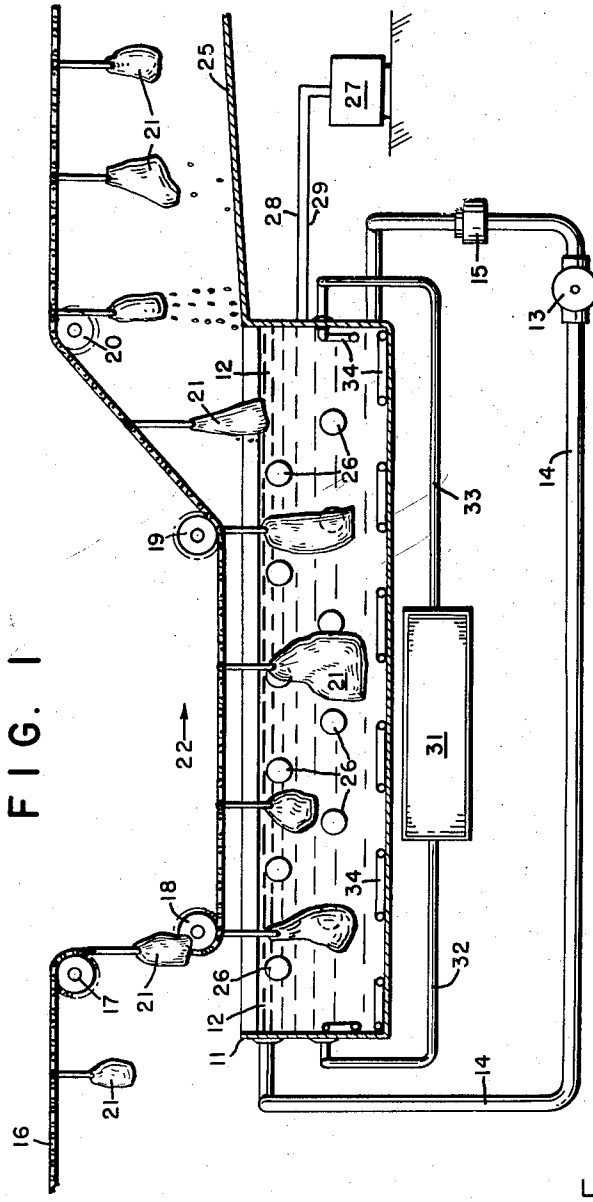


FIG. 1

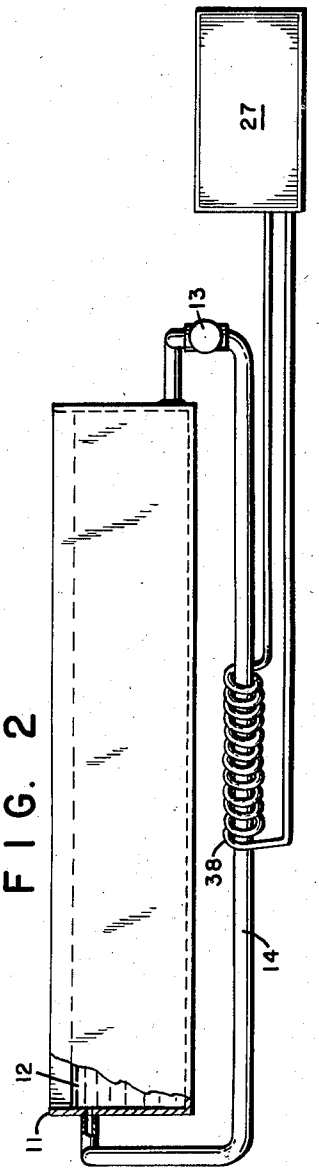


FIG. 2

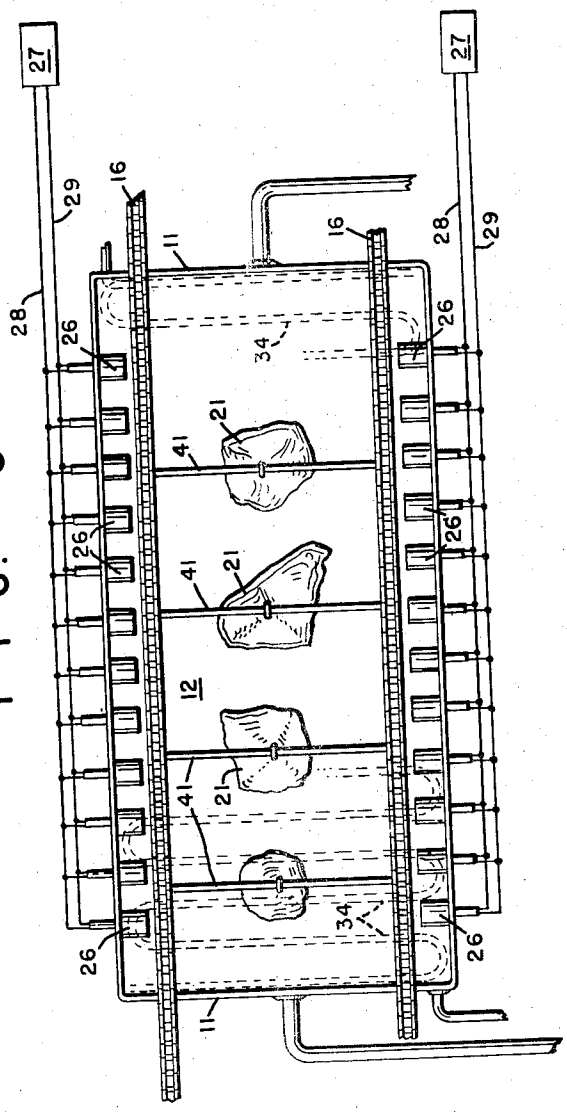
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FIG. 3



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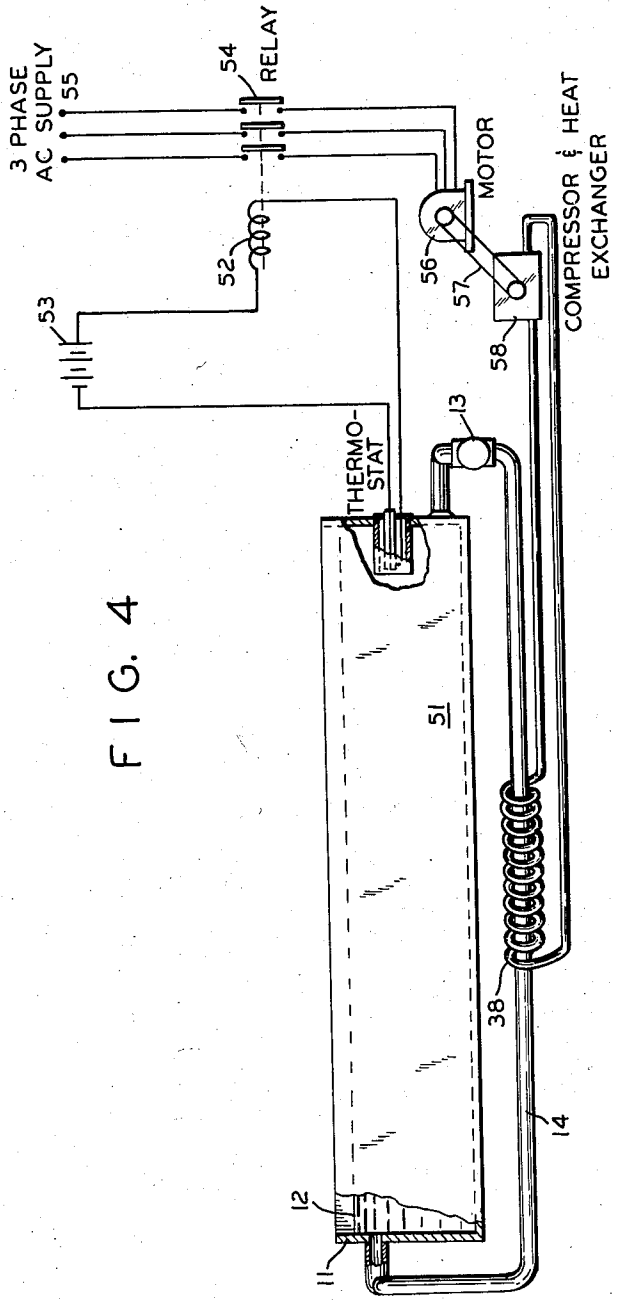


FIG. 4

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APPARATUS FOR TREATING ARTICLES

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Application December 20, 1957, Serial No. 704,181

4 Claims. (Cl. 99—254)

The instant invention is related generally to an apparatus and method for treating articles, and more particularly, refers to an apparatus for treating articles by the application of compressive wave energy, specifically the application of high frequency oscillations in the sonic-ultrasonic frequency range.

The invention is related also to my U.S. Letters Patent entitled "Food Tenderizer," U.S. Patent No. 2,806,246, dated September 17, 1957 and to my copending application for U.S. Letters Patent entitled "Food Tenderizer," Serial No. 537,720, filed September 30, 1955, now U.S. Patent No. 2,830,912, dated April 15, 1958, in which I disclose broadly an apparatus and method respectively for treating a normally deformable article by the application of sound energy in order to render the article more tender. The instant invention discloses certain improvements in the apparatus so as to provide an installation which is adapted for treating articles on a mass production scale. To this end, the instant apparatus in its broad concept and in a typical embodiment comprises a stationary tank which is filled with a liquid such as brine. Articles to be tenderized are immersed by means of conveyor means into the tank for a predetermined length of time and while immersed, the articles are being exposed to energy in the sonic-ultrasonic frequency range. In addition, cooling or refrigerating means are provided to maintain the article and liquid at a predetermined temperature whereby the cooling means are of sufficient capacity to absorb the heat generated by the sound energy producing means and also the ambient thermal energy effective upon the tank and its contents.

An object of this invention therefore is the provision of an improved tenderizing apparatus.

Another object of the invention is the provision of an apparatus for treating a large quantity of articles on a mass production scale.

A further object of this invention is the provision of an apparatus for treating articles which is provided with cooling means in order to maintain certain predetermined temperature conditions at which the most effective treatment is obtained.

A still further object of the instant invention is the provision of an apparatus for treating an article by means of high frequency vibrations in the sonic-ultrasonic frequency range while the article is immersed in a refrigerated brine.

Still another and further object of the instant invention is the provision of means for conveying articles through a liquid bath while the articles are being treated with sonic or ultrasonic vibrations.

Further and other objects of this invention will be apparent by reference to the following description taken in conjunction with the accompanying drawings in which:

Figure 1 is an elevational view, partly in section, of the apparatus;

Figure 2 is a modification of certain features illustrated in Figure 1;

Figure 3 is a partial plan view of the apparatus shown in Figure 1, and

Figure 4 is a view similar to Figure 2 but includes schematic circuit connections for the temperature control means.

Referring now to the figures and Figure 1 in particular, numeral **11** identifies a tank which is filled with a liquid such as a brine solution. The brine may be circulated through the tank by means of a pump **13** and piping **14**. A filter **15** inserted along the piping **14** serves to filter and purify the brine as it is being circulated. A conveyor means **16**, being guided over a series of overhead rollers **17**, **18**, **19**, and **20** respectively, serves to convey articles **21** supported therefrom through the tank. It will be observed that the motion of the conveyor is in the general direction of arrow **22** so that the articles are brought from the left side of the figure, become immersed into the brine, and finally are lifted out of the brine and conveyed away from the tank. A splash board **25** attached to the exit end of the tank is provided so that liquid dropping from the articles **21** as they are lifted out of the brine, is returned to the tank.

Disposed along the sides of the tank there is placed a plurality of spaced transducer elements **26** which are energized from a source of electric energy **27** via conductors **28** and **29** to produce vibrations in the sonic-ultrasonic frequency range. These transducers may be magnetostriction transducers, piezoelectric transducers or any other transducers, such as air resonators, which produce vibrations in the sonic-ultrasonic frequency range in response to energy applied thereto. The vibrations from the transducers are transmitted to the articles **21** via the liquid **12** so that the liquid acts essentially as a coupling medium between the transducer elements and the articles.

It is well known that elastic bodies absorb compressive wave energy, thus forming an attenuator to the high frequency vibrations. In order to effectively treat the articles with vibrations in the sonic-ultrasonic frequency range, the normally elastic or deformable articles are rendered substantially rigid by freezing prior to exposure to the high frequency vibratory treatment. To maintain the articles frozen while being treated and to prevent the heat losses produced in the transducers from causing a temperature rise of the brine and of the articles immersed therein, refrigerating means **31** are provided which, by means of pipes **32** and **33** connected to cooling coils **34** disposed within the tank, first lower the temperature of of the brine and then maintain the brine and the articles at the desired low temperature. Such refrigerating means may comprise a compressor with necessary accessories and ammonia or Freon gas as refrigerant. By means of this refrigerating arrangement the temperature of the brine and of the articles can readily be maintained at or below the freezing point of water. Obviously other refrigerating means, such as ice, Dry Ice, etc., may be used in the same or similar manner. The freezing of the articles and the provision of keeping the articles frozen while immersed in the liquid, aside from permitting the treatment by compressive wave energy, also serves to place limits on the water absorption by the articles during treatment. Commercially accepted standards tend to limit the water absorption of meat for instance, to about three percent. By regulating and adjusting the temperature of the article, of the brine, and of the length of exposure, the water absorption can be maintained accurately within the prescribed limits. In other instances it may be desirable to place the article within a thin sealed wrapper in order to avoid contact between the brine and the article. A conforming wrapper of thin plastic sheeting is one example of such an enclosure.

Circulating the brine by means of pump **13** has another beneficial effect, that is, continuous agitation of the brine will prevent freezing of the liquid. It will be apparent that instead of the circulating means shown, continuous agitation by mixing blades or impellers could be used without deviating from the principle disclosed.

Figure 2 shows a variation of the refrigerating means provided for maintaining the tank and its contents at the desired temperature. Refrigerating coils 38 are coiled about the brine circulating piping 14 so that the brine is refrigerated as it circulates between the pump 13 and the tank 11.

It will be apparent that the refrigerating means shown in block form is provided with thermostatic controls to maintain the brine within the desired limits and to overcome the thermal effects of the ambient temperature, the thermal losses of the transducer elements and the other losses which may exist in the entire system.

Figure 3 is a plan view of the arrangement shown in Figure 1 and shows two spaced flexible link chains 16 which act as the conveyor means and which support a plurality of spaced transverse rods 41, each rod supporting dependingly an article 21 to be treated. It will be apparent that instead of a set of spaced claims, a "monorail" conveyor means or similar conveying means may be used for transporting the articles through the processing tank. Each side of the tank is lined with a plurality of transducer elements which are energized from a source of high frequency electrical energy 27. By referring to Figure 1 it will be seen that the transducers are arranged in a pattern so as to cover substantially the entire area of the bath without establishing a definite pattern or dead spots within the tank. Instead of operating all generators from a single frequency, it may be found advantageous to employ varying frequencies along the tank passage so as to exclude still further the possibility of violent resonant frequencies or harmonic frequencies. Instead of employing transducers which are directly immersed into the liquid and which directly transfer their vibratory energy to the liquid, it is readily possible to couple the transducers to the tank walls so as to cause the tank walls to oscillate at sonic or ultrasonic frequencies, and the energy then being transferred from the tank walls to the liquid and to the article immersed in the liquid.

Figure 4 shows the thermostatic controls which may be employed to maintain the temperature of the liquid at the desired low level. One or more thermostats 51 are mounted into the tank so as to sense the temperature of the brine solution. When the temperature of the solution exceeds a certain predetermined level, the thermostat closes a circuit and energizes coil 52 of an electromagnetic relay which is series connected with the thermostat via a source of low voltage electrical energy 53. When the coil is energized, associated electrical contacts 54 of the relay are closed to establish connection between the three phase A.-C. supply 55 and motor 56, which via a belt 57 drives a conventional refrigeration compressor and heat exchanger combination 58. As soon as the brine has been lowered to the desirable level, the thermostat opens the circuit to coil 52, thus causing the connection between the electrical supply of energy 55 and the motor to become opened thereby stopping the operation of the compressor.

By the way of example, the following illustration will serve to indicate a typical method of treatment which has been tried and which has been found to produce satisfactory results. Articles of meat were frozen and immersed in a brine maintained at a temperature of minus five degrees centigrade for several minutes and while immersed being treated with high frequency vibrations produced by nickel magnetostriction transducers operating at a frequency from five to twenty kilocycles. The power per transducer head was in the order of 1300 to 1500 watts peak power with about 250 watts average power. Microscopic analysis and taste tests of treated versus untreated articles of meat showed that the processing causes a considerable tenderization of the meat. Similar tests have been conducted with other products and articles of food, and in every instance there has been found a tenderizing action to take place.

It will be apparent to those skilled in the art that the time, frequency, and power ranges employed may be subject to wide variations depending upon the type of transducer and the type of article employed and that the above values are for illustrative purposes only.

While there have been described certain embodiments of the foregoing invention, it will be apparent to those skilled in the art that various further modifications may be made therein without departing from the principle of the present invention which shall be limited only by the scope of the appended claims.

What is claimed is:

1. An apparatus of the type described comprising; a tank containing a brine solution; a plurality of transducer elements disposed in spaced relationship along the tank, each transducer receiving electric energy for imparting oscillations in the sonic-ultrasonic frequency range to the contents of said tank; conveyor means disposed to move frozen articles through said tank whereby the articles establish contact with said solution and receive said energy from said transducers; a refrigeration system coacting with the contents of said tank to maintain said brine refrigerated and said articles frozen while being treated with sonic-ultrasonic energy, and means for circulating said brine solution within said tank.

2. An apparatus of the type described comprising: an elongated tank containing a liquid; a plurality of transducer elements mounted in spaced relationship to one side of the tank, each transducer receiving energy for imparting oscillations in the sonic-ultrasonic frequency range to the tank walls and the contents of the tank; conveyor means disposed to move articles through the tank whereby the articles establish contact with the liquid and receive energy from said transducers as they are conveyed past said transducers; a refrigeration system cacting with the contents of said tank to maintain said lquid at a temperature below the freezing point of water while the articles are being treated in the apparatus, and means for preventing freezing of said liquid within said tank.

3. An apparatus of the type described comprising: an elongated tank containing a liquid; a plurality of transducer elements mounted in spaced relationship to one of the longer sides of the tank, each transducer receiving energy for imparting oscillations in the sonic-ultrasonic frequency range to the tank walls and the contents of the tank; conveyor means disposed to move articles through the length of the tank whereby the articles establish contact with the liquid and receive energy from said transducers as they are conveyed successively past said transducers; a refrigeration system coacting with the contents of said tank to maintain said liquid at a temperature below the freezing point of water while the articles are being treated in the apparatus, and means for preventing freezing of said liquid within said tank.

4. An apparatus of the type described comprising: a tank containing a brine solution; a plurality of transducer elements disposed in spaced relationship along the tank, each transducer receiving energy for imparting oscillations in the sonic-ultrasonic frequency range to the contents of said tank; conveyor means disposed to move frozen articles through said tank whereby the articles establish contact with said solution and receive said energy from sad transducers; a refrigeration system coacting with the contents of said tank to absorb the heat generated by said transducers and maintain the brine refrigerated and the articles frozen while being treated with sonic-ultrasonic energy; means for circulating said brine solution within said tank, and thermostatic control means for maintaining said brine at a predetermined temperature level.

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