Nov. 12, 1929. S. HILLER 1,735,393

APPARATUS FOR TREATING MATERIALS

Filed Aug. 9, 1924 3 Sheets-Sheet 1

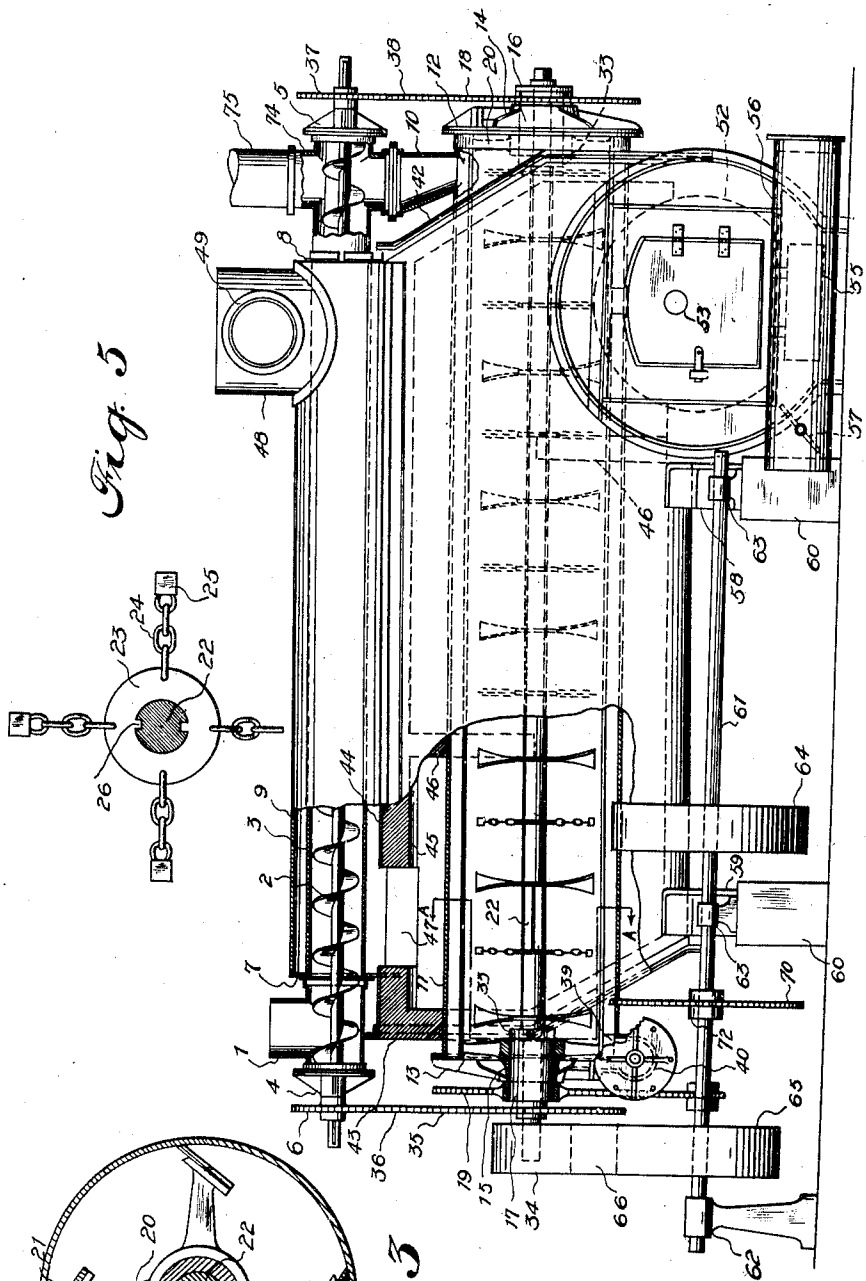

Fig. 1

Fig. 5

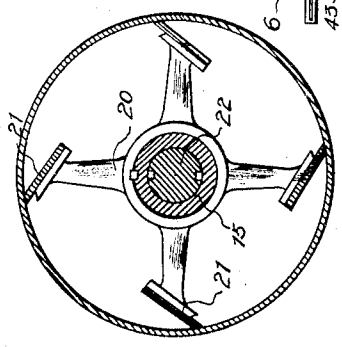

Fig. 3

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APPARATUS FOR TREATING MATERIALS

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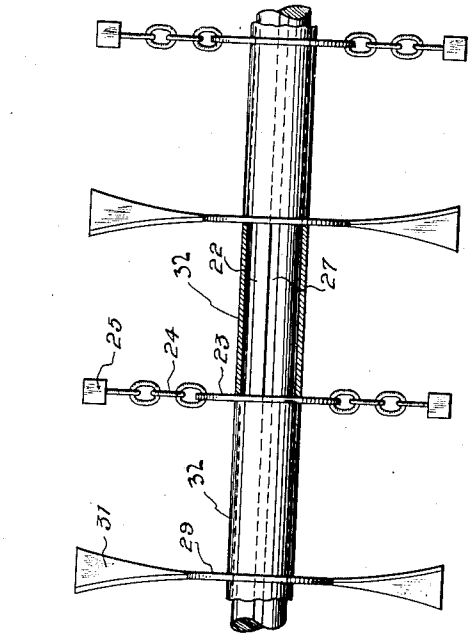

Fig. 4

Fig. 2

Fig. 6

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APPARATUS FOR TREATING MATERIALS

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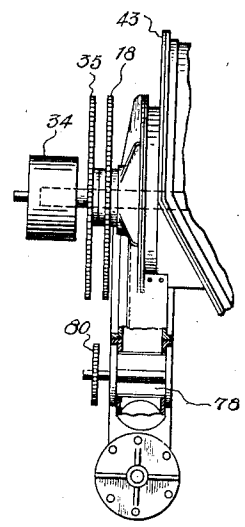

Fig. 8

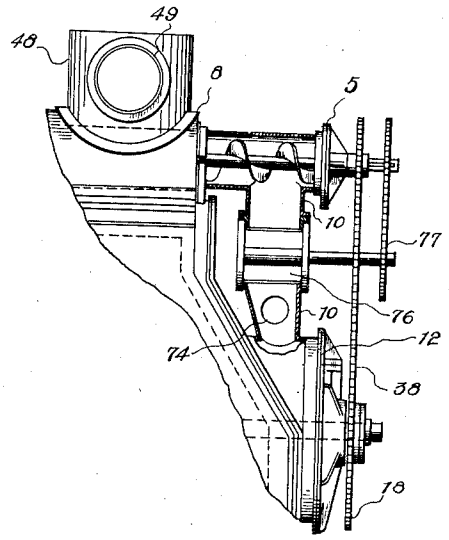

Fig. 7

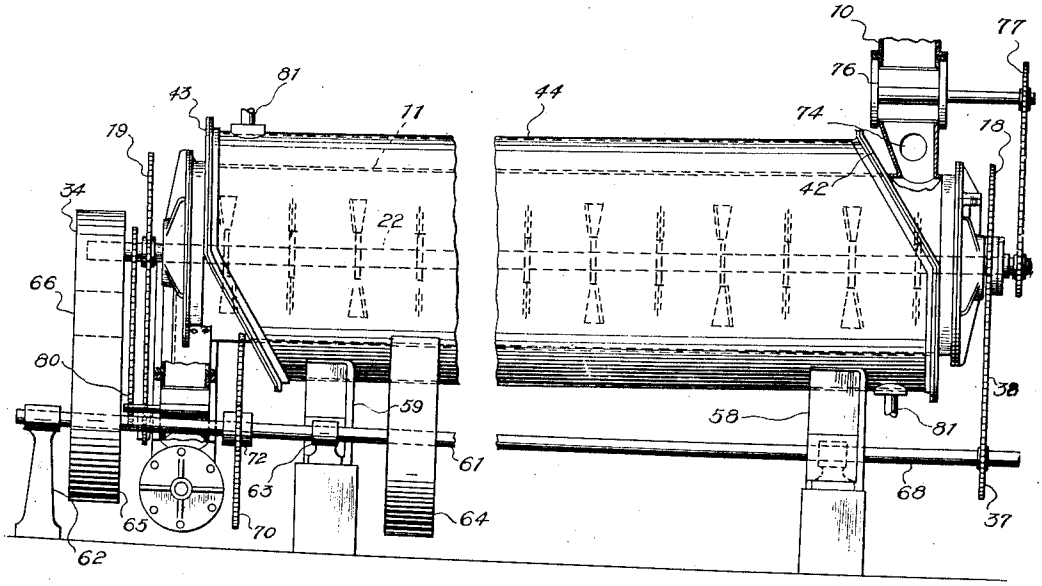

Fig. 9

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UNITED STATES PATENT OFFICE

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APPARATUS FOR TREATING MATERIALS

Application filed August 9, 1924. Serial No. 731,146.

The present invention relates to improvements in drying, rendering, evaporating, distilling and dehydrating apparatus adaptable in many relations.

More particularly the invention relates to impact pulverizing dryers, roller mills, rendering apparatus, evaporators, dehydrators and the like in which a very rapid and efficient action is attained at unusually low temperatures, in a manner radically different from anything heretofore proposed. As customarily carried out, ordinary drying, evaporating, rendering, dehydrating and like operations depend almost entirely upon the application of heat to break down the moisture, oil and liquid bearing cells. In drying or dehydrating operations, masses of the material are handled in such manner that even when the cells are broken down by heat, sufficient heat must be applied to drive the freed moisture through thick layers of material. The result is that in order to thoroughly dry materials by the prior methods, far more heat must be applied than is actually necessary to effect this desired result, and the materials must be subjected to high temperatures for relatively long times. Many materials when subjected to usual heating methods to effect drying, dehydration, rendering, evaporation, thickening, and like operations, suffer chemical changes, and deterioration in quality.

Other materials although unharmed in quality by heating are difficult to handle rapidly and efficiently in continuous manner, and when inflammable materials are handled, they become dangerous. Many materials, such as for example, of the mucilaginous type have never been successfully dried in continuous manner. By providing apparatus in which the material being heated is simultaneously treated in a manner to mechanically break down the cellular structure of the material, I have found it possible to dry, render, evaporate, thicken, grind, and dehydrate all sorts of materials at lower temperature ranges and far more rapidly and efficiently than has been heretofore possible.

The preferred form of the apparatus comprises a fixed heated cylinder in which beaters or paddles revolving at high speed spread the wet material to be treated in thin layers around the interior, and a set of revolving scrapers or wipers which immediately remove the material from the heated surface, to be again thrown or spread thereon by the beaters or paddles. The scraping or wiping and throwing actions are repeated many times a minute, the wet material being started at the hottest end of the cylinder and progressively advanced to cooler portions of the cylinder as the drying proceeds, until the desired degree of dehydration, evaporation, rendering, or thickening has been attained, when the material is discharged from the evaporator. Because the nature of treatment is such that the materials are in contact with the heated surfaces for very short intervals only due to the scraping or wiping action, very high temperatures may be applied to the cylinder while the cylinder will remain at relatively lower temperatures due to the rapid absorption of heat by the materials, and low temperatures are maintained in the material. This results in an exceptionally high rate of evaporation and rapid drying at lower temperatures than heretofore obtainable and without burning or scorching the material. By providing suitable valves at the feed and discharge ends of the evaporator, and suitable exhaust pumps, the operations in the dehydrator may be carried out under a vacuum or pressure, in which event relatively wider ranges of temperatures of the material are available. To show the wide range of usefulness of the present apparatus, and the many novel processes and products made possible by utilization of the present apparatus in connection with various auxiliary apparatus, the following of my related inventions are set forth.

In the packing industry various grades of fats known as oleo-fats, edible fats, and inedible fats are produced from the various parts of the animals. In addition to driving off the water or moisture where large percentages are present, it is necessary to heat the tallow or fat to a point where it will melt to a liquid state and separate from the meat parts, and to break down the cellular struc-

ture in which the fats and tallows are confined. The higher grade of fats are obtained at the lower temperatures, and as the temperatures are raised the grade of fats procured is lowered, due to discoloration and chemical changes caused by the action of the heat on the fats. The present method is to treat the high grade material, such as the caul and ruffle fat first by placing in a tank which is heated by water jacket to temperatures of 120 to 140 or 150 degrees F. and agitating. At these low temperatures only a portion of the fat in the material can be liberated, even though the heating is carried on for hours. Because of the length of time required to effect a reasonable degree of separation at these low temperatures, decomposition, and the development of fatty acids proceeds. which causes some deterioration in the rendered product. After the first low temperature treatment. the materials are removed from the water bath and placed in rendering apparatus in which higher temperatures are utilized to effect further rendering to produce lower grade fats. Finally the residue is removed and pressed. Every time a batch is opened at the end of a step, access of air, cooling of the material, and the generation and escape of offensive odors occurs. A long period of time is required in the handling of the material and deterioration of the product proceeds progressively. Manual labor is required to handle the batches. Before a batch can be started a sufficient quantity to fill the tanks must be accumulated, and rendering tanks must be available. The delays after the animals are killed in rendering by the batch process are largely responsible for the offensive odors in the vicinity of packing houses.

By the application of the present invention to the rendering of high grade or oleo-fats it is possible to effect a substantially complete and continuous separation in very rapid manner and at temperatures ranging as low as 110 degrees F. The apparatus for this use includes a suitable cutter to reduce the fat to relatively small particles preferably uniform in size, the continuous rendering and beating or pulverizing unit as hereinafter set forth with a suitable water heating jacket, a separating drain arrangement to remove the free liquid fats from the residue or cracklings, and a high pressure press to press the cracklings dry and remove the remaining free fats. At this point the cracklings may be ground if sufficiently cool to be brittle, or they may be first cooled and then ground to be used for food or fertilizer. The apparatus for this purpose may be substantially as shown in the rendering apparatus of my co-pending application, Serial Number 709,652, filed April 28, 1924, issued as Patent Number 1,518,926 December 9, 1924 except for the method of heating the rendering unit cylinder. The temperature of the water bath is carefully maintained at a temperature where no discoloration or deterioration of the rendered product occurs, and the actual temperatures of the material may be held as low as 110 degrees F. The rendering goes on continuously rather than in a batch process, and a rapidly changing layer of material is thrown and impacted against the heated surface and then immediately scraped or wiped off. The continuous beating and impacting divides and breaks down the cellular structure, and contacting with the heated surface reduces the freed fats to a liquid stage. All of the caul or ruffled fats or those parts of animals containing about 60 to 75 percent tallow and five to twenty percent moisture may in this manner be rendered at low temperatures in a single operation, and within a time of as low as five to thirty minutes in passing through the apparatus. Freshly killed fats can be rendered within a very short time and before decomposition or deterioration sets in.

A further highly important feature is that all vapors given off in rendering are confined and drawn through a single pipe so that they may be wholly deodorized and purified by burning in a combustion chamber, passing through beds of activated charcoal, chlorination, or they may be treated in any other well known manner to effect purification and deodorization.

For the lower grade of animal parts containing more than 15 to 20 percent water, and less than 60 to 75 percent of tallow or fats, the same type of apparatus is utilized as for the caul and ruffle fats except that higher temperatures are utilized for the rendering shell against which the material is impacted and the cells shattered. Steam heating or direct heating jackets may be utilized for medium grade parts from which the edible fats, such as lard, shortening and the like are produced, and rendering temperatures of this material are maintained at from 110 degrees F. to 212 degrees F. This type of material is treated in a manner to reduce the moisture content to from 5 to 20 percent in the residue which is fed to the press, the most satisfactory moisture content being from 8 to 12 percent. The driving off of the moisture consumes more heat energy than the melting of the tallows, and for this reason the temperatures are higher, resulting in a lower grade of fats. By the present process of treatment it is possible, however, to step up the grade of fats obtainable because of the lower temperature ranges at which rendering is possible due to the mechanical shattering of cells and impacting of the shattered shell on the heated surfaces. By lengthening the time of treatment and lowering temperatures, as by slowing the feed of the material through the rendering unit and increasing the rapid-

ity of beating and scraping, substantially all of the fats in the lower grade animal parts may be removed at low temperatures and high grade products obtained. The treatment may be carried out in batteries of rendering units to lengthen the time of treatment, and each successive unit may run the material at slightly higher temperatures if desired until the percentage of moisture has been reduced to the range of 5 to 20 percent, and preferably below 15 percent in the residue. By using the vacuum form of rendering unit as shown in said Patent Number 1,518,926, to lower the pressures, a speeding of the dehydrating process and lowering of heat requirement due to lowering pressure is attained.

For rendering of inedible parts of animals, such as the lungs, livers, entrails and like parts or offal, a washer of well known type is added to the above mentioned rendering equipment, and the parts are washed before being rendered. These parts have the highest percentage of moisture and are at present rendered at temperatures above 212 degrees F. In my improved apparatus, direct heat is applied to the rendering shell which may be far above 212 degrees F. Due to the rapid beating and scraping or wiping action, and the latent heat of vaporization of the moisture content, the material does not go over 212 degrees F. and may be held materially under 212 degrees F. when the percentage of moisture is reduced to within the range of 5 to 20 percent, and preferably ranging from 8 to 12 percent. By using the vacuum apparatus the maximum temperature of the mass may be lowered to the boiling point of water or below for the particular pressure used.

It will be noted that for all rendering operations to obtain high grade materials, the reduction of moisture content to from 5 to 20 percent limits with the preferable range between 8 and 12 percent in the residue is essential for efficient carrying out of my invention in handling these products. It will also be noted that the temperatures of the material range from 110 to 212 degrees F. The time limits will depend upon practical considerations of the desirability of lowering capacities or increasing the apparatus by installing tandem rendering units in order to lower rendering temperatures and to step up the grade of the products. Rendering may be carried out in practical manner for high grade products by allowing heating and shattering actions to proceed as the material passes through a single unit for a period of from 10 to 20 minutes, which is far shorter than has heretofore been obtainable. Efforts to render continuously in a vacuum with treatments averaging three hours in passing material through cookers have been made recently with no practical success although materially higher temperatures were maintained.

In the whaling industry, as at present practiced, the rendering of the blubber and oil bearing parts of the whale are necessarily carried on in particularly offensive manner. Usually the whale parts are in an advanced state of decomposition when rendered, resulting in highly offensive odors and deterioration in the rendered product. By applying my rendering apparatus as set forth in connection with the packing house problems, and applying the rendering limits of 110 degrees F. to 212 degrees F. and reduction to 5 to 20 percent moisture, the blubber may be disposed of continually while fresh and in completely deodorized manner. The unit is of sufficiently small size to enable batteries to be installed on ship-board and rendering to be carried out without the necessity of towing the dead whales back to a base. The entire oil bearing whale parts may be rendered and reduced to meal rapidly and in continuous manner.

In the rendering of cod livers, an advanced state of decomposition usually exists before the livers are rendered. This results in a putrid mass which yields a tainted oil, from which it is impossible to remove the unpleasant taste with refining methods. By utilizing my rendering apparatus the cod livers may be handled continuously and while fresh, and the oil produced in this manner is palatable and entirely devoid of the unpleasant taste commonly associated with cod liver oil. The apparatus may be miniature in size to suit the requirements for economical continuous operation in small amounts or of larger capacities for larger plants. In like manner special capacity units may be readily made to render shark livers, and other fish livers or parts from which special oils may be obtained.

As at present handled in packing houses, blood from the killed animals is run into tanks and live steam is then injected to coagulate the blood. The mass is then passed into hydraulic presses and as much of the surplus water as it is possible to remove in this manner is pressed off. The pressed cake which is semi-dried blood is then passed through dryers of well known forms to complete the drying. The process is discontinuous and requires the services of a number of men. No continuous process of drying blood has been heretofore possible because of the mucilaginous nature of the blood, which cannot be handled in the ordinary continuous dryers until coagulated and pressed. By pumping blood into my improved rendering apparatus at the feed end, dried ground or pulverized blood may be continuously withdrawn at the discharge end, and the services of one man have replaced those of five or more men operating the processes heretofore used. Blood

as dried in my apparatus is treated to reduce the moisture content to from 5 to 15 percent and the temperatures thereof are maintained at approximately 212 degrees F. or under during the process. The cross feed conveyor of the apparatus hereinafter disclosed may be removed and the blood pumped through a pipe. My novel apparatus for rendering or drying and grinding blood is an important related invention of great value in the packing industry.

Many foodstuffs may be subjected to concentration, thickening, evaporating and drying in my improved apparatus at temperatures far below those heretofore obtainable. Substances of mucilaginous character when thickened, such as milk, buttermilk, casein, eggs and other sticky substances, may be continuously reduced to a dry powdered form at temperatures so low that the natural flavors remain and a burnt or cooked taste may be avoided. For handling materials of this class which are ordinarily in liquid form, feed pumps and pipes are utilized as set forth in connection with the drying of blood. The shell temperatures may be very high when the substances are in the liquid state, and because of the wiping and beating action, the actual temperature of the material may be kept below 212 degrees F., if desired. As the material thickens down to a sticky mass, it cannot be handled in any other known continuous apparatus as it sticks, burns, and gums up the machinery. Due to the relatively slow wiping and lifting action of the scrapers or wipers in my apparatus, the sticky masses are lifted upward, then drop down into the high speed beaters which strike the material so rapidly and are rotating at such high speeds that the sticky material is hurled against the hot surfaces and is again immediately scraped or wiped off, lifted, dropped and beaten again, as it advances to cooler sections of the apparatus, and as will more fully appear hereinafter.

Moisture is continually driven off by the application of heat to shattered cellular structure, and the material rapidly drys beyond the sticky stage and is finally reduced to a dry powder. For efficient drying of foodstuffs in a manner to avoid cooked or scorched taste, especially in the drying of milk, temperatures ranging around 130 degrees F. are preferably maintained. Tandem batteries of dryers may be utilized with decreasing shell or jacket temperatures as the drying proceeds, and the vacuum forms may be utilized. For thickening of materials, such as in the manufacture of evaporated or condensed milk, a very efficient action at low temperatures is attained. The raising of liquids by the slow moving wipers and dropping through the beaters which impact the liquid against the shell maintains a rapidly changing layer of liquid on the heated surface, an effect which has been heretofore never attained in evaporating or distilling liquids.

The apparatus has made possible an entirely new method of manufacturing known food products, such as tomato paste. By my novel apparatus for forming tomato paste, the tomatoes are passed through a pulper which removes the skins and seeds from the flesh content, leaving the flesh content in a pulp as has been heretofore the practice. Instead of placing the pulp in vats and thickening by hours of cooking, or evaporating as is at present the practice, I pass the mass through my evaporator and rapidly thicken it to the desired consistency without reaching a temperature of more than 212 degrees F. and usually lower in the material, although the shell may be at a much higher temperature. My improved apparatus may be applied to the continuous manufacture of catsups and like products comprising largely tomato meat as a base, by pulping the tomatoes, then adding the seasoning and other ingredients in suitable quantities at a uniform rate, then passing the mixture through my improved pulverizer and evaporator in which the mass will be simultaneously and rapidly cooked, thickened, beaten, mixed, and reduced into a homogeneous mass ready for packing as it leaves the apparatus. In like manner, any food compound, such as fruit butters, jellies, and the like requiring cooking, thickening and mixing may be handled continuously by feeding the ingredients simultaneously and at a proper rate into my improved apparatus and treated until reduced to the desired consistency.

Many novel concentrated foods, extracts, powders, and the like may be manufactured in continuous manner by my novel apparatus. The actual drying temperatures of the material may be made so low that the natural flavoring of the article treated remains while dehydration may be carried to a point where the powdered or flaked product will keep indefinitely when sealed in suitable moisture proof containers or cartons. A striking example of what may be accomplished is shown in the production of unsalted cod-fish flakes or shreds. As at present treated, cod is alternately pickled in brine and dried until the meat is thoroughly impregnated with salt, and the meat is then flaked. The result is a flaked or shredded cod product which is highly salted and must be soaked in water to remove the salt before it is fit for use. The palatable natural flavor of the cod is partially destroyed in the process. In my improved flaking process, the fresh cod is steamed just sufficiently to loosen the flesh from the bone, and then heated to separate the flesh from the bone, or the flesh is separated by hand or in any other convenient manner. The flesh is then passed through my dehydrator and is treated until the moisture content is reduced

to from 5 to 10 percent at temperatures ranging from 140 degrees F. to 212 degrees F. The spores, bacteria and germination are killed by the treatment and the flesh is discharged a dry shredded flake of short needle like particles which may be preserved indefinitely in moisture proof containers and when used had the natural cod flavor, a result which has never been heretofore produced. By a similar treatment the non-oil bearing meat from animals, whale meat, hake, haddock, pollock, and other ground fish, shrimp, lobster, and the like may be rapidly and economically reduced to highly concentrated finely divided dried food products, and which when utilized will retain the natural food flavor of the fresh meat treated. Tough meats, and meats at inaccessible points may be reduced and packed for shipment in sealed moisture proof containers. Enormous waste may be salvaged in this manner and be made highly valuable. Waste products from canneries, such as fruit waste, tomato waste and the like may be treated and valuable by-products recovered.

The non-oil bearing waste products from cod-fish, hake, haddock, pollock, shrimp and lobster waste can be efficiently and commercially reduced to fertilizers, poultry and cattle food, in a manner which has heretofore never been possible. Shrimp waste in particular is a product presenting unusual difficulties because of the small shell inclosed water bearing pockets which cannot successfully be shattered and the water driven off except by utilization of my improved principle of mechanical pulverizing, shattering and heating.

Many forms of non-oil bearing vegetables may in like manner be dehydrated and reduced to powdered form, such as potatoes, pumpkins, and the like without destroying the natural flavors and other qualities of the materials due to the low temperatures which may be maintained in the material.

In the extraction of oil from grains, such as corn; fruits, such as olives, cottonseed, linseed, kernels of various fruit pits; oil bearing nuts, such as peanuts, cocoanut, copra, and fish and other oil bearing meats, particularly those containing high percentages of water soluble proteins and other water soluble contents, the meats may be separated from the skins, pits, bones and non oil bearing parts by pulping or in any other suitable manner. A particularly effective method of pulping is to pass the high water content materials, such as olives, and fish through my high pressure screw press, as disclosed in copending application, Serial Number 724,662 with the plates reversed or the angles of the steps pitched to form a gurry of the meat which is forced out through the screen openings in the form of a more or less emulsified mixture of the natural water content, oil and solid content of the meat, while the skins, shells, pits, bones and other non oil bearing substances pass out of the discharge end in a cake. Any other method of separating the oil bearing meats may, however, be utilized, and the formation of emulsions or solutions of water soluble contents is immaterial and may be disregarded. The mixture of emulsion as the case may be, of solids, oils and water are passed into my improved dehydrator and the moisture content is reduced to 5 to 20 percent, and preferably between 8 and 15 percent at temperatures ranging from 110 to 212 degrees F. depending upon the desired grade of oil. The dehydrated mixture of hot oil and solids is then treated exactly as is the case with rendering of fats above set forth, by draining off the free oils, and then expressing the solids in my improved high pressure press.

Any mixture or emulsion of oil and water or solution of matter in volatile solvents may be broken down in my apparatus. Where the solvents are inflammable, safe temperatures may be maintained by utilization of water heating jackets, and air may be substantially excluded by use of well known types of sealing valves at the feed and discharge end. Refining and recovering of oils containing insoluble grit, or dirt, emulsified or diluted with gasoline or other deleterious volatile agents may be economically carried out by forming emulsions, filtering or centrifuging to remove the solid particles, and then dehydrating or driving off the moisture of solvents to the desired degree in my improved apparatus. Where expensive solvents are used, a complete salvage may be effected.

Water soluble compounds, such as sugar, salt and numerous chemicals can be economically refined and simultaneously ground or pulverized by forming saturated solutions thereof, separating the insoluble substances or dirt from the solution and then dehydrating the solution until the desired degree of dryness is reached. The dryer the solid material becomes, the finer it will be ground or pulverized by the impacting action.

In the refining of salt manufactured by evaporating ocean water, it is necessary to wash out impurities and discolorations which arise through the bursting of minute bugs which feed on the salt, and through impurities in the water. The present method is to wash the salt with a substantially saturated salt water solution to remove the dirt, and then the wet salt is dried. The drying of the salt is an irksome, slow and expensive process by the present methods. By passing the wet salt through a suitable form of my apparatus, it is rapidly dried and simultaneously shattered and pulverized. The moisture is, rapidly removable to the point of bone dryness if desired, and the salt may be reduced to an impalpable powdered mass. In a similar manner, wet sugar, gypsum, cement, and

many chemicals may be ground, dried and pulverized.

In the reduction of syrups to solid powdered form, my new dehydrator has a wide and useful field. For example, maple syrup, cane syrup and the various fruit juices may be reduced to dry powdered form directly from a liquid or semi-liquid state, and at temperatures so low as to leave the natural flavorings unimpaired.

I am able to prepare many novel concentrated fruit extracts, sugars, and flavors in dry powdered form for use in cooking, preparation of drinks, and the like, and can salvage over-ripe and cull fruits, which prior to the passage of the 18th amendment were used in the preparation of alcoholic drinks, such as cider, and wines, and which cannot now be so utilized because of the high alcoholic content developed in the juices before they can be marketed. In my novel apparatus for handling these fruits, the meats and juices of the fresh fruits are separated from the skins and seeds in any well known manner as by pulping, peeling, or hand separation, and the meats and juices are then passed at a uniform rate into my dehyrator and there beaten and dried to a finely powdered mass, and until the moisture content is reduced to from 5 to 10 percent. The temperatures of the material range from 212 degrees F. downward and are so low that concentrated natural flavorings are obtained. Apples, grapes, apricots, peaches, plums, prunes, pineapples, oranges, lemons, melons of all kinds, and in fact all known fruits, may be reduced to powdered extracts in this way.

A further wide field for the invention exists in the production of dry pulverized coals, cokes, charcoals and other carbonaceous materials. It is well known that finely divided or pulverized carbon or coal is highly inflammable, and when properly injected into a combustion chamber in air jets or other suitable burning arrangements, it will burn like a gas or oil flame leaving no unburned coal as waste in ash or clinker. Present methods of burning coal are inefficient, and used only because of the practical impossibility of pulverizing coal to a suitable degree of fineness. Coal with as much as 5 percent moisture is very wet and can be pulverized only by drying at increased cost. In my improved pulverizing and drying apparatus, wet lump coal can be passed into the feed end where it is cracked and dashed to pieces and impacted against the heated shell. The moisture is driven off rapidly by the dividing action, and is literally thrown out of the cells against the heated surface by the inertia effect as the pieces are beaten and crushed against each other, and the heated shell. The dryer the material becomes, the finer it will pulverize until finally it is reduced to a substantially bone dry powder. The combustible gases driven off may be burned to furnish heat for the dehydrating unit, or may be salvaged for other uses. A wide field of usefulness for the impalpably powdered product exists as fuel in ships, locomotives, power plants, household heating units, and for all uses where oil or gas burners are now used, as the pulverized product may be cheaply manufactured from all grades of coal.

The invention makes possible continuous and economical low temperature distillation of products, such as sawdust, woodchips, straws, stalks, weeds and the like, and all carbonaceous matter. The by-products may be recovered from the gases and the powdered residue used as charcoal or used for fuel. These fuels are utilized in a manner to cause complete combustion and the waste due to ash, clinkers, and inefficient burning is eliminated causing an enormous saving in fuel. The temperatures of drying and distillation may be maintained so low that the combustible contents which volatilize at high temperatures remain in the fuel adding to the thermal or calorific value thereof, while dangers from explosions are reduced to a minimum due to low temperatures and exclusion of the atmosphere. The low temperatures of distillation result in the recovery of improved by-products.

In like manner grains such as wheat, rice and the like, may be dehydrated and reduced to fine flours in continuous and more economical manner than has heretofore been possible. In handling material of this nature, or in the handling of any material such as pulverized coal, charcoal, dried milk, buttermilk and the like where it is desirable to control the size of the particles, air currents may be passed through the dryer from the feed to the discharge end to entrain the particles of sufficient fineness to remain suspended in current. These particles may then be separated in well known forms of cyclones or separators. By regulating the velocity of the air currents passing through the apparatus the fineness of the particles removed can be controlled. In this form of apparatus the discharge will be carried out continuously due to the action of the air currents.

In fact my apparatus and novel principles of drying are applicable to the separation of liquids and solids of all kinds; to the separation of water from combinations of water, oils and solids whether the oil and water are emulsified in so-called permanent or temporary form; to the separation of water and volatile solvents from oils; to the commercially practicable grinding or pulverizing of wet materials, and to many other uses.

Still another highly important field for the apparatus exists in the cracking of oils. For this use the apparatus may be arranged with suitable valves to permit high pressures to be built up or maintained, and the cracking

or splitting operations are carried on in this manner. In like manner, distillation of coal, wood and the like may be effectively carried out under pressure.

A further important feature of my invention is the extreme flexibility in size and capacities for which it will operate in commercially feasible manner. Laboratory dryers may be made of such small capacity as to handle a few pounds of material at a time under actual conditions which will exist on a commercial scale. It enables scientists and investigators to determine at small cost what can be accomplished in practice, enabling bone dry chemicals to be attained rapidly for experimental work rather than waiting on the present laborious and tedious drying methods, in this manner speeding investigations, and giving unparalleled research facilities. Convenient electric heating, gas heating, and oil heating arrangements may be provided, and suitable temperatures, measuring and control instruments may be arranged for the accurate determination of the most desirable practical conditions.

These and many other uses are available for my novel apparatus and the principles underlying the same and of which the following is a detailed disclosure of preferred embodiments.

Referring to the drawings—

Fig. 1 is a side elevation partially in section showing one form of apparatus for treating solid materials.

Fig. 2 is an end view of the apparatus shown in Fig. 1.

Fig. 3 is a sectional view taken along line A—A of Fig. 1 showing the arrangement of wipers and beaters.

Fig. 4 is a detailed sectional view showing the construction of the beater shaft and related parts.

Fig. 5 is a side elevation showing the chain beaters.

Fig. 6 is a side elevation showing the feeding beaters.

Figs. 7 and 8 show a modified arrangement for high vacuum operation.

Fig. 9 shows an arrangement for utilizing water or steam heating jackets for rendering high grade fats.

Certain classes of materials to be treated are fed into a hopper 1 which communicates with the feed end of a preheater comprising a feed screw 2 surrounded by a cylindrical casing 3 and suitably journaled in end plates 4 and 5 (Fig. 1). Screw 2 is driven by a sprocket 6. Cylinder 3 is supported in and extends through supporting end plates 7 and 8 which in turn support a heating jacket or encasing sheet 9 in a manner to form a heating jacket for preheater cylinder 3.

At its discharge end cylinder 3 communicates with an enclosed passage 10 which in turn communicates with the feed end of cylinder 11 which may be formed of cold drawn steel tubing, or may be of any other suitable construction. Mounted in end plates 12 and 13 are suitable ball, roller or other bearings 14 and 15, in which scraper, wiper or lifter, drive sleeves 16 and 17 are rotatably journaled. Secured to sleeves 16 and 17 are driving sprockets 18 and 19 therefor. Fastened to and rotatable with sleeves 16 and 17 are split scraper, wiper or lifter supporting spiders 20. Supported from the arms of spiders 20 in any suitable manner are scraping, wiping or lifting bars 21. For handling certain classes of material a scraping and lifting action of bars 21 on the interior surface of cylinder 11 is desirable, and in this case the bars may be pivotally mounted on the spiders 20 with springs to hold them against the cylinder to insure constant engagement and to compensate for wear. The scraping action is desirable where mucilaginous materials which tend to stick to the cylinder walls are to be treated. Materials to be rendered or other materials which will not stick so readily need only be wiped off and in certain cases actual scraping contact of the bars 21 on the cylinder 11 is not necessary. The bars in the latter cases serve as wipers and lifters and may be rigidly secured to spiders 20.

For relatively long cylinders a central supporting spider may be provided, as shown in copending application, Serial Number 709,652, filed April 28, 1924, issued as Patent number 1,518,926, December 9, 1924 mounted on a suitable roller or ball bearing center, which in turn is mounted rotatably on a beater, paddle, or hammer shaft 22. Shaft 22 is suitably journaled in sleeves 16 and 17 and has secured thereto at regular intervals a series of stamped collars 23 to which sections of beating chains 24 are secured. Welded to the ends of chains 24 are steel hammer blocks 25. Collars 23 are provided with projections 26 which fit into keyways 27 formed in shaft 22. Interposed at regular intervals between collars 23 are stamped fan-like feeding beaters 29, provided with projects 30 which seat in keyways 27 of shaft 22, and with suitably inclined beating blades 31. Members 23 and 29 are held in properly spaced relation by the tube sections 32 which slide over shaft 22. The spacers and beaters are secured in position on shaft 22 by removable collars 33 which may abut against sleeves 16 and 17 to limit end movement of the shaft, or any other suitable holding means may be provided. It will be noted that in this manner a simple built up beater shaft is provided in which the sections are duplicates and are easily replaceable. The function of the blade beaters is to feed the material along the cylinder, and as will more fully hereinafter appear, the number of these beaters may be varied within wide limits, or pivoted hammers, such as

are used in well known impact pulverizers may be substituted for the fan and the chain hammers and beaters. The number and character of beaters will depend largely upon the character of material to be treated.

Shaft 22 is extended and has secured thereto a drive pulley 34 through which it is driven at a high rate of speed, causing the chains 24, or pivoted hammers as the case may be, to fly out and rapidly beat the material in cylinder 11. Secured to and driven by sleeve 17 is a sprocket 35 which drives sprocket 6 through a chain 36. As above set forth, sprocket 6 drives feed screw 2, which in turn at its opposite end drives a sprocket 37. Sprocket 37 drives sprocket 18 through a chain 38. Sprockets 18 and 19 drive sleeves 16 and 17 and accordingly bars 21, at a relatively slow rate to continuously remove, scrape or wipe the material from the interior of cylinder 11 as it is impacted thereon by the rotation of the beaters or hammers. In practice a speed of rotation of 500 R. P. M. for the beater shaft, and of 10 R. P. M. for the bars 21 has given excellent results in rendering operations. For materials that stick or burn readily, or where low temperature operation is desired, the speeds may be increased. For drying and pulverizing solids very high beater or hammer speeds, such as are used in the well known impact pulverizers may be used, and when there is no tendency for the material being treated to stick, the lifter bars may in certain cases be removed. It will be understood that the relative directions of rotation of bars 21 and the beaters may be made the same or opposite by the provision of suitable drive arrangements.

To provide for a control of the speed of feeding the materials continuously and progressively through cylinder 11, the cylinder may be given a suitable downward pitch. This pitch may be such as to either aid or retard the action of the feeding beaters so that by changing the cylinder pitch, the feeding may be speeded or retarded to suit the particular requirements of the material being treated; when the feeding beaters are eliminated the feed may be attained entirely by pitching the cylinder; by providing scrapers or wipers slightly helical in form to effect the advance of the material; or by utilizing any desired combination of these expedients. The arrangement is such that as the desired stage of treatment is reached in the material it passes out through a discharge opening 39 in cylinder 11, into a discharge conveyor casing 40 which is supported from head 13 and cylinder 11. For handling solids a suitable conveying screw 41 driven in any convenient manner may be provided, in casing 40, and if a mixture of liquids and solids are handled, suitable drain arrangements for draining away the liquids are provided, as set forth in the patent numbered 1,518,926.

Cylinder 11 is supported in a pair of castings 42 and 43 which form the ends of a heating jacket therefor, and support a metallic shell 44 which forms the walls of the jacket. For the direct application of heated gases of combustion to cylinder 11 the metallic shell and end walls of the jacket are lined with suitable fire brick concrete or fire brick 45, or like material. Baffle projections 46 are formed integrally with the lining and to extend partially around and to support cylinder 11, as shown in Fig. 1. The plates 7 and 8 of the preheater jacket are supported from shell 44 and an opening 47 is formed in the cylinder heating chamber through which the hot gases may pass into the preheater jacket and may then escape to the atmosphere through stack or exhauster connections 48 and 49. The lined dehydrator heat chamber may be divided, as shown in the case to permit the complete manufacture of the apparatus in portable sections, and to avoid the necessity of pouring the lining at the location where the plant is to be installed. This type of construction gives a readily portable and economical structure which may be manufactured and erected at a minimum cost.

The cylinder heating jacket communicates with the combustion chamber 50 of a furnace, as shown in Figs. 1 and 2. The furnace preferably consists of a metallic shell 51 cylindrical in section, having a suitable lining 52 of fire brick or other suitable material. Any suitable form of fuel burning arrangement, as for example, an oil, gas, or powdered coal burning nozzle 53 is provided. Openings 54 for the admission of air to the combustion chamber communicate with an air passage 55 which in turn communicates with a cylinder 56 provided with a damper or draft regulator 57. It will be understood, however, that any convenient fuel burning arrangement may be utilized.

Heat chamber shell 44 is supported from suitable castings 58 and 59, which in turn are supported on blocks 60. The angle of inclination or pitch of cylinder 11 may be varied by varying the sizes of blocks 60. A line shaft 61 supported from journals 62 and 63, and driven from a pulley 64 or in any suitable manner, has mounted thereon a pulley 65 which drives pulley 34 on shaft 22 through a belt 66. A sprocket 67 on shaft 61 drives a counter shaft 68 through a chain 69 and a sprocket 70 (Fig. 2). Counter shaft 68 is supported from blocks 60 by journals 71 and carries a sprocket 72 which through a chain 73 drives the scraper, wiper or lifter drive sprocket 19.

In the handling of certain classes of material, such for example, as in the rendering of fish, fish waste, blood, packing house offal, garbage, fats, blubbers, and many other ma-

terials noxious, unpleasant, and harmful gases and vapors are evolved. For certain other classes of materials valuable by-products may be recovered from the gases. For convenience in handling these gases, a single outlet connection 74 is provided between the preheater when used, and the passage 10 to which a vapor or gas discharge pipe 75 is connected. From pipe 75 the gases evolved may be passed directly to an inlet in the combustion chamber, through activated charcoal beds, through chlorinating apparatus, or may be treated in any other convenient way to effect deodorization, or they may be treated in appropriate manner to recover by-products contained therein. In order to lower the pressures in cylinder 11, suitable exhaust fans or pumps may be utilized to draw the gases and vapors out through pipe 75. It will be noted that all of the gases evolved in the preheater and in cylinder 11 are drawn through pipe 75. By providing suitably proportioned preheater and discharge conveyors, these conveyors, when treating materials containing solids, may serve as seals for low vacuum operation.

In cases where it is desired to operate the apparatus under a high vacuum or a high pressure continuously operating feed and discharge valves, such for example as are shown for the feed and discharge valves of the pressure cooker in Patent No. 1,489,980, and in the vacuum arrangement described in copending application, Serial Number 656,095, filed August 6, 1923, may be utilized. In this case, as shown in Fig. 7, end plates 7 and 8 are lengthened and a rotary feed valve 76 of the character shown in application, Serial Number 656,095, suitably driven in properly timed relation with the remaining apparatus by a sprocket 77 or in any other convenient manner is interposed in connection 10 between the preheater and cylinder 11. The connection 74 for the withdrawal of gases in the vacuum form is made in passage 10 below the feed valve. The connection between the discharge opening 39 of cylinder 11 and press feed conveyor casing 40 is lengthened as shown in Fig. 8, and a discharge valve 78, similar in structure to feed valve 76, and driven in properly timed relation by a sprocket 80 is provided therein. Valves 76 and 78 are driven to effect the feed and discharge of materials into and from the cylinder 11 at a proper rate, and will not permit external pressure to enter into body 11. When these valves are used, a high vacuum may be maintained in the cylinder due to the withdrawal of gases by the exhaust fan or pump. For the handling of oils, for distillation under pressure, suitable check valves to regulate the escape of gases and to maintain the desired pressure in the apparatus may be provided. The valves 76 and 78 will handle the admission and discharge of solids or mixtures of solids and liquids under pressure. For admitting fluids under pressure suitable pumps and check valves may be provided.

The use of the preheater of feed conveyor, while desirable for certain materials, such for example as wet carbonaceous material for distillation and other materials to be dried, is not essential for any of the materials treated and may accordingly be removed if desired. If this is done the construction may be considerably simplified as the preheater and conveyor parts are eliminated entirely, and the material may be fed directly into passage 10 in either of the forms disclosed. In this case, counter shaft 68 may be extended so that sprocket 18 may be driven from a sprocket mounted thereon, and stack connection 48 may be made directly over opening 47 in the heating jacket 44. Such an arrangement is useful in handling blood and like substances which may be pumped directly into passage 10 by suitable pumps.

For rendering purposes, where water or steam is used as the heating medium, the structure of the cylinder 11, the beater and scraper arrangement and discharge conveyor arrangements may be hereinbefore disclosed, and as shown in Fig. 9, the end plates for the heating jacket will remain substantially the same. The preheater parts are removed and the material may be fed directly into passage 10. The combustion chamber is also removed and shell 44 is provided with suitable inlet and outlet connections 81 for heated water or live steam as the case may be. Although the high vacuum form has been here shown, it will be understood that the other forms hereinbefore described may be provided with water or steam jackets.

The laboratory dryers may be the same in structure as those heretofore described, with relatively smaller parts, or cylinder 11 may be wound with electrical resistance heating coils in place of gas, steam or water jackets.

For handling materials to be reduced to fine powders of controlled or regulatable size, the principles of air separation or flotation may be applied, and the discharge may be carried out entirely by air currents, or a combination of air flotation and the methods of discharge hereinbefore disclosed may be utilized. The coarser particles may then be passed through further treatments in other units until carried away in the air currents. With the combination, an effective separation of materials of different densities, such as flesh and bone particles, or meat and pit particles may conveniently be carried out; the lighter or more easily pulverized particles being carried off in air currents, while the coarser particles will discharge out of the discharge openings. Edible fish flours may in this way be produced without first separating the flesh from the bone; and other high

grade products mixed with waste may be salvaged.

Operation

In operation the various parts are driven at the proper relative speeds for the particular material being treated, and the cylinder 11 is heated to the proper temperature by the admission of heated gases of combustion, hot water, or live steam into the heating jackets. The heating of the cylinder by water or steam will be readily understood. Novel provision for the directing of heated gases of combustion in the jackets has however, been made and the action of these gases will accordingly be described in detail.

Fuel supplied through burner 53 is ignited and heated gase of combustion pass upward from chamber 50, and circulate through the heating chamber around the exterior of cylinder 11, passing to the left around baffle walls 46 and cylinder 11, as shown by the broken line arrow in Fig. 1, until they pass through opening 47 either directly into stack connection 49, or when the preheater is used, into the preheater jacket. In the preheater jacket the gases pass to the right and out through stack 49. It will be noted that the hottest gases contact with cylinder 11 at the right or feed end in Fig. 1, as they pass to the left they are progressively cooled by the transfer of heat to the cylinder 11 and the contents thereof so that by the time they reach cylinder 3, the temperature has been reduced to a point where burning of the materials passing therethrough will be avoided.

The material to be treated is fed into the preheater when used and is carried by screw 2 to the right in Fig. 1 through cylinder 3 where it is heated due to the action of the gases surrounding this cylinder. From cylinder 3 the preheated materials drop into passage 10, and valve 76 when used, and then is fed into cylinder 11. When valve 76 or the preheater are not used, the material passes directly into passage 10.

As the material enters cylinder 11, the beaters, hammers or paddles strike it and throw or splash it against the heated interior surface. As the material impacts against the heated surface, the structure of the solids is broken or shattered and as the structure shatters free liquid or moisture and the lighter constituents are thrown out of the solids against the shell. If the material is such as will stick to the shell or burn, before sticking or burning can occur, bars 21 scrape or wipe the material off the heated surfaces and fresh material is immediately splashed, thrown or impacted thereon by the beaters, hammers or paddles. The material scraped or wiped off is lifted upward by the bars 21, falls through the cylinder, is mixed with other material and again splashed or thrown against the heated surface. This action is repeated many times a minute and results in constantly changing layers and surfaces of the material being impacted against the hot cylinder surface. The result is a very rapid evaporation of moisture contained in the materials, distillation of volatile contents, and melting of fat particles and like actions without, however, resulting in any harmful heating or burning of the materials.

Due to the action of the feeding beaters or the inclination or pitch of cylinder 11, or both when used, the material is continuously advanced to the left in Fig. 1, as it is thrown, heated, scraped, wiped, beaten and thoroughly mixed, and as it advances the moisture, volatile constituents, fats or oils, are progressively removed, until the material is discharged through opening 39, through valve 78 when used, or directly into press feed conveyor casing 40. As the material is advanced, it is contacted with progressively cooler areas of cylinder 11, when gases of combustion are used as a heating medium, so that burning of the material may be avoided as it dries or the treatment proceeds, and the temperatures are such as to give a more rapid rate of heat transfer and evaporation than could be attained if cylinder 11 were uniformly heated. The heating, beating, impacting, wiping and scraping actions result in a thorough breaking down of the cellular structure, frees the oil, fats, liquids and moisture from the cells so that when the material is discharged into the press feed conveyor it is a mixture of hot free oil or fluid fats and fine solids or finely powdered dry solids as the case may be. The action of the scrapers or wipers and beaters in dividing and breaking down the material is much more effective than obtained in the usual forms of impact pulverizers due to the simultaneous heating and drying action attained. The dryer the material becomes, the finer it will grind or pulverize, so that wet materials, such as coal, salt, sugar, and the like may be continuously reduced to a powdered dry mass, a result heretofore unobtainable in impact pulverizers.

The vapors and gases driven from the materials in cylinders 3 when used, and 11 are drawn through pipe 75, and treated in appropriate manner to deodorize or recover by-products as the case may be. When valves 76 and 78 are used, the treatment may be carried out in a relatievly high vacuum or pressure, as the case may be. The ease with which substantially complete deodorization of the gases discharged from the treated materials may be carried out makes the process substantially odorless, so that it may be operated in the vicinity of residences, food canneries and like locations where objectionable odors constitute a serious nuisance.

The treatment of the material discharged from the apparatus will naturally depend upon the nature thereof. Mixtures of hot oil

or rendered fats and solids are treated to separate the oils and produce meals while dry solids may be directly packed for shipment or storage.

Having described preferred embodiments of the invention, what is desired to be secured by Letters Patent and claimed as new is:

1. In combination, a cylinder; means for continuously feeding materials to said cylinder at a predetermined rate, a plurality of relatively low speed rotary lifters in said cylinder; a plurality of rigid rotary high speed beaters in said cylinder; discharge means for continuously withdrawing material from said cylinder; and means for driving said feeding means, lifters, beaters, and discharge means at a predetermined relative speed to maintain a rapidly changing layer of materials on the inner wall continuously advancing from said feeding means to said discharge means through said cylinder.

2. In combination, an enclosed space with heated walls; means for continuously feeding fresh material into said enclosed space at a substantial uniform and measured predetermined rate; a plurality of relatively high speed beaters mounted in said space and adapted to strike materials fed into the path thereof and throw the same against said heated walls; relatively low speed means for quickly removing the materials from said walls into the path of high speed beaters to be again struck and thrown against said walls; and means for continuously advancing the materials through and out of said enclosed space at a substantially uniform rate as the striking and removing proceeds.

3. In combination, a heated cylinder; means for continuously feeding materials at a substantially uniform rate to said cylinder; means for causing the advance of materials continuously through said cylinder and to continuously discharge therefrom at a substantially uniform rate; relatively high speed rotatable means in said cylinder adapted to strike said materials and to throw the same against the interior surface thereof; and relatively low speed rotatable means for quickly removing the materials from the interior surface of said cylinder into said cylinder to be repeatedly struck by said first mentioned rotatable means.

4. In combination, a cylinder; means for continuously feeding materials at a substantially uniform rate to said cylinder; means for causing the advance of materials continuously through said cylinder and to continuously discharge therefrom at a substantially uniform rate relatively high speed rotatable means in said cylinder adapted to strike said materials and to throw the same against the interior surface thereof; relatively low speed rotatable means for quickly removing the materials from the interior surface of said cylinder into said cylinder to be repeatedly struck by said first mentioned rotatable means; and means for continuously withdrawing gases and vapors from said cylinder.

5. In combination, a cylinder, means for feeding materials to said cylinder at a substantially uniform and predetermined rate; relatively high speed rotary means in said cyinder operative to mechanically divide the materials fed thereto by said feeding means and to spread the same in a relatively thin layer on the interior of said cylinder; a plurality of relatively low speed rotary lifters to raise the material in said cylinder and to drop it into said rotary means; said high speed rotary means and cylinder being arranged to cause the materials to advance continuously through said cylinder, and means for continuously removing the materials from said cylinder at a substantially uniform rate.

6. In combination, a cylinder, means for feeding materials to said cylinder at a substantially uniform and predetermined rate; a relativey high speed rotary means in said cylinder operative to mechanically divide the materials fed thereto by said feeding means and to spread the same in a relatively thin layer on the interior of said cylinder, a plurality of relatively low speed rotary lifters to raise the material in said cylinder and to drop it into said rotary means; said high speed rotary means and cylinder being arranged to cause the materials to advance continuously through said cylinder, and means for continuously withdrawing evolved vapors and gases from said cylinder.

7. In combination, a heated cylinder; means for feeding materials to said cylinder at a predetermined uniform rate comprising a substantially pressure tight feed valve; means comprising relatively low speed rotary lifters and relatively high speed impacting beaters for feeding said materials through said cylinder at a predetermined and definite speed with relation to the feeding of materials thereto in a relatively thin and rapidly changing layer of material in contact with the interior of said cylinder; and means comprising a substantially pressure tight discharge valve for continuously withdrawing the materials from said cylinder at a predetermined rate with relation to the advance of the material through said cylinder.

In testimony whereof, I affix my signature.

STANLEY HILLER.