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[54] APPARATUS FOR TREATING ELASTOMERIC MATERIALS

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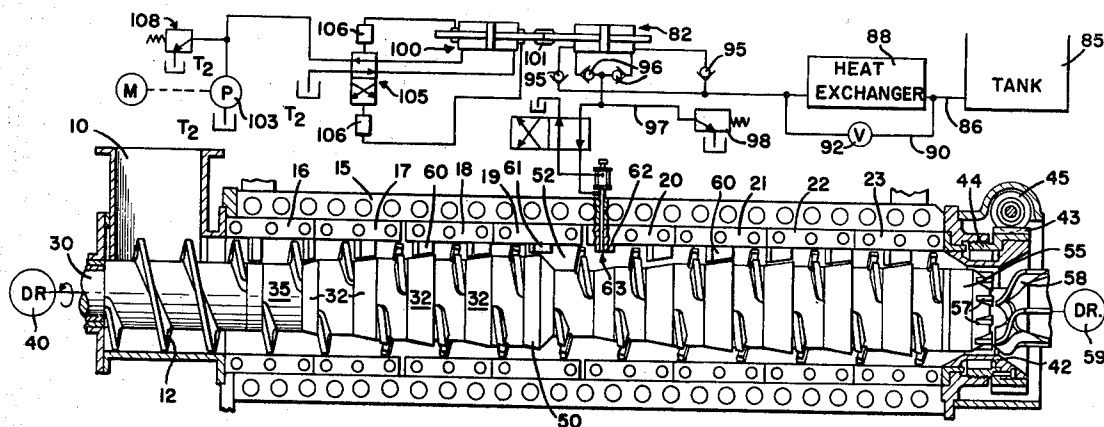
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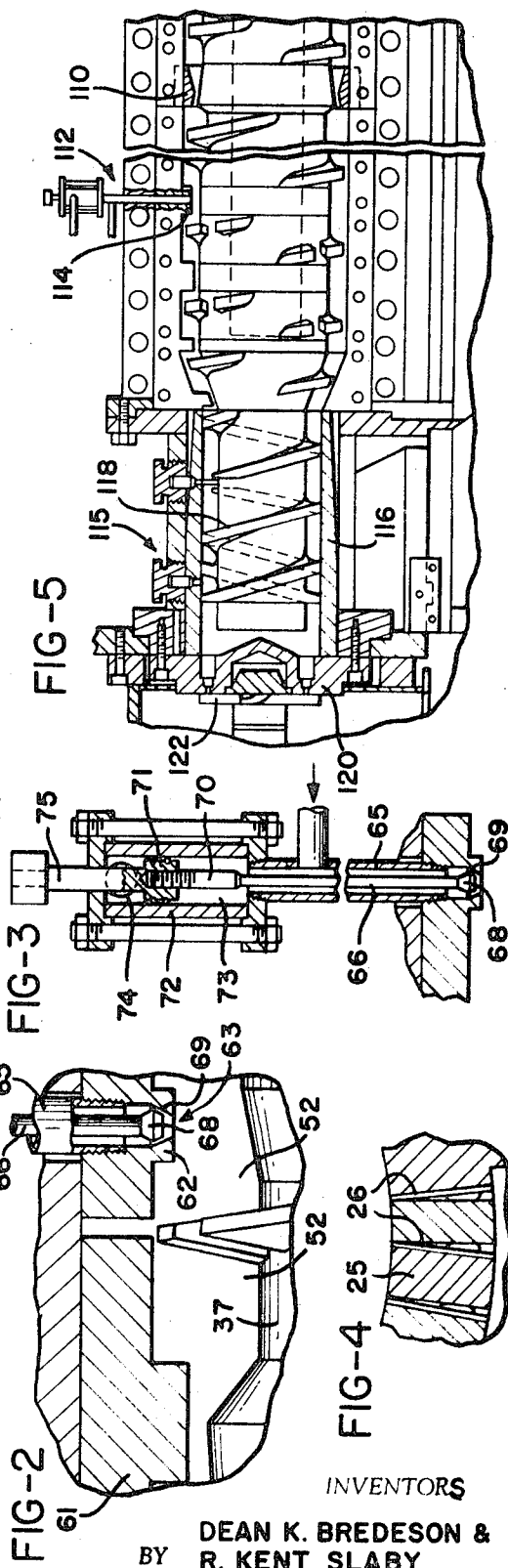
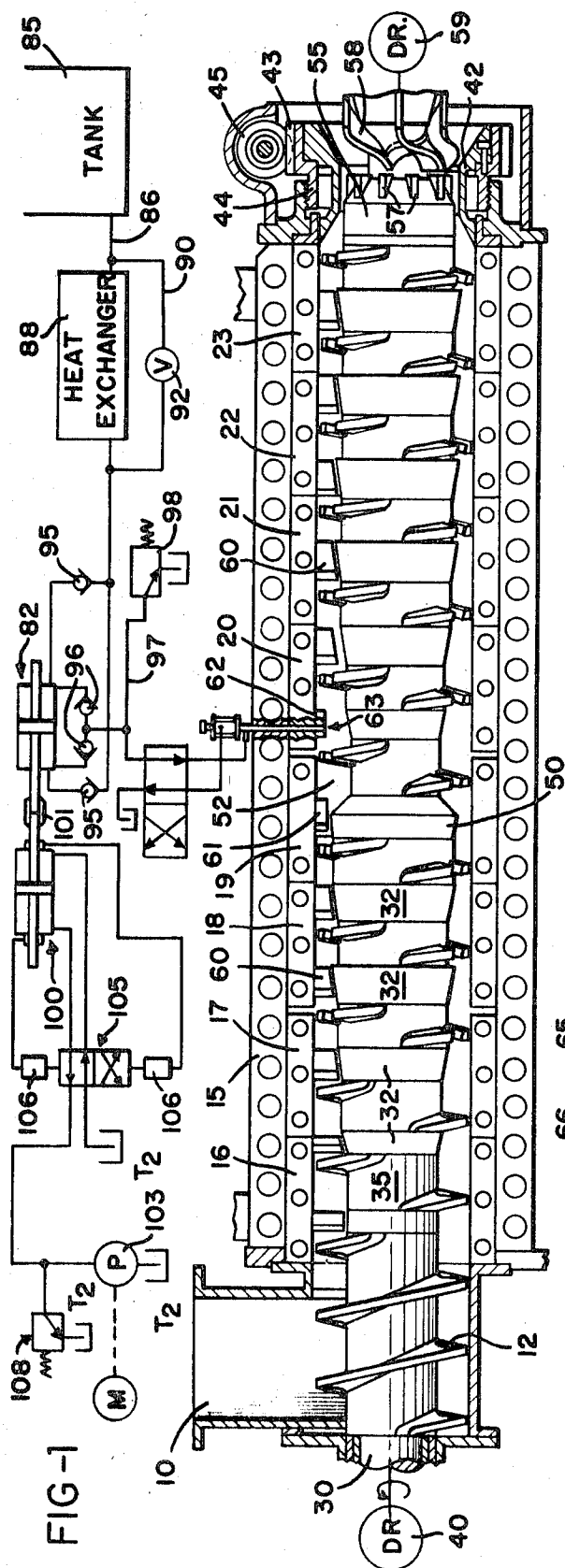
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[57] ABSTRACT

Apparatus for adding liquids such as oils to elastomeric materials such as rubber includes a continuous screw press with intermediate chambers where the material is worked under pressure. Liquid is supplied near the center of the chamber through injector bars, and is mixed into the material as it proceeds out of the chamber toward the press exit. The elastomeric materials may be first processed in the press to remove included moisture.

3 Claims, 5 Drawing Figures





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APPARATUS FOR TREATING ELASTOMERIC MATERIALS

BACKGROUND OF THE INVENTION

The invention has special reference to a system employing a mechanical screw press for introducing liquids such as plasticizers, extenders, or antioxidants into elastomeric materials such as natural or synthetic rubbers, preferably during a combined drying process of the material. A typical liquid may be an oil such as a light process oil of the naphthenic or slightly aromatic type. This oil serves as an intermolecular softener and lubricant which increases the plasticity and workability of the material so that it can be more easily formed into different shapes. An oil is also frequently used as an extender along with carbon black for increasing the bulk of the rubber compound to provide a lower cost without noticeably reducing any of the significant properties, and in many cases producing superior properties.

SUMMARY OF THE INVENTION

The present invention is directed to improved apparatus for treating elastomeric materials and the like by compressing the material in a first stage of a drainage-type screw press to produce an increase in pressure and temperature by friction heat for removing the moisture by drainage and flashing off of the moisture. Apparatus of this general type, used for a different purpose and in a different way, is disclosed in U.S. Pat. No. 3,111,080. The material is worked under pressure while liquid is simultaneously added. The liquid is readily received by the material, and can be worked and pressed into the material in the second stage of the press where the pressure may be further increased. This general overall process when performed in a multistage mechanical screw press not only provides for efficient drying but has been found to provide an efficient, thorough and uniform mixing of the fluid into the material. It is especially desirable for use on natural rubber in which heretofore the mixing of liquids, particularly oils, has presented many difficulties. The continuous process has also been determined to be an efficient method of adding oil or other liquids into synthetic rubber instead of mixing in the liquid during the coagulation step, which is the present procedure.

Furthermore, by controlling the temperature of the liquid being added, the liquid can be used to provide some cooling effect on the rubber material, in addition to being mixed into it, and thus the addition of liquid also can perform the added function of controlling the temperature of the material during the moisture removing process. By controlling and changing the temperature of the liquid, compensation can be made for possible overheating of the rubber material, and thus an effective continuous process is obtained where water or moisture is removed from the rubber material, and oil is added to obtain an "oil extended" rubber product. Furthermore, the drying and extending operations are all performed in one piece of apparatus and in a continuous process, where the temperature of the material is maintained within safe limits.

Accordingly, the object of this invention is to provide a novel apparatus for impressing and mixing of a liquid into elastomeric materials; to provide such apparatus where the addition and mixing of liquid is combined in one continuous operation with the drying of the material; and the liquid may be used to control the temperature of the material in apparatus for producing oil-extended dry natural rubber materials and the like, wherein the oil is readily pressed and mixed into natural rubber to assure a thorough dispersion of the oil and a homogeneous oil-extended natural rubber product; and to provide an apparatus wherein liquid can readily be pressed into the elastomeric material being treated, at the same time using the addition of the liquid to control the temperature of the material, to avoid overheating of the material and damage thereto.

Other objects and advantages of this invention will be apparent from the following description, the accompanying drawing and the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a somewhat diagrammatic elevational view of a screw press showing one form of the apparatus, with one-half of the cage removed to expose and illustrate the multistage construction, and including a diagram of the circuit for injecting liquid;

FIG. 2 is an enlarged detail view of one of the injector parts shown in FIG. 1;

FIG. 3 is a sectional view showing details of the valve and injector lug for adding liquid to materials processed in the apparatus;

FIG. 4 is an enlarged fragmentary sectional view through a portion of the cage of the apparatus, illustrating the manner in which openings are provided between the bars making up the walls of the chamber; and

FIG. 5 is a view similar to FIG. 1 showing a modified form of press.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, which illustrates preferred embodiments of the invention, FIG. 1 shows somewhat diagrammatically, a continuous duty, interrupted flight, screw-type-expressing machine having an inlet hopper 10 through which materials to be worked upon and treated are supplied. The materials are received between the flights of the feed screw 12 and carried thereby from the hopper 10 into the main body of the apparatus, which is made up of an outer cage structure 15 formed by two symmetrical halves which are bolted together. One-half has been removed in FIG. 1 to illustrate the interior of the apparatus.

Within this outer cage structure there are a plurality of sub-assemblies of sections 16, 17, 18, 19, 20, 21, 22 and 23 with sections 16-19 forming the first stage of the press and sections 20-23 forming the second stage. Each of these sections is formed by a framework supporting a plurality of axially extending screen bars 25 (FIG. 4), in some sections separated by suitable small spacers 26. Further details of the construction of these subassemblies are illustrated in U.S. Pat. No. 3,126,820. The important point, as far as the present apparatus is concerned, is that those sections of the apparatus where liquid is to be drained are provided with so-called drainage openings defined openings defined between adjacent screen bars making up the section, while the sections where injection occurs do not have such openings, at least not near the point of injection.

Within the elongated cylindrical chamber defined by the casing or cage structure, and mounted on the main shaft 30, are a plurality of collar members 32 some of which may be tapered as shown so as to decrease the cross-sectional area between the collar and the cage section walls. Intermediate these collars, and also fixed to rotate with the shaft, are pressure worms 35. These pressure worms are essentially of like construction, with a worm body 37 and an interrupted flight 38 which preferably is notched at a number of locations, as shown in FIG. 2, to produce a more thorough shearing and working of the material in the apparatus. The main difference between the various pressure worms 35 is that the worm bodies 37 are of different diameter, progressively increasing generally according to the larger diameter of the preceding collar. The pressure worms take up material forced around the preceding collar, and move the material under pressure over and around the succeeding collar and onto the next pressure worm. Rotation of the shaft 30, which produces this action, is obtained from a conventional drive 40, which may include any suitable form of power together with a gear case or the like by which the desired rotation of the feed worm and pressure worms is obtained.

The cage structure 15 preferably is of constant diameter, and has an entrance or feed opening where the feed worm 12 enters the cage structure, and a discharge opening formed by a discharge ring 42 at the opposite end of the cage structure. This ring preferably is fastened to a rotatable helical gear 43 carried on a threaded extension 44 such that rotation of the

adjusting worm gear 45 will rotate gear 43 and cause axial adjusting movement of the discharge ring 42.

The collar members 32 and the bodies of worm members 37 cooperate with the interior walls of the cage structure to provide a through annular passage for the material, with such passage varying in cross-sectional area at different locations. In one embodiment of the invention this passage decreases gradually in cross section, so that pressure is built up on the material in the first stage up to the space around collar member 50. This collar member includes a portion which may taper inwardly such that the annular space between it and the cage walls increases on the downstream side of this collar. Therefore, in this section and within the following chamber portion 52 surrounding the next pressure worm, the pressure on the material may be somewhat reduced by reason of the increase in volume permitting expansion of the material within the zone. In this region the spacers are not used, to prevent drainage. Then, progressing toward the discharge end of the cage, the pressure collars may again increase progressively in cross section, and the worm bodies likewise correspondingly increase in size, such that pressure is again applied to the material until it reaches the discharge collar 55 which projects at least partially into the discharge ring 42. Preferably the discharge collar is provided with a set of breaker lugs 57 arranged to cooperate with a rotatable shredder member 58 having a rotary drive 59. Material passing through the discharge opening is engaged between the shredder 58 and the lugs or teeth 57, and is cut or torn into relatively small pieces which are expelled through the discharge ring 42 into any suitable collection device.

One feature of the present invention relates to the relationship of the drainage or venting opening between the screen bars in the various sections of the cage structure. As the annular cross-sectional area of the passage through the apparatus decreases, the pressure on the material will increase. It is understood that in operation the passage between the rotatable parts and the walls of the cage structure is essentially full of compacted material which is being continuously worked and compressed. This results in substantial frictional heating. If desired, this heating may be regulated by flowing heat exchange fluid or liquid through suitable passages such as shown in said U.S. Pat. No. 3,126,820. As pressure on the material increases, the tendency is to squeeze some of the material into the drainage openings between screen bars 25, therefore it is desirable to attain a balance between the maximum size of opening for the best possible drainage and such reduction in the opening as mentioned above to avoid complete clogging thereof by materials squeezed into the openings. Where pressure on the material is first released, as in chamber portion 52 at the end of the first stage, the drainage opening size is increased, thereby assuring the best possible venting and removal of vapors and liquids. By way of example, in one form of apparatus constructed in accordance with the invention the drainage opening between screen bars 25, in the section 16, is approximately 0.060 inch in width. Comparable openings in section 17 are reduced to 0.040 inch, in section 18 the openings are reduced to 0.030 inch, and in the first part of section 19 the drainage openings are further reduced to 0.020 inch in width. In the last part of section 19 the opening size is increased to about 0.060 inch, then there are no openings in section 20. The size of drainage openings in sections 21, 22 and 23 decreases in size corresponding to the sizes for sections 17, 18 and 19. It has been found through operation of apparatus of this type that vapors tend to flow to the point of lowest pressure, in other words to the entrance to chamber portion 52, around collar 50 and by having larger drainage openings at this point it is possible to achieve optimum venting, thereby assuring that all vapors are quickly removed from the chamber.

As shown in FIG. 1, stationary breaker lugs, indicated by the general numeral 60, are provided to prevent rotation of the material with the collars 32 and to cooperate with the notched worm flights 38 to obtain a tearing, shearing and

working action of the material. However, a feature of the invention is provided by the specific construction of the breaker lug 62 (FIG. 3). The breaker lug 62 is spaced outward from the collar within the chamber portion 52. A controlled injection nozzle 63 (FIG. 2) is mounted in lug 62 for directing plasticizing oil into the middle of the mass of material in this chamber portion.

Details of one nozzle are shown in FIG. 3. The tubular body 65 is fitted into the lug, and a valve stem 66 carries a head 68 which cooperates with a seat 69 to control flow into the chamber. The stem has a threaded part 70 which is received in a piston 71 movable in a cylinder 72. Oil under pressure is supplied to the stem side chamber 73 when it is to be injected. This automatically opens the nozzle. Valving the oil under pressure to the opposite chamber 74 will shut off the nozzle. The projecting stem 75 provides a means for locking the nozzle closed if desired, and also gives a visual indication of nozzle position.

The liquid plasticizer to be mixed with the rubber material is supplied from a pipe or manifold 80 which may receive this fluid from a positive displacement reciprocating cylinder pump 82. Particularly in the treatment of natural rubber and the like, a liquid such as oil is used to provide a so-called "oil extended" rubber product. This oil is provided from a suitable tank 85 connected through pipe 86 to a conventional heat exchanger 88 which is employed to heat the oil to a desired temperature. The oil thus is maintained at a predetermined temperature, which can be controlled by suitable control of the heating exchanger 88. This temperature of the oil preferably is somewhat less than the temperature of the material encountered in the chamber portion 52 of the press, such that the oil tends to absorb some heat from the frictionally heated rubber material and thereby provide a cooling effect on the rubber which prevents overheating and damaging of the rubber material. At the same time, the warmed oil is thoroughly mixed into the rubber material by reason of the mechanical working of the material from the notched pressure worm flights and the interaction of these flights with the collars and breaker bars. A bypass 90 is provided around the heat exchanger 88, and a control valve 92 is included in the bypass, whereby cool oil from the tank can be supplied directly to the cylinder 82 if additional cooling effect should be needed.

The cylinder 82, as shown in FIG. 1, is of the reciprocating double-acting type, which receives the oil to be injected through the check valves 95 and delivers the oil through check valves 96 into a manifold 97 which leads to the entrance tubes 75 of the injectors. A pressure-relief valve 98 is provided, which will bypass oil back to the tank 85 if the pressure increases beyond a predetermined limit. This arrangement provides positive displacement pumping at relatively high pressure, to assure that the oil is effectively injected into the material within the press.

The pump 82 is driven by a double-acting reciprocating motor 100 which is connected to the pump through a coupling 101. A separate hydraulic circuit for driving the motor 100 includes a tank T2 from which hydraulic fluid is pumped through pump 103 to a conventional servo-operated reversing valve 105. This valve has pilot cylinders 106 at its opposite ends connected to the opposite heads of the motor 100, thus as the motor piston reaches one limit of its stroke, the buildup of pressure will cause the appropriate pilot 106 to shift the valve 105 thereby reversing the pressure connections to the motor 100 and reversing its direction. At the same time the return connection to tank T2 is likewise reversed. An adjustable bypass valve 108 is connected to the outlet side of pump 103, and by adjusting the pressure of the pump outlet side of pump through this valve, it is possible to increase or decrease the reciprocating speed of the motor 100, thereby controlling the rate of displacement of the pump 82.

FIG. 5 illustrates a modified form of apparatus which may be used in accordance with the invention. The press structure is generally of the type disclosed in greater detail in copending application Ser. No. 763,647, filed Aug. 19, 1968 entitled

MECHANICAL SCREW PRESS, now U.S. Pat. No. 3,574,891 issued Apr. 13, 1971 which is assigned to the assignee of this application. Apparatus of the type shown in FIG. 5 has been found particularly advantageous in drying of natural rubber. It differs from the apparatus shown in FIG. 1 primarily in two respects. There is an intermediate choke ring 110 in the chamber of the press, upstream from the injector nozzle 112, which extends through bar 114, and which is of the same construction as shown in FIG. 3, and previously described. Secondly, in place of the shredder structure shown in FIG. 1, an extruder section 115 is provided at the discharge end of the press, including an imperforate extruder barrel 116 which is of smaller diameter than the intermediate diameter of the press chamber, and a double helical extruder worm 118 operates within the barrel 116. At the discharge of the barrel 116 there is a die plate 120 through which the rubber material is discharged, and a rotating knife 122, driven from a separate motor (not shown) cuts the material extruded through the die into relatively small particles. In this apparatus, the rubber material is essentially free of moisture, while adding to it the oil injected through the nozzle 112.

By use of the above-described screw press apparatus, the addition of liquids to rubber material is accomplished easily and completely in the same operation by which moisture is removed from the material. This is particularly advantageous in the treating and handling of natural rubber materials, where addition of liquids has heretofore required rather complex operations. Furthermore, the liquid besides being thoroughly mixed into the final product may also assist in controlling the temperature of the rubber material, and thus prevents overheating and damaging of the rubber material.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. An improved screw press apparatus for continuous drying of elastomeric material and for mixing of fluid into the materi-

al during the drying operation, comprising wall means defining an elongated chamber having drainage openings therein, conveying and working means including a shaft rotatably mounted within said chamber and adapted to be power driven and a plurality of successive collars and worm bodies having flights thereon and mounted on said shaft with at least said worm bodies connected for rotation with said shaft, stationary breaker lugs extending between said worm flights for cooperating with said flights to provide a shearing and working action on the material, and said chamber being divided into at least first and second stages in each of which said working and conveying means increases progressively the pressure on the material conveyed through the chamber, means forming a zone between said stages in which pressure on the material is effectively decreased; the improvement comprising,

the drainage openings in said first stage being progressively reduced in size corresponding to the increase in the diameter of the working and conveying means to minimize extrusion of the material through said openings as the pressure increases while providing for escape of moisture and vapor released from the material,

said drainage openings being of increased size in said zone between stages to provide optimum venting from said zone,

said wall means being imperforate immediately downstream of said expansion zone, and means for injecting a liquid into the region surrounded by imperforate wall means for mixing of the liquid into the material within the second stage.

2. Apparatus as defined in claim 1, wherein said injecting means includes an injector nozzle extending through one of said breaker lugs to release the liquid near the center of the chamber.

3. Apparatus as defined in claim 2, including a positive variable displacement pump means adjustable independently of the press speed and connected to deliver the liquid under pressure to said nozzle.

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