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(54) SYSTEM AND METHOD FOR ENHANCING COOLING OF A FEED PRODUCT DURING PRODUCTION

(76) Inventor: **Paul A. Standafer**, Worthington, MN (US)

Correspondence Address:
S. Wade Johnson
DORSEY & WHITNEY LLP
Suite 1500
50 South Sixth Street
Minneapolis, MN 55402-1498 (US)

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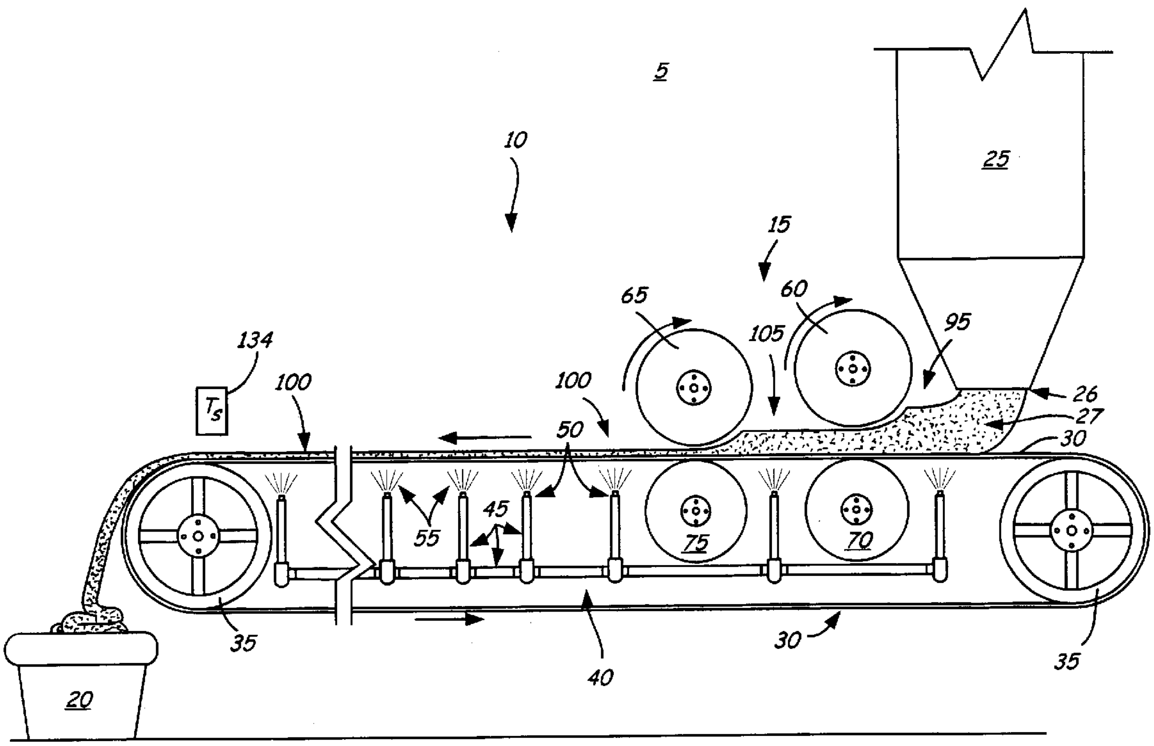
(57) **ABSTRACT**

A system for enhancing the cooling of a product stream, wherein the product stream is a livestock feed product, is disclosed. The system has a reduction station and a conveyor system with a conveyor belt routed through the reduction station. The conveyor belt is used to transport the product stream through the reduction station. The reduction station increases the surface area to volume ratio of the product stream.



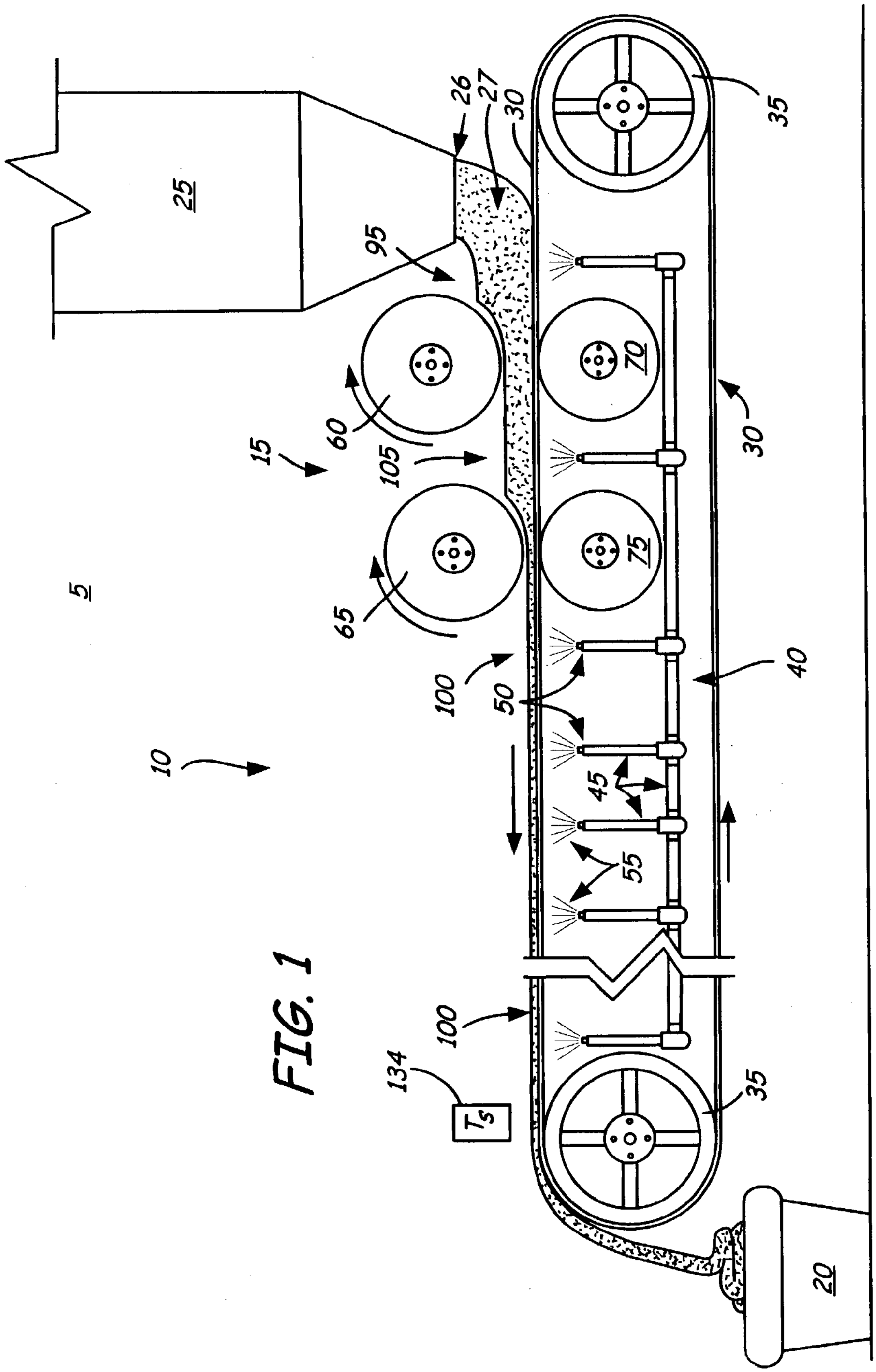


FIG. 1

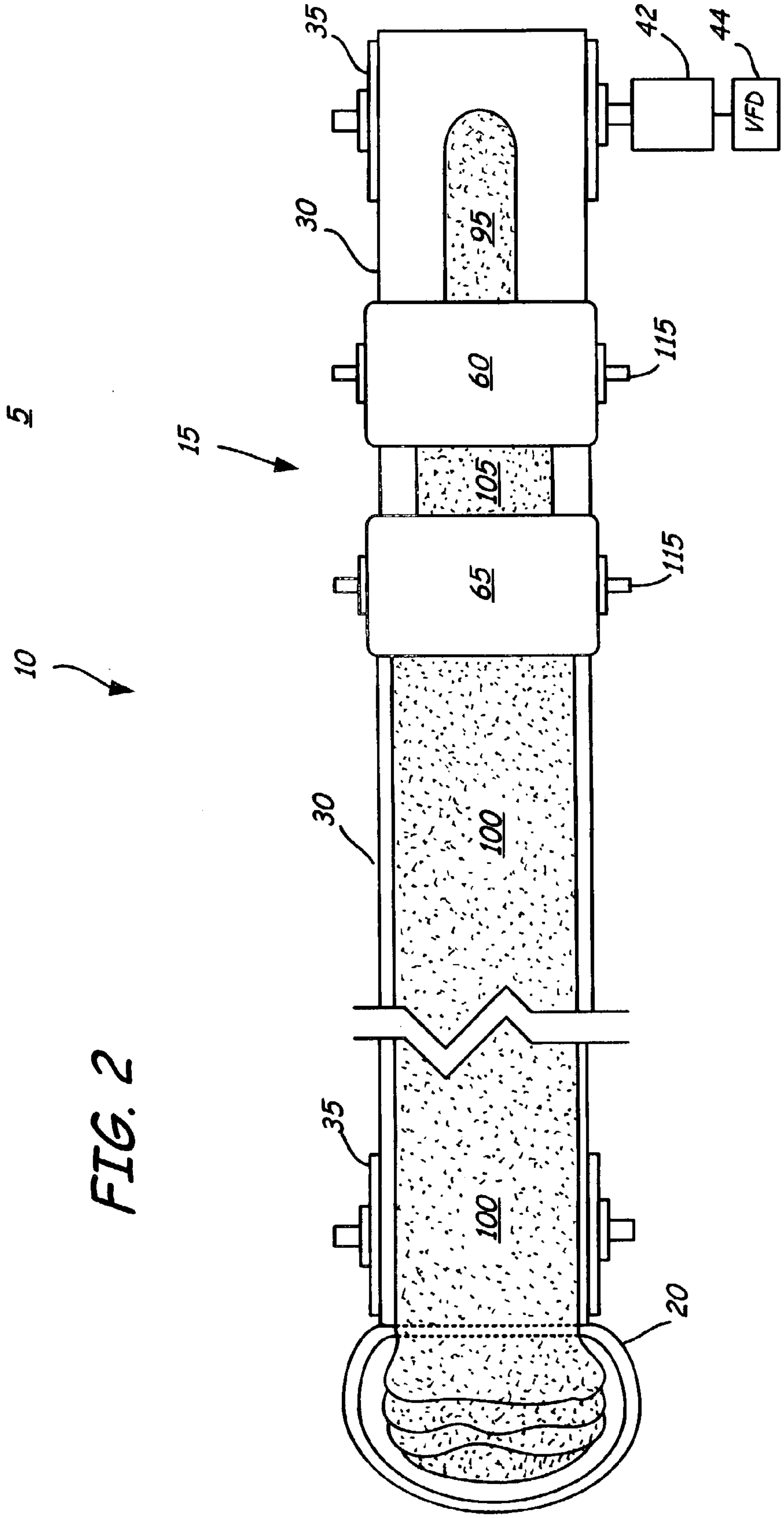
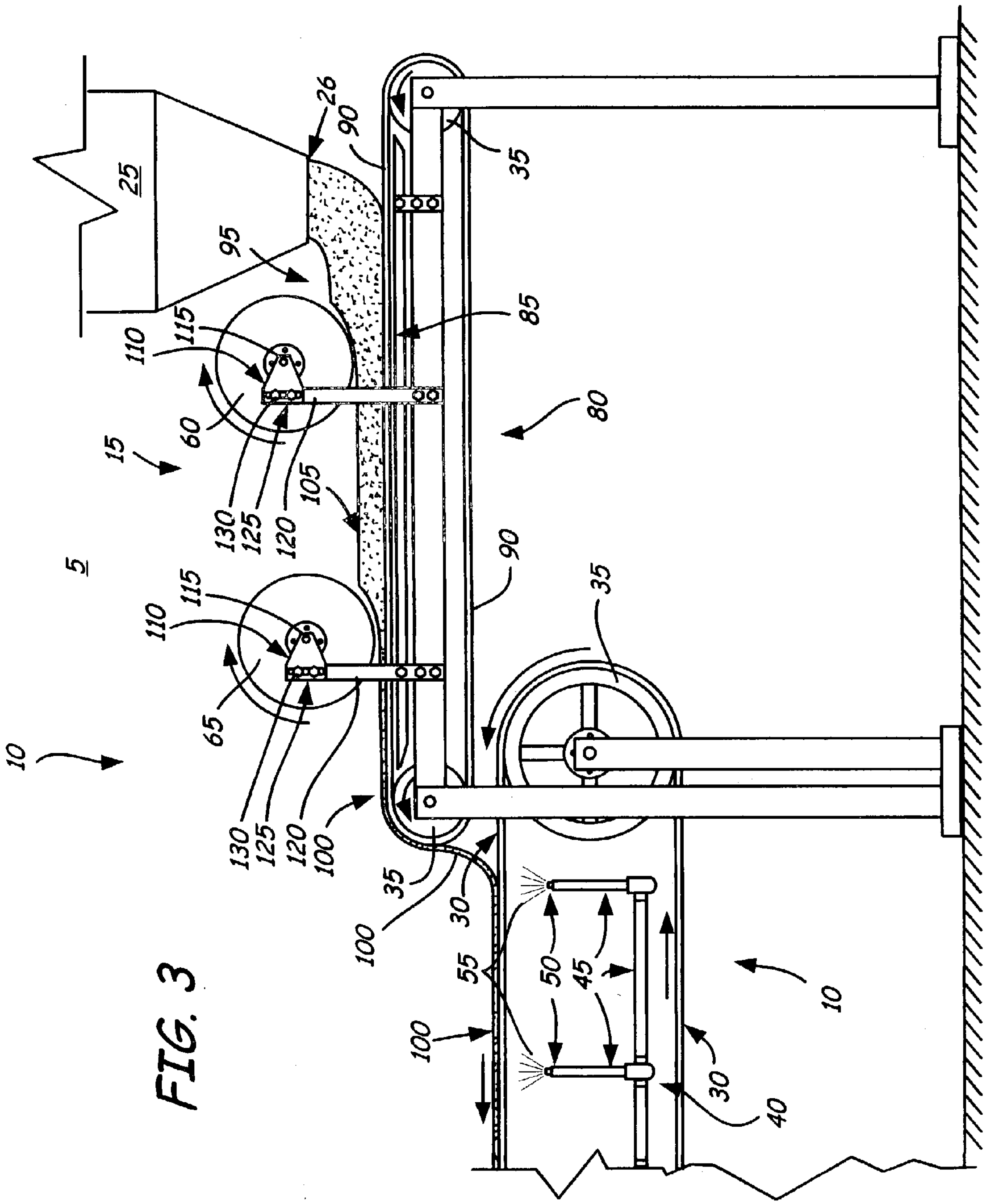


FIG. 2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10
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25
26
30
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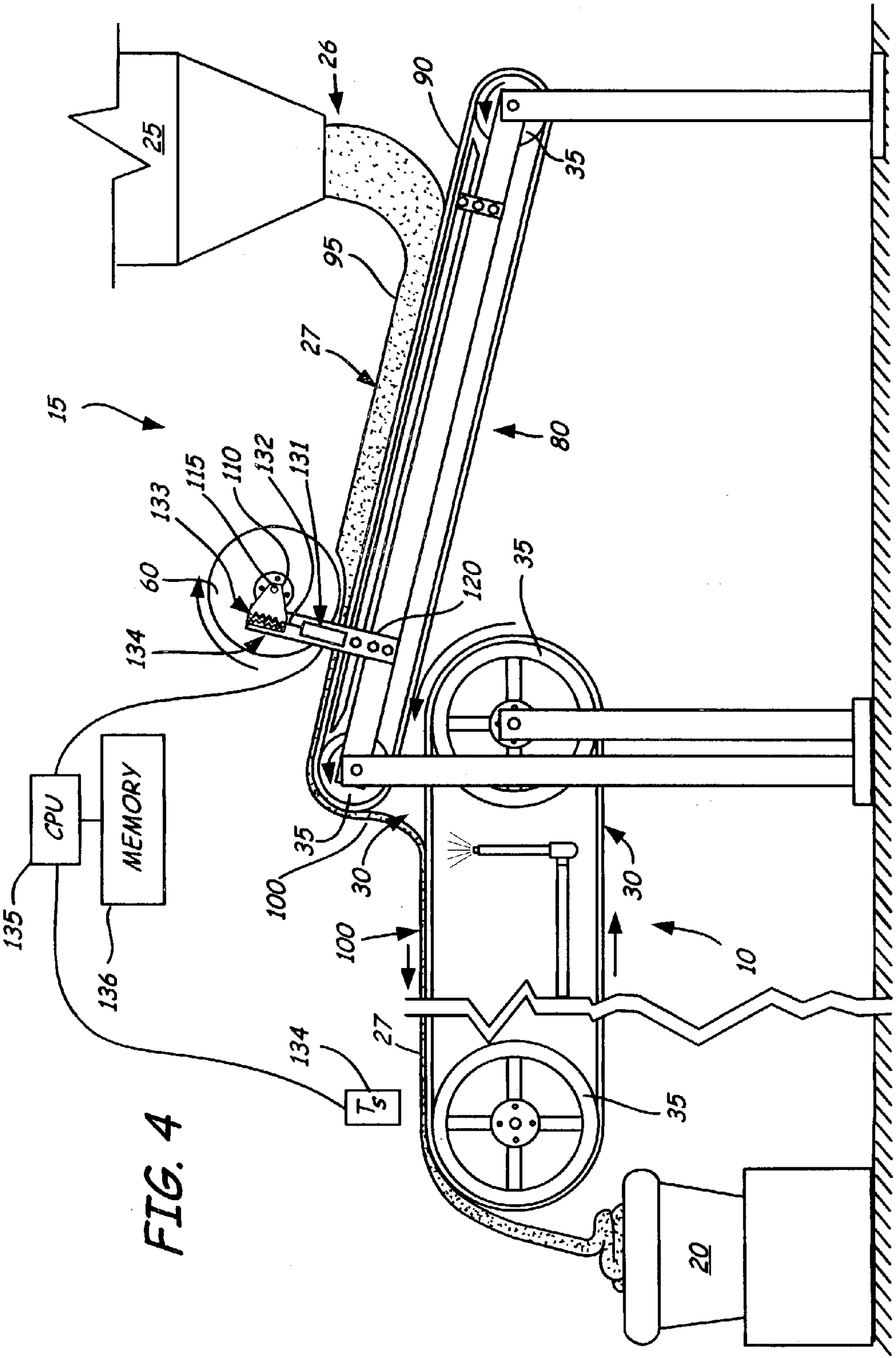
115
120
125
130

FIG. 3


CPU
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15
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132
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135
136

FIG. 4

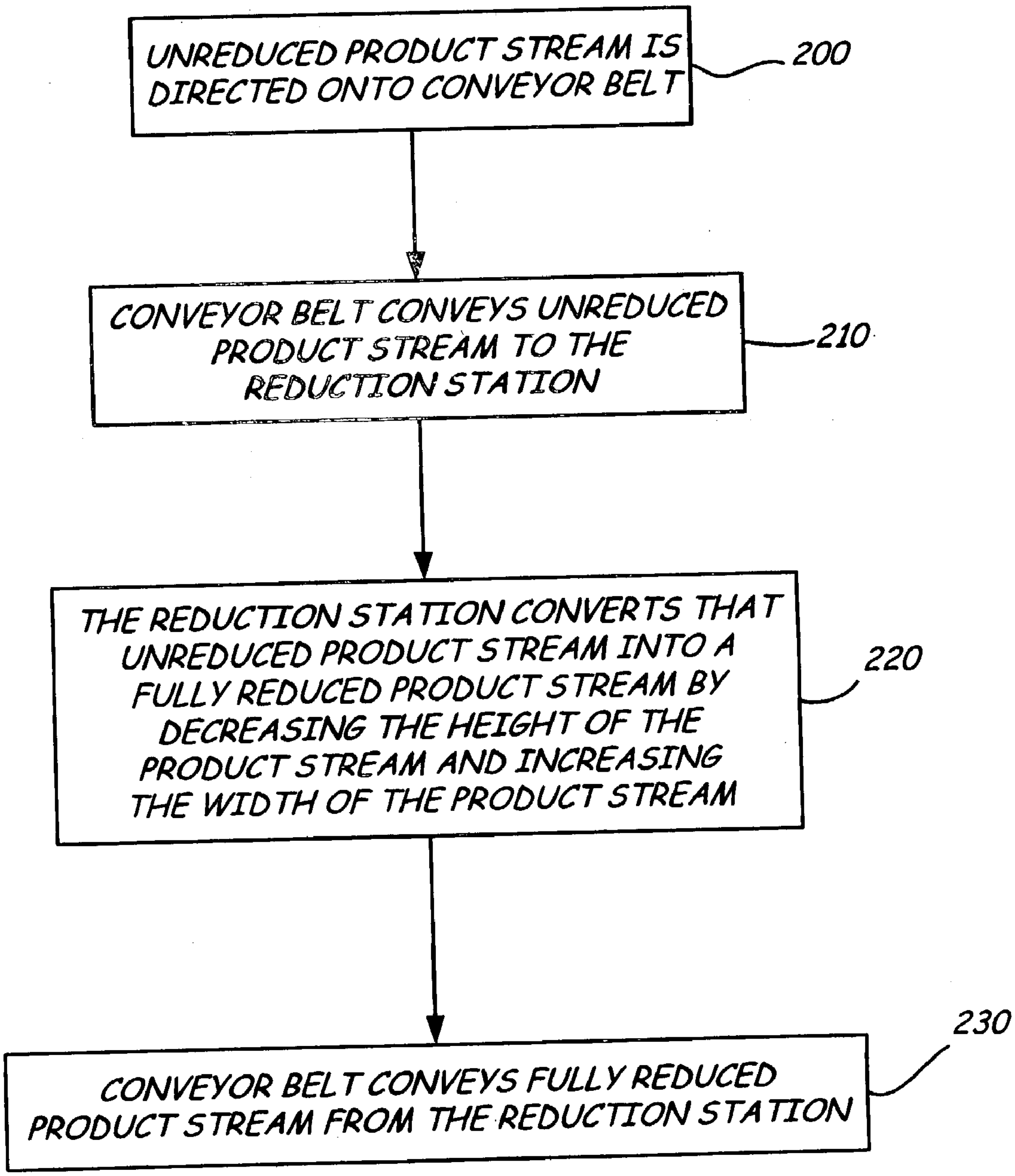
UNREDUCED PRODUCT STREAM IS DIRECTED ONTO CONVEYOR BELT
200
CONVEYOR BELT CONVEYS UNREDUCED PRODUCT STREAM TO THE REDUCTION STATION
210
THE REDUCTION STATION CONVERTS THAT UNREDUCED PRODUCT STREAM INTO A FULLY REDUCED PRODUCT STREAM BY DECREASING THE HEIGHT OF THE PRODUCT STREAM AND INCREASING THE WIDTH OF THE PRODUCT STREAM
220
CONVEYOR BELT CONVEYS FULLY REDUCED PRODUCT STREAM FROM THE REDUCTION STATION
230

FIG. 5a

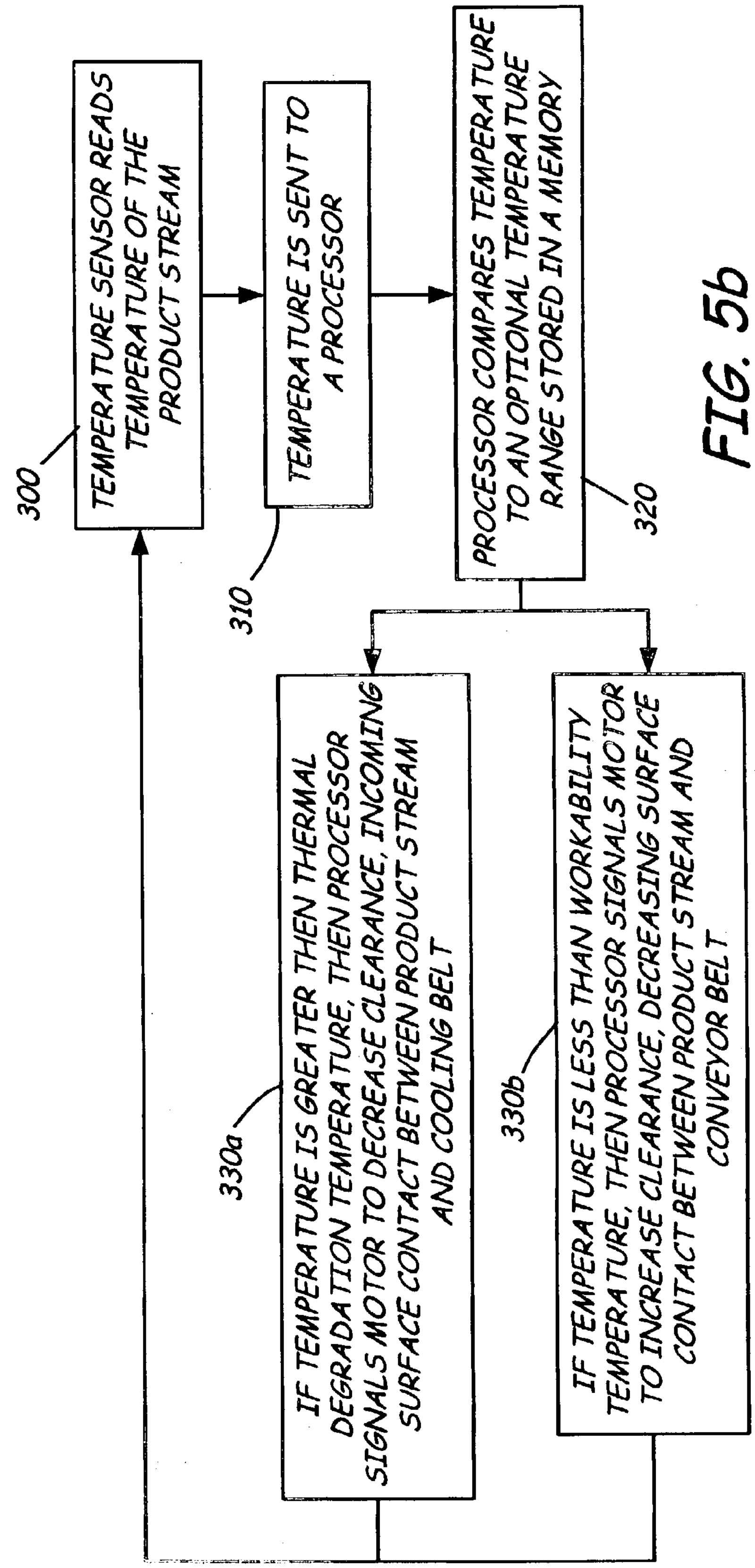
300
TEMPERATURE SENSOR READS TEMPERATURE OF THE PRODUCT STREAM
310
TEMPERATURE IS SENT TO A PROCESSOR
320
PROCESSOR COMPARES TEMPERATURE TO AN OPTIONAL TEMPERATURE RANGE STORED IN A MEMORY
330a
IF TEMPERATURE IS GREATER THEN THERMAL DEGRADATION TEMPERATURE, THEN PROCESSOR SIGNALS MOTOR TO DECREASE CLEARANCE, INCOMING SURFACE CONTACT BETWEEN PRODUCT STREAM AND COOLING BELT
330b
IF TEMPERATURE IS LESS THAN WORKABILITY TEMPERATURE, THEN PROCESSOR SIGNALS MOTOR TO INCREASE CLEARANCE, DECREASING SURFACE CONTACT BETWEEN PRODUCT STREAM AND CONVEYOR BELT

FIG. 5b

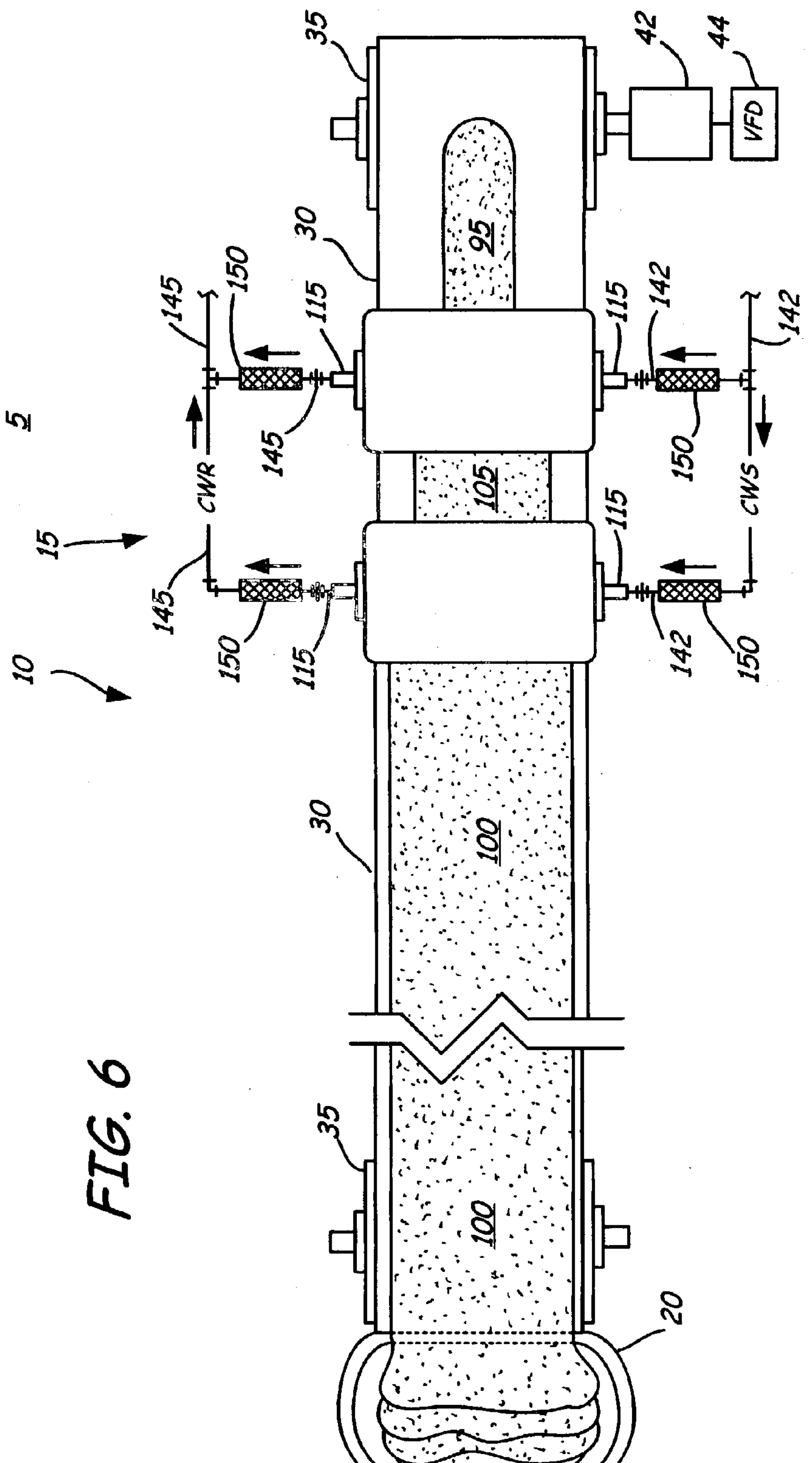

FIG. 6

SYSTEM AND METHOD FOR ENHANCING COOLING OF A FEED PRODUCT DURING PRODUCTION

FIELD OF THE INVENTION

[0001] The invention relates to a system and method for cooling a product stream during its production.

BACKGROUND OF THE INVENTION

[0002] Feed supplements have been used for many years as vehicles to provide energy, protein, minerals, vitamins and medicaments to animals, especially livestock. Molasses-based feed supplements have been an especially popular and effective form of livestock feed supplement. Since molasses is highly palatable to livestock, a molasses-based feed supplement must be consumption limiting to prevent livestock from over indulging in any one visit to the supplement.

[0003] One method of making a molasses-based feed supplement consumption limiting is to provide it to livestock in the form of a hard and durable low-moisture feed block. Low-moisture feed blocks are made by heating a fluid mixture of molasses and other nutrients until the mixture is fully dehydrated. The mixture is then poured into a form or tub and cooled.

[0004] While heating is necessary to fully dehydrate a molasses-based feed supplement to achieve a feed block that is hard and durable, heat causes thermal degradation of sugars such as those found in molasses. Heat also causes thermal degradation of the nutrients contained in the feed supplement, creating reaction products that are often indigestible to the animals eating the feed supplement. Thermal degradation is especially problematic for processors of molasses-based feed supplements because the molasses supplied to feed supplement processors often vary from supply to supply. As a result, it can be difficult to fine-tune the dehydration process so as to minimize thermal degradation.

[0005] The longer the feed supplement remains in a heated state, the greater the thermal degradation of the sugars and nutrients and the greater the creation of indigestible reaction products. Failure to adequately decrease the temperature of the feed supplement prior to placing the supplement in a form or barrel can cause the supplement to react and to increase its temperature on its own. This can result in complete degradation of the supplement. Complete degradation of the supplement is more likely to occur when the supplement is manufactured during high ambient temperature conditions. Thus, it is advantageous to rapidly reduce the temperature of the molasses-based feed supplement once the supplement has exited the dehydration process.

[0006] There is a need in the art for a system and method that rapidly reduces the temperature of a fully dehydrated molasses-based feed supplement once the supplement has exited the dehydration process.

BRIEF SUMMARY OF THE INVENTION

[0007] The invention, in one embodiment, is a system for enhancing the cooling of a product stream during production wherein the product stream is a livestock feed product. The system has a squeeze roller and a conveyor system with a conveying belt. The squeeze roller is located above the conveyor belt. A livestock feed product is routed between the conveyor belt and the squeeze roller thereby reducing the product in height and increasing the product in width. This is done to facilitate cooling of the product stream.

[0008] The invention, in another embodiment, is a system for increasing the surface area of a product stream wherein the product stream is an animal feed product to be cooled. The system has a reduction station and a conveyor system. The conveyor system has a conveyor belt routed through the reduction station. The conveyor belt is used to transport the product stream through the reduction station. The reduction station reduces the product stream in height and increases the product stream in width.

[0009] The invention, in yet another embodiment, is a method for increasing the surface area of a product stream wherein the product stream is an animal feed product to be cooled. The product stream is directed onto a conveyor belt and conveyed to a reduction station. The reduction station reduces the height of the product stream and increasing the width of the product stream as the product stream is conveyed through the reduction station.

[0010] While multiple embodiments are disclosed, still other embodiments of the invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. As will be realized, the invention is capable of modifications in various obvious aspects, all without departing from the spirit and scope of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is a schematic side view of a product cooling system incorporating a cooling belt conveyor and a series of squeeze rollers that reduce a product stream in height and increase the product stream in width, thereby increasing the surface contact between the product stream and the cooling belt.

[0012] **FIG. 2** is a schematic plan view of the system shown in **FIG. 1**.

[0013] **FIG. 3** is a schematic side view of product cooling system incorporating a squeeze belt conveyor reducing a product stream in height and increasing the product stream in width before the product stream reaches the cooling belt conveyor.

[0014] **FIG. 4** is a schematic side view of the product cooling system incorporating an inclined squeeze belt conveyor reducing a product stream in height and increasing the product stream in width before the product stream reaches the cooling belt conveyor.

[0015] **FIG. 5***a* is a block diagram illustrating a method of increasing the surface area contact between a product stream and a conveyor belt.

[0016] **FIG. 5***b* is a block diagram illustrating a method of automatically adjusting the surface area contact between a product stream and a conveyor belt based on a temperature reading taken from the product stream.

[0017] **FIG. 6** is a schematic plan view of the system shown in **FIG. 1** employing chilled squeeze rollers.

DETAILED DESCRIPTION

[0018] **FIG. 1** is a schematic side view of a product cooling system **5** according to one embodiment of the invention. As shown in **FIG. 1**, the system **5** includes a cooling belt conveyor **10**, a reduction station **15**, a product barrel **20**, and a hopper **25** with an orifice **26**. The hopper **25** is located above one end of the cooling belt conveyor **10** and the product barrel **20** is located below the other end of the cooling belt conveyor **10**. The reduction station **15** is located at a point along the cooling belt conveyor **10** between the hopper **25** and the barrel **20**.

[0019] A product stream **27**, the product being a fully dehydrated molasses-based feed supplement or other similar animal feed product, emanates from the orifice **26** of the hopper **25** onto the cooling belt conveyor **10**. The cooling belt conveyor **10** transports the product stream **27** through the reduction station **15** where the product stream **27** is reduced in depth and increased in width. This facilitates cooling of the product stream **27** because the surface contact between the cooling belt conveyor **10** and the product stream **27** is increased. After leaving the reduction station **15**, the product stream **27** travels along the cooling belt conveyor **10** to the product barrel **20** or form.

[0020] The cooling belt conveyor **10** includes a cooling belt **30**, conveyor wheels **35** and a cooling water spray system **40**. The cooling belt **30** travels about the conveyor wheels **35**. The cooling belt **30** is stainless steel or another material also having good heat transfer and product release capabilities.

[0021] As shown in **FIG. 2**, the cooling belt is powered by one or more electric motors **42**. As further indicated in **FIG. 2**, in one embodiment of the invention, the electric motor **42** has a variable frequency drive (VFD) **44** that allows the cooling belt **30** to travel at different speeds. For example, in one embodiment, the VFD **44** causes the cooling belt **30** to travel at approximately 1 to approximately 30 feet per minute. In another embodiment, the cooling belt **30** travels at a speed of approximately 30 to approximately 60 feet per minute. In another embodiment, the cooling belt **30** travels at a speed of approximately 60 to approximately 100 feet per minute. In another embodiment, the cooling belt **30** travels at a speed of approximately 100 feet per minute or greater. In another embodiment, the cooling belt **30** travels at a speed of approximately 60 feet per minute.

[0022] The length of the cooling belt conveyor **10** may vary depending on the desired temperature drop of the product being cooled, the temperature of the water in the cooling water spray system **40**, and the travel speed of the cooling belt **30**. For example, in one embodiment of the invention, the cooling belt conveyor **10** is between about 10 and about 150 feet long or longer. In another embodiment, the cooling belt conveyor **10** is approximately 50 feet long. In other embodiments of the invention, the conveyor will be greater than or less than 50 feet long.

[0023] The width of the cooling belt **30** may vary depending on the width of the product stream **27** emanating from the orifice **26** of the hopper **25**. For example, in one embodiment of the invention, the cooling belt **30** is between about 4 and about 48 inches wide or wider. In another embodiment, the cooling belt **30** is between about 12 and about 36 inches wide. In another embodiment, the cooling belt **30** is between about 18 and about 30 inches wide. In another embodiment, the cooling belt **30** is about 24 inches wide. Finally, in another embodiment, the cooling belt **30** is about 30 inches wide.

[0024] As shown in **FIG. 1**, the cooling water spray system **40** is located within the cooling belt conveyor **10** and has water piping **45** terminating in spray heads **50**. To cool the cooling belt **30**, water spray **55** emanates from the spray heads **50** and contacts the bottom surface of the cooling belt **30**. In one embodiment of the invention, the water used in the cooling water spray system **40** is water pumped from underground aquifers. This ground water exits the spray heads at approximately 50 to approximately 65 degrees Fahrenheit. In another embodiment, the ground water would be approximately 58 to approximately 62 degrees Fahrenheit.

[0025] In one embodiment, the water used in the cooling water spray system **40** is chilled water from a chiller. The chilled water may exit the spray heads **50** at approximately 40 to approximately 55 degrees Fahrenheit. In other embodiments, the water temperature may be higher or lower than these values. In one embodiment, other cooling mediums are applied against the bottom of the cooling belt **30**, for example brine solutions or cooled air. In one embodiment of the invention, jets of cooled air blow down on the top of the product stream **27** as it travels along the cooling belt conveyor **10**.

[0026] In one embodiment of the invention, the cooling belt conveyor **10** utilizes about 0.01 to about 10.0 gallons per minute (gpm) of cooling water per linear foot of the cooling belt conveyor **10**. In another embodiment, the cooling belt conveyor **10** utilizes about 0.05 to about 2.0 gpm of cooling water per linear foot of the cooling belt conveyor **10**. In another embodiment, the cooling belt conveyor **10** utilizes about 1.2 to about 1.8 gpm of cooling water per linear foot of the cooling belt conveyor **10**.

[0027] The reduction station **15**, in the embodiment shown in **FIG. 1**, has a first stage squeeze roller **60**, a second stage squeeze roller **65**, a first support roller **70**, and a second support roller **75**. The squeeze rollers **60**, **65** are located above the cooling belt **30**. The contact surfaces of the squeeze rollers **60**, **65** are stainless steel, TEFLON®, or another material known in the art as possessing good product release characteristics. The support rollers **70**, **75** are located below the cooling belt **30** and their corresponding squeeze rollers **60**, **65**. The support rollers **70**, **75** support the cooling belt **30**.

[0028] In the embodiment shown in **FIG. 3**, the reduction station **15** is located on a squeeze belt conveyor **80** and has a first stage squeeze roller **60**, a second stage squeeze roller **65**, and a low-friction board **85**. The squeeze rollers **60**, **65** are located above the squeeze belt **90** and the low-friction board **85** is located below the squeeze belt **90**. The low-friction board **85** supports the squeeze belt **90**. The squeeze belt **90** is stainless steel, TEFLON®, or another material known in the art as possessing good product release characteristics. The squeeze belt **90** travels about conveyor wheels **35**.

[0029] In one embodiment, whether the reduction station **15** is located on the cooling belt conveyor **10** or on the squeeze belt conveyor **80**, the reduction station **15** includes only one squeeze roller **60**. In other embodiments, the reduction station **15** has more than two squeeze rollers **60**, **65**. Also, there may be more than or less than two support rollers **70** per reduction station **15**. Furthermore, in other embodiments, the low-friction board **85** may be substituted for support rollers **70**, **75**, or vice versa.

[**0030**] As shown in **FIG. 3**, in one embodiment, the reduction station **15** is separate from the cooling belt conveyor **10**. Specifically, the squeeze belt conveyor **80** has a reduction station **15** and is installed in a horizontal configuration, terminating above the cooling belt conveyor **10**. In the embodiment shown in **FIG. 4**, the squeeze belt conveyor **80** is installed in an inclined manner, sloping up from the orifice **26** of the hopper **25** to the cooling belt conveyor **10**. In another embodiment, the squeeze belt conveyor **80** is installed in an inclined manner sloping down from the orifice **26** of the hopper **25** to the cooling belt conveyor **10**

[**0031**] Operation of the invention will now be explained by referring to **FIGS. 1, 2** and **5**. This explanation is equally applicable to the embodiments illustrated in **FIGS. 3 and 4**, except the product streams **27** in **FIGS. 3 and 4** are reduced on the squeeze belt conveyors **80** before being routed to the cooling belt conveyors **10**. **FIG. 5***a* is a block diagram showing the steps of a method for increasing the surface area contact between a product stream **27** and a conveyor belt.

[**0032**] Referring to **FIGS. 1, 2** and **5**, a product stream **27**, the product being a fully dehydrated molasses-based feed supplement or other similar animal feed product, exits the orifice **26** of the hopper **25** onto the cooling belt **30** as an unreduced product stream **95** (block **200** in **FIG. 5***a*). As shown in **FIGS. 1 and 2**, the height and width of the unreduced product stream **95** are approximately equal to the dimensions of the orifice **26**.

[**0033**] In one embodiment of the invention, the height of the unreduced product stream **95** is approximately 2.0 to approximately 6.0 inches and the width is approximately 1.0 to approximately 12.0 inches. In one embodiment, the height of the unreduced product stream **95** is approximately 1.25 to approximately 1.50 inches and the width is approximately 4.0 to approximately 4.5 inches. In other embodiments, the height and width of the unreduced product stream **95** may be other sizes.

[**0034**] The unreduced product stream **95** is carried along the cooling belt **30** to the reduction station **15** (block **210** in **FIG. 5***a*). The reduction station **15** converts the unreduced product stream **95** into a fully reduced product stream **100** by decreasing the height of the product stream **27** and increasing the width of the product stream **27** (block **220** in **FIG. 5***a*).

[**0035**] In one embodiment of the invention, the reduction station **15** will have decreased the height of the product stream **27** by about 10 to about 98 percent or more. In another embodiment, the reduction station **15** will have decreased the height of the product stream **27** by about 25 to about 75 percent.

[**0036**] In one embodiment of the invention, the reduction station **15** will have increased the width of the product stream **27** by about 10 to about 500 percent. In another embodiment, the reduction station **15** will have increased the width of the product stream **27** by about 50 to about 200 percent.

[**0037**] In one embodiment of the invention, the height of the fully reduced product stream **100** is approximately 0.25 to approximately 3.0 inches and the width is approximately 2.0 to approximately 24.0 inches. In one embodiment, the height of the fully reduced product stream **100** is approximately 0.5 to approximately 0.75 and the width is approximately 8.0 to approximately 9.0 inches. In other embodiments, the height and width of the fully reduced product stream **100** may be other sizes.

[**0038**] In the embodiment illustrated in **FIGS. 1 and 2**, the reduction station **15** converts the unreduced product stream **95** into the fully reduced product stream **100** as follows. As the unreduced product stream **95** reaches the reduction station **15**, the unreduced product stream **95** is drawn between the rotating first stage squeeze roller **60** and the traveling cooling belt **30**. The height of the unreduced product stream **95** is reduced to the height of the partially reduced product stream **105** (see **FIG. 1**). The width of the unreduced product stream **95** is increased to the width of the partially reduced product stream **105** (see **FIG. 2**).

[**0039**] The partially reduced product stream **105** is carried along the cooling belt **30** to the rotating second stage squeeze roller **65**. The partially reduced product stream **105** is drawn between the rotating second stage squeeze roller **65** and the traveling cooling belt **30**. The height of the partially reduced product stream **105** is reduced to the height of the fully reduced product stream **100** (see **FIG. 1**). The width of the partially reduced product stream **105** is increased to the width of the fully reduced product stream **100** (see **FIG. 2**). The cooling belt **30** carries the fully reduced product stream **100** from the reduction station **15** (block **230** in **FIG. 5***a*).

[**0040**] In one embodiment, the width of the fully reduced product stream **100** is now nearly equivalent to the width of the cooling belt **30**. As a result, the heat transfer rate from the product stream **27** to the cooling belt **30** is maximized because the contact area between the product stream **27** and the cooling belt **30** is maximized and because the surface area to volume ratio of the product stream **27** is maximized. Thus, the temperature of the product stream **27** can be quickly reduced, preventing further degradation of the product.

[**0041**] Upon exiting the reduction station **15**, the fully reduced product stream **100** travels along the cooling belt **30** to a product barrel **20** or form. Once a barrel **20** or form is filled with product, the barrel **20** or form is taken to a storage area where the product is allowed to harden.

[**0042**] The space between each squeeze roller **60**, **65** and the cooling belt **30** or squeeze belt **90**, as the case may be, can be adjusted via a thickness adjustor **110** as shown in **FIG. 3**. Thus, the rate of heat transfer from a product stream **27** to a cooling belt **30** may be controlled by adjusting the thickness adjustor **110** to modify the width of the product stream **27** as it leaves the reduction station **15**.

[**0043**] In one embodiment, the axle **115** of a squeeze roller **60**, **65** is supported on each end by a thickness adjustor **110**. The thickness adjustor **110** is slidably mounted on a roller frame **120**. The thickness adjustor **110** has one or more slots **125** that slidably engage with bolts **130** that protrude through the slots **125** from the side of the roller frame **120**. The space between a squeeze roller **60**, **65** and a belt **30**, **90** may be increased by moving the roller's thickness adjustors

110 up along their roller frames **120**. Similarly, the space between a squeeze roller **60**, **65** and a belt **30**, **90** may be decreased by moving the roller's thickness adjustors **110** down along their roller frames **120**. In either case, the bolts **130** are then tightened to secure the thickness adjustors **110** in place.

[**0044**] In one embodiment, as shown in **FIG. 4**, the thickness adjustors **110** are automated in that they are moved along a roller frame **120** by a motor **131**. In one embodiment, the motor **131** turns a shaft **132** that turns a worm gear **133** that meshes with a gear rack **134**. As the worm gear **133** rotates against the gear rack **133**, the thickness adjustor **110** is caused to translate along the roller frame **120**. In other embodiments, other gear configurations are utilized to allow the motor **131** to translate the thickness adjustor **110**. In still other embodiments, the thickness adjustor **110** is translated along the roller frame **120** via a hydraulic piston.

[**0045**] As indicated in **FIG. 4**, in one embodiment, a temperature sensor **134** will be located near the end of the cooling belt conveyor **10**. In other embodiments, the temperature sensor **134** will be located in other locations along the cooling belt conveyor **10** or the squeeze belt conveyor **80**.

[**0046**] As outlined in **FIG. 5*b***, in one embodiment, a temperature sensor **134** reads the temperature of the product stream **27** at some point before the product stream **27** enters the barrel **20** (block **300**). The temperature of the product stream **27** is sent to a processor **135** (block **310**). The processor **135** compares the temperature of the product stream **27** to an optimal temperature range stored in a memory **136** (block **320**).

[**0047**] As previously explained in this specification, if the product stream **27** is insufficiently cooled, significant thermal degradation of the product may occur. The temperature above which significant thermal degradation will occur is called the thermal degradation temperature. Alternatively, if the product stream **27** is excessively cooled, it will lose its workability and will be unable to conform to the barrel **20**. The temperature below which workability is lost is the workability temperature. Consequently, the optimal temperature range is a temperature range where the product stream **27** is warm enough to readily conform to the barrel **20** (i.e., above the workability temperature) but not so warm that unacceptable thermal degradation will occur (i.e., below the thermal degradation temperature). The optimal temperature range may vary from day to day depending on the chemical makeup of the molasses being used and the ambient temperature.

[**0048**] If the temperature of the product stream **27** is greater than the thermal degradation temperature, the processor **135** will signal the motor **131** to decrease the clearance between the squeeze roller **60** and the belt **30**, **90** (block **330*a***). This will increase the surface contact between the cooling belt **30** and the product stream **27** to lower the temperature of the product stream **27**.

[**0049**] If the temperature of the product stream **27** is less than the workability temperature, the processor **135** will signal the motor **131** to increase the clearance between the squeeze roller **60** and the belt **30**, **90** (block **330*b***). This will decrease the surface contact between the cooling belt **30** and the product stream **27** to raise the temperature of the product stream **27**.

[**0050**] Once the product stream **27** has had time to react to the adjustment and its temperature has stabilized, the temperature sensor **134** will take another temperature reading. If the new temperature reading is still not within the optimum temperature range, the processor **135** will again signal the motor **131** to adjust the thickness adjustors **110** as necessary.

[**0051**] In another embodiment, where a processor **135** and a memory **136** are not available, an operator uses a temperature sensing device to read the temperature of the product stream **27** at some point before the product stream **27** enters the barrel **20**. The operator compares the temperature reading to an optimal temperature range. If the temperature reading is greater than the thermal degradation temperature, the operator adjusts the thickness adjustors **110**, either manually or via the motor **131**, to decrease the clearance between the squeeze roller **60** and the belt **30**, **90**. This will increase the surface contact between the cooling belt **30** and the product stream **27** to lower the temperature of the product stream **27**.

[**0052**] If the temperature reading is less than the workability temperature, the operator adjusts the thickness adjustors **110**, either manually or via the motor **131**, to increase the clearance between the squeeze roller **60** and the belt **30**, **90**. This will decrease the surface contact between the cooling belt **30** and the product stream **27** to raise the temperature of the product stream **27**.

[**0053**] Once the product stream **27** has had time to react to the adjustment and its temperature has stabilized, the operator will take another temperature reading. If the new temperature reading is still not within the optimum temperature range, the operator will again adjust the thickness adjustors **110** as necessary.

[**0054**] As illustrated in **FIG. 6**, to further enhance the removal of heat from a product stream **27**, the aforementioned embodiments may have one or more squeeze rollers **60**, **65** that are chilled squeeze rollers **140**.

[**0055**] As shown in **FIG. 6**, the supply piping **142** and return piping **145** connect to the ends of each axle **115**. Each axle **115** is hollow and serves as a conduit for a cooling medium to enter or exit the chilled squeeze rollers **140**. Candidates for a cooling medium include, but are not limited to, ground water, chilled water, CFCs, HFCs, HCFCs, and ammonia.

[**0056**] The cooling medium flows through the supply piping **142**, into a chilled squeeze roller **140**, and into the return piping **145**. As the cooling medium flows through a chilled squeeze roller **140**, the cooling medium absorbs heat that transfers from the product stream **27** through the surface of the chilled squeeze roller **140**.

[**0057**] Each piping connection to the axle **115** of a chilled squeeze roller **140** has a flexible pipe element **150**. The flexible pipe elements **150** allow the chilled squeeze roller **140** to be raised or lowered on its thickness adjustors **110** and prevents vibration from being transmitted from the chilled squeeze roller **140** to the piping **142**, **145**.

[**0058**] The amount and rate of heat transfer from a product stream **27** may vary depending on several different variables, such as the material of the cooling belt **30**, the temperature and flow rate of the water sprayed against the cooling belt **30**, the travel speed of the cooling belt **30**, the depth of the product stream **27**, the amount of surface contact between the cooling belt **30** and the fully reduced product stream **100**, and the composition of the product stream **27**.

[**0059**] As shown in **FIG. 4**, in one embodiment of the invention, an unreduced product stream **95** of fully dehydrated molasses-based feed supplement exits the orifice **26** of the hopper **25** onto an inclined squeeze belt conveyor **80**. The unreduced product stream **95** has a height of 1.25 to 1.50 inches and a width of 4.0 to 4.5 inches. The unreduced product stream **95** travels up the squeeze belt conveyor **80** where it enters a reduction station **15** having a single squeeze roller **60**. In other embodiments, the reduction station **15** will have two or more squeeze rollers **60**.

[**0060**] The product stream exits the reduction station **15** as a fully reduced product stream **100** having a height of 0.5 to 0.75 inch and a width of 8.0 to 9.0 inches. The fully reduced product stream **100** travels from the squeeze belt conveyor **80** onto the cooling belt **30**.

[**0061**] The cooling belt conveyor **10** is approximately 50 feet long and has a stainless steel cooling belt **30** that travels at approximately 60 feet per minute. A VFD 44 allows the cooling belt **30** to travel at lower or higher speeds. Ground water having a temperature of approximately 58 to 62 degrees Fahrenheit is sprayed against the bottom of the cooling belt **30**. By the time the product stream **27** has traveled from the orifice **26** of the hopper **25** to the product barrel **20**, the product stream will have experienced a temperature decrease of approximately 8.0 to approximately 12.0 degrees Fahrenheit.

[**0062**] Although the invention has been described with reference to preferred embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

I claim:

1. A system for enhancing the cooling of a product stream wherein the product stream is a livestock feed product, the system comprising:

a conveyor system including a conveyor belt; and

a squeeze roller located above the conveyor belt and positioned to reduce the height and increase the width of the product stream.

2. The system of claim 1 wherein the conveyor belt is a cooling belt.

3. The system of claim 1 wherein the conveyor belt is a squeeze belt.

4. The system of claim 3 further comprising a cooling belt, wherein the product stream, having been reduced in height and increased in width on the squeeze belt, travels from the squeeze belt to the cooling belt.

5. The system of claim 1 wherein the squeeze roller has a thickness adjustor that allows the space between the squeeze roller and the conveyor belt to be increased or decreased.

6. The system of claim 1 further comprising a piping system circulating a cooling medium and wherein the squeeze roller is connected to the piping system and is a chilled squeeze roller.

7. The system of claim 1 further comprising a second squeeze roller positioned to further reduce the height and increase the width of the product stream.

8. The system of claim 1 further comprising a support roller, the support roller positioned to support a portion of the conveyor belt near the location of the squeeze roller.

9. The system of claim 1 further comprising a low-friction board positioned to support a portion of the conveyor belt.

10. A system for enhancing the cooling of a product stream wherein the product stream is a livestock feed product, the system comprising:

a reduction station configured to increase the surface area to volume ratio of the product stream; and

a conveyor system having a conveyor belt routed through the reduction station, the conveyor belt configured to transport the product stream through the reduction station.

11. The system of claim 10 wherein the conveyor belt is a cooling belt.

12. The system of claim 10 wherein the conveyor belt is a squeeze belt.

13. The system of claim 12 further comprising a cooling belt located near a distal end of the squeeze belt, wherein the product stream, after traversing the reduction station, travels from the squeeze belt to the cooling belt.

14. The system of claim 10 wherein the reduction station comprises a first reduction stage.

15. The reduction station of claim 14 further comprising a second reduction stage.

16. The system of claim 10 wherein the reduction station comprises a squeeze roller.

17. The system of claim 16 wherein the squeeze roller has a thickness adjustor that allows the space between the squeeze roller and the conveyor belt to be increased or decreased.

18. The system of claim 16 further comprising a piping system circulating a cooling medium and wherein the squeeze roller is connected to the piping system and is a chilled squeeze roller.

19. The reduction station of claim 16 further comprising a support roller, the support roller positioned to support a portion of the conveyor belt near the location of the squeeze roller.

20. The reduction station of claim 16 further comprising a low-friction board positioned to support a portion of the conveyor belt.

21. A method for enhancing the cooling of a product stream wherein the product stream is a livestock feed product, the method comprising:

directing the product stream onto a conveyor belt;

conveying the product stream to a reduction station; and

increasing the surface area to volume ratio of the product stream.

22. The method of claim 21 wherein the surface area to volume ratio of the product stream is increased by applying a squeeze roller to reduce the height and to increase the width of the product stream as the product stream is conveyed through the reduction station.

23. The method of claim 22 wherein the height of the product stream is decreased to approximately 0.25 to approximately 1.0 inch.

24. The method of claim 22 wherein the height of the product stream is decreased by approximately 10 to approximately 98 percent.

25. The method of claim 24 wherein the height of the product stream is decreased by approximately 25 to approximately 75 percent.

26. The method of claim 22 wherein the width of the product stream is increased by approximately 10 to approximately 500 percent.

27. The method of claim 26 wherein the width of the product stream is increased by approximately 50 to approximately 200 percent.

28. The method of claim 21 further comprising cooling the product stream with a cooling conveyor belt.

29. The method of claim 28 wherein the step of cooling the product stream comprises spraying water against the bottom of the cooling conveyor belt.

30. The method of claim 29 wherein the water is ground water having a temperature of approximately 50 to approximately 65 degrees Fahrenheit.

31. The method of claim 29 wherein the water is chilled water having a temperature of approximately 40 to approximately 55 degrees Fahrenheit.

32. The method of claim 28 wherein the cooling conveyor belt travels at approximately 30 to approximately 90 feet per minute.

33. The method of claim 21 wherein the conveyor belt is a squeeze belt and the method further comprises conveying the product from the reduction station to a cooling conveyor belt.

34. The method of claim 21 wherein the reduction station comprises a chilled squeeze roller and the method further comprises circulating a cooling medium through the chilled squeeze roller.

35. The method of claim 21 further comprising monitoring a product stream temperature and adjusting the surface area to volume ratio of the product stream to maintain the product stream temperature above a workability temperature and below a thermal degradation temperature.

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