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**Veldkamp et al.**

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(54) **METHOD AND APPARATUS FOR REMOVING FAT FROM MEAT CUTS**

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(51) **Int. Cl.**[7] ..... **A22C 17/12**
(52) **U.S. Cl.** ..... **452/134**; 452/127
(58) **Field of Search** ..... 452/134, 127

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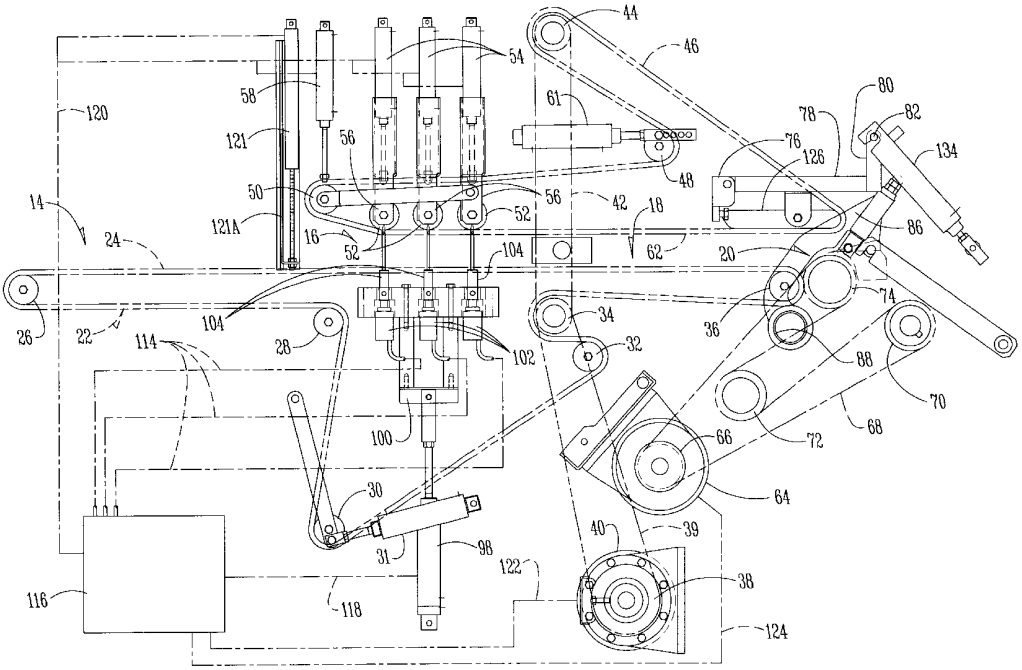
(57) **ABSTRACT**

A method for removing a portion of fat from meat cuts involves placing a meat cut on a longitudinal conveyor, pressing sensor probes into the meat cut to measure the relative thickness of fact and the location of lean in the meat, and then withdrawing the sensor probes from the meat. An electronic signal is transmitted from the sensor to a controller along with an encoder signal to determine the depth from the outer lower surface of the meat cut through a layer of fat in the meat to a layer of lean in the meat. Data taken from the foregoing step determine the desired position of the blade. A predetermined amount of fat is thereupon cut from the meat cut by the blade. An apparatus for removing a portion of fact from meat cuts includes a frame and at least one sensor probe including fiber optics to permit scanning of the interior of a meat cut penetrated by the probe. Power for moving the probe into the meat is mounted on the frame along with a skinning blade mounted in a path of movement of a meat cut on the frame. A controller on the frame takes data from the sensor probe and determines the linear depth of fat material on the meat cut and lean material in the meat cut. The controller then determines the operating position of the blade and positions the blade to effect the removal of the desired amount of fat.

**14 Claims, 8 Drawing Sheets**

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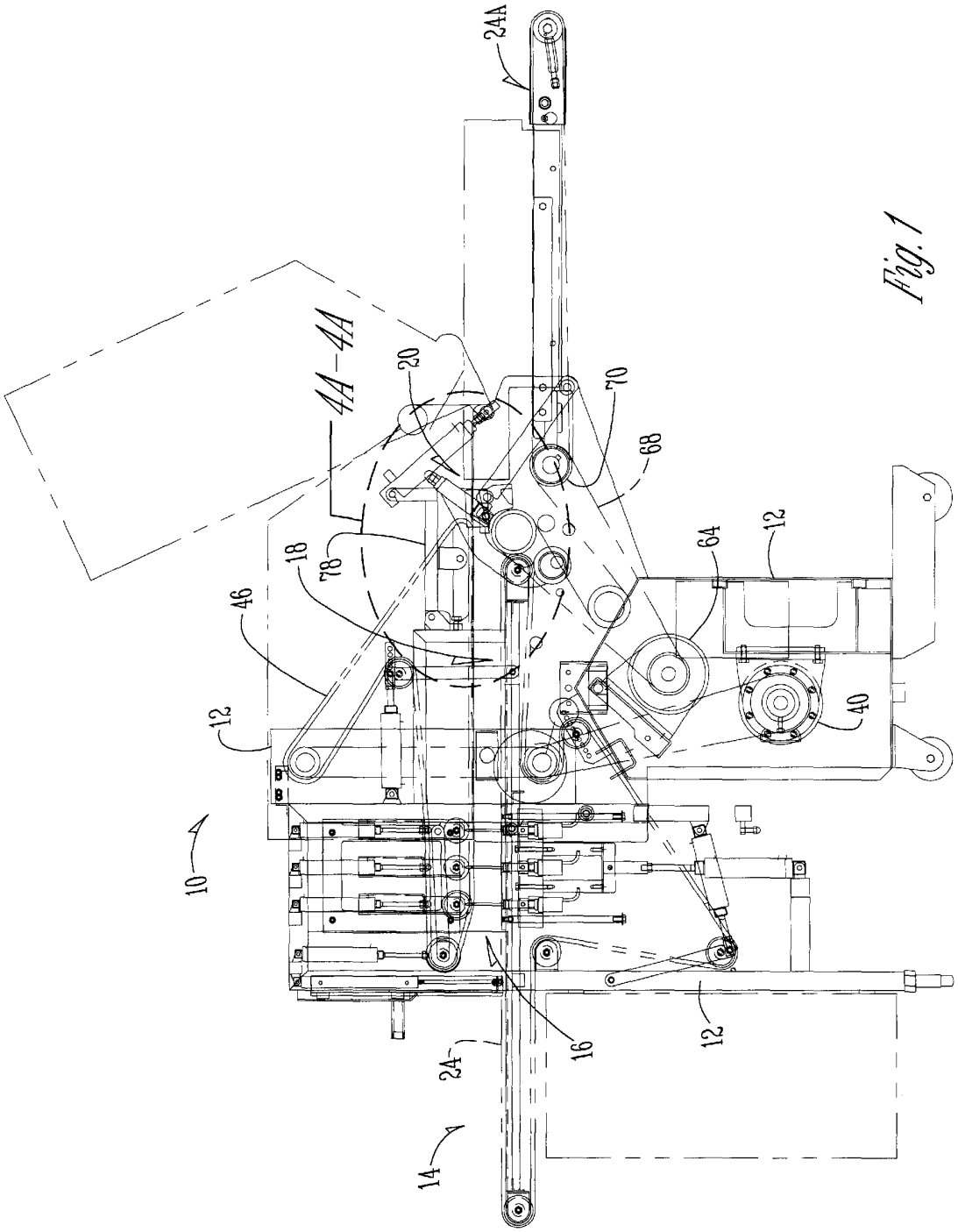
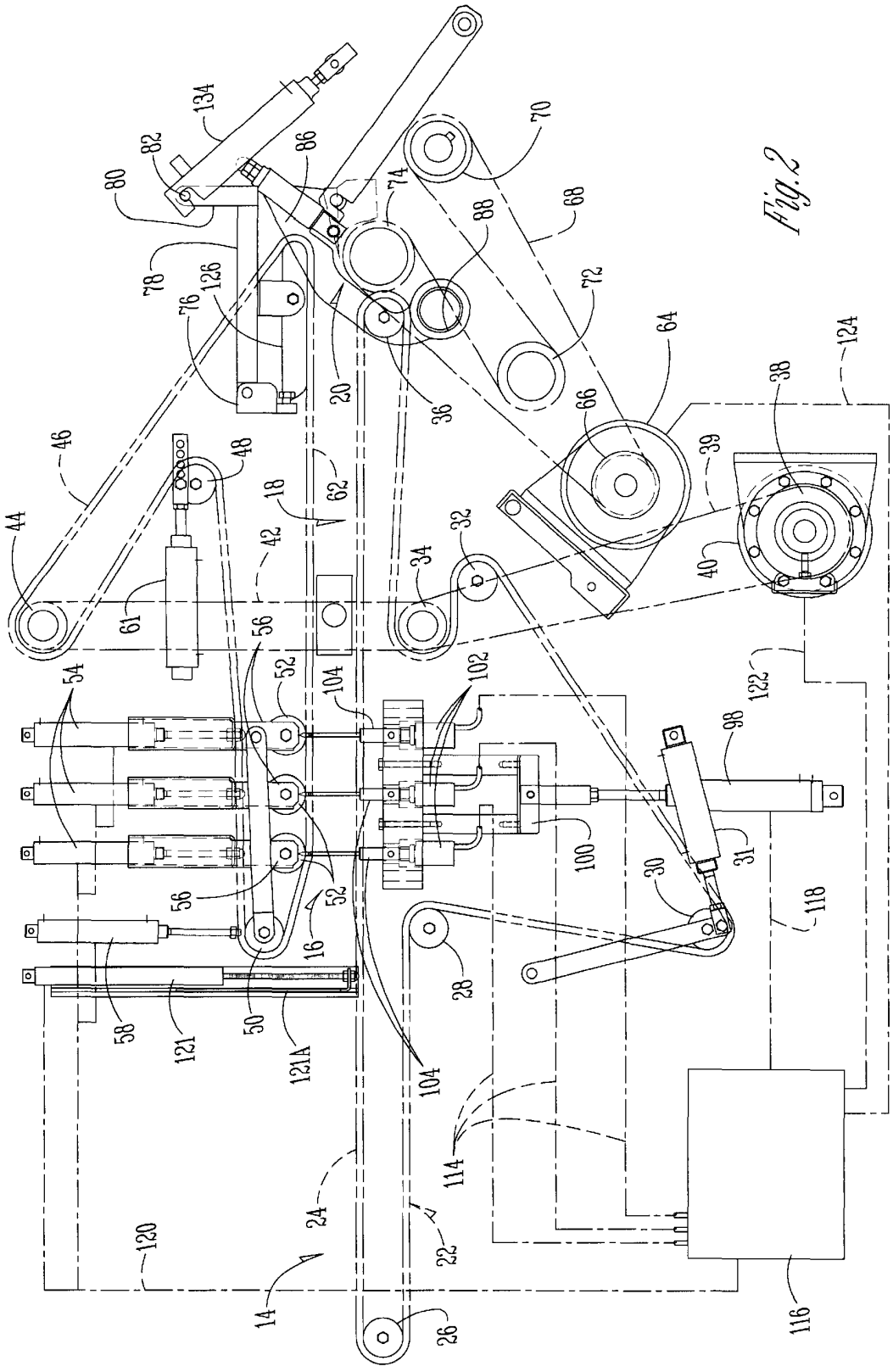



Fig. 1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121A
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Fig. 2

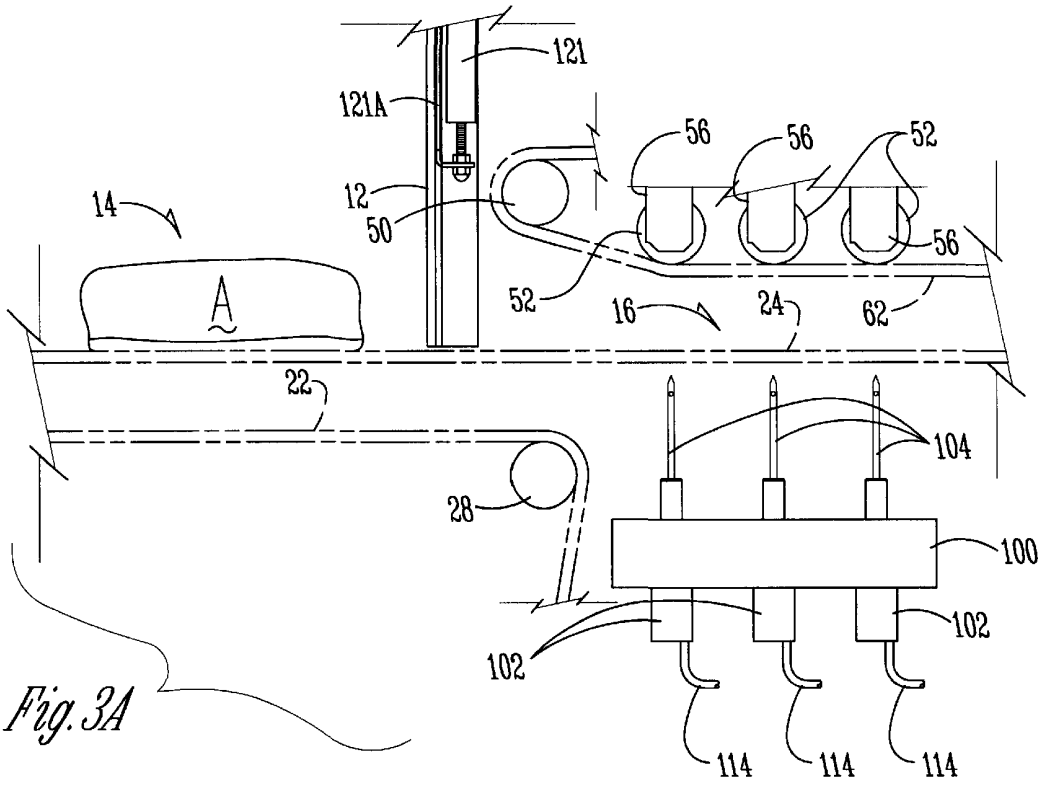
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Fig. 3A

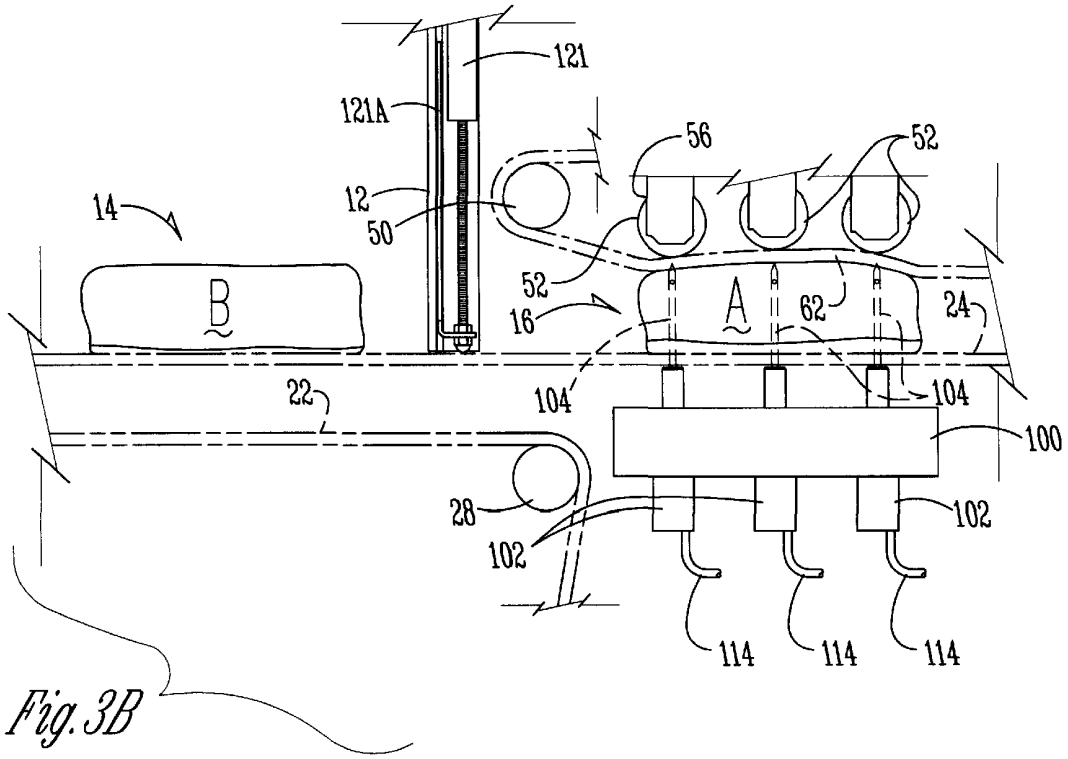
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Fig. 3B

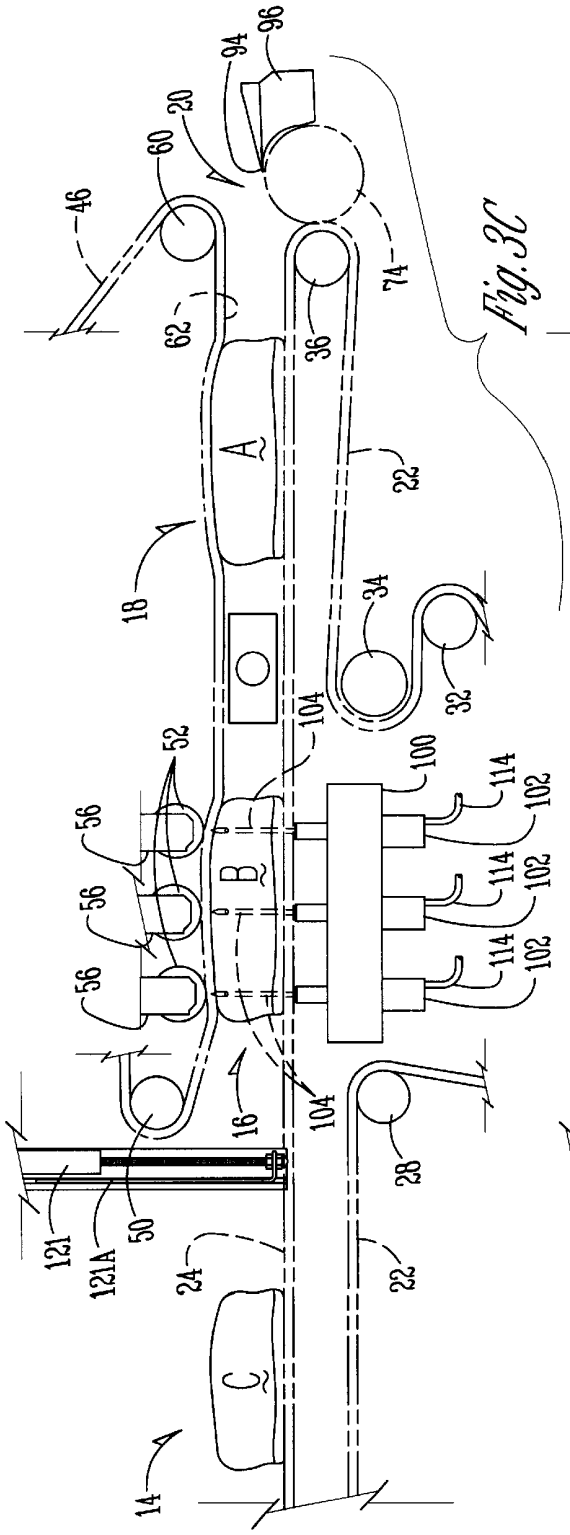
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Fig. 3C

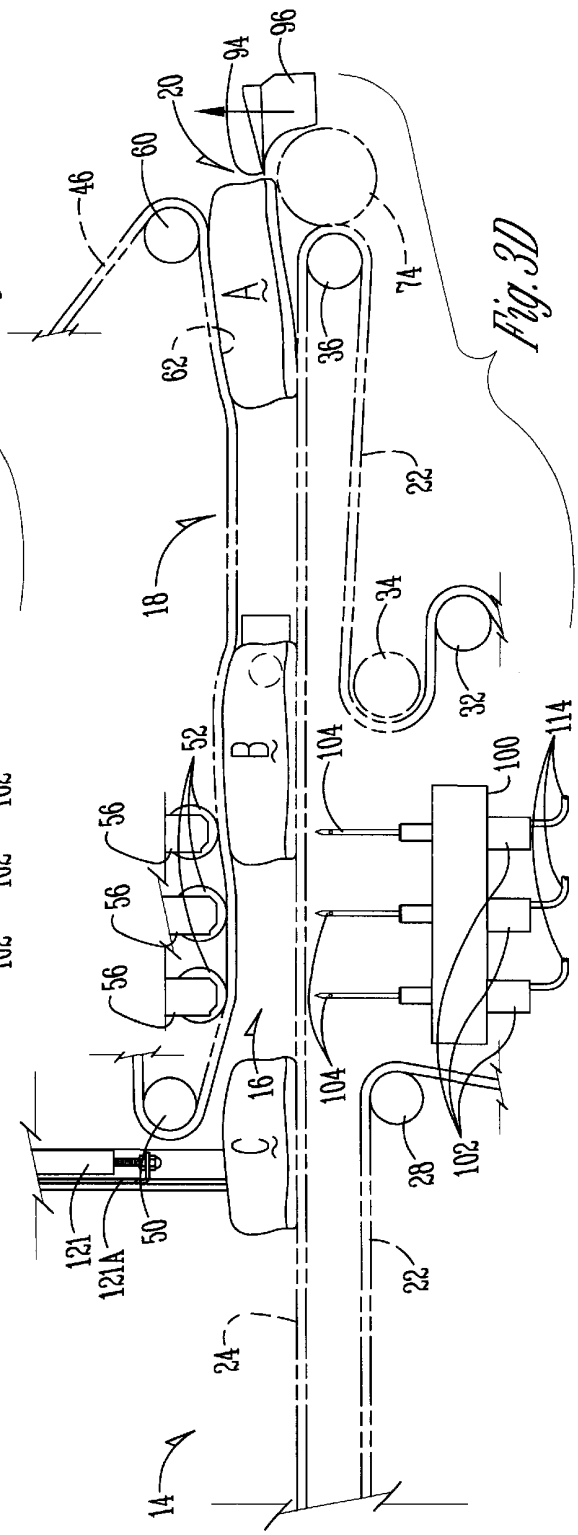
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Fig. 3D

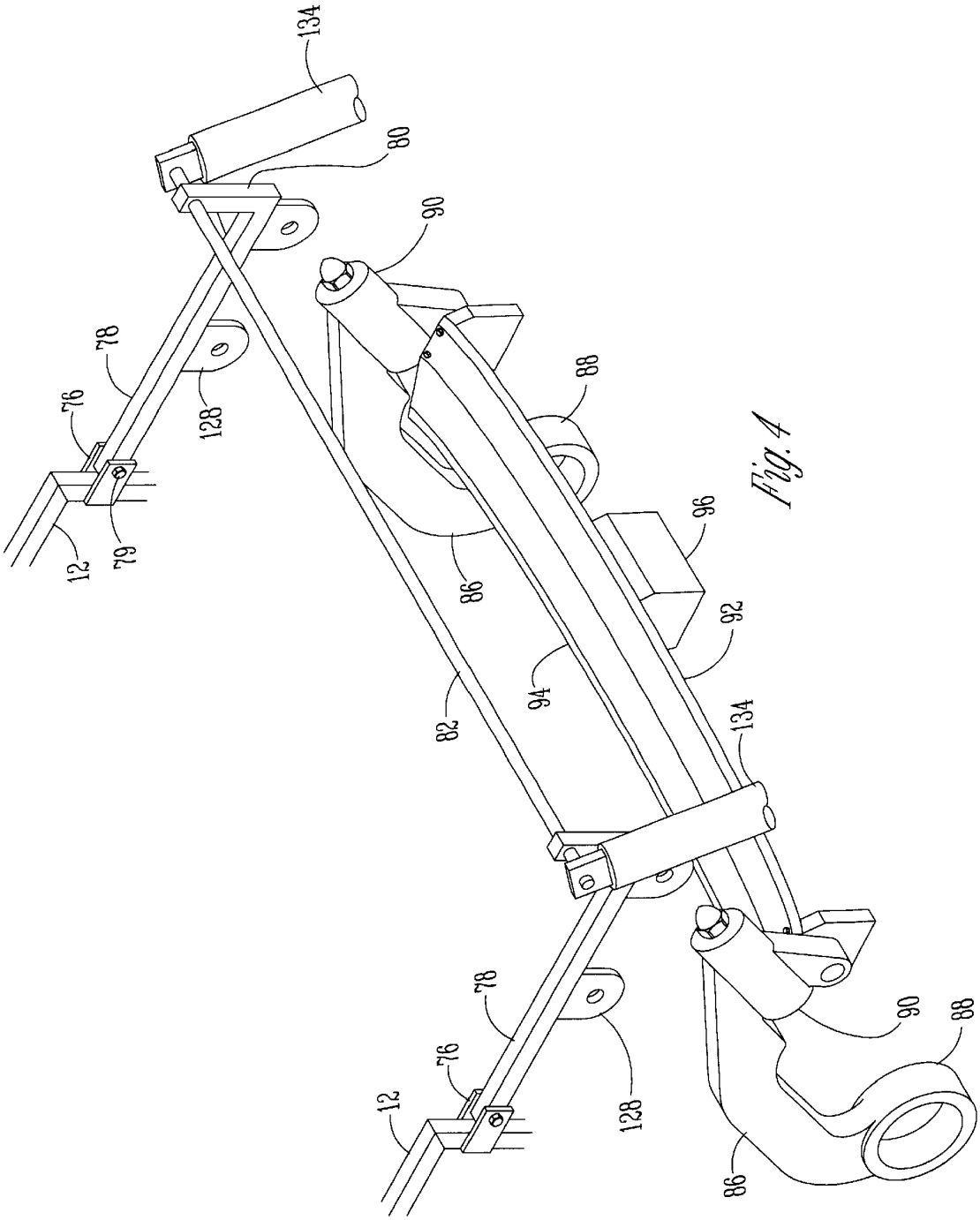


Fig. 4

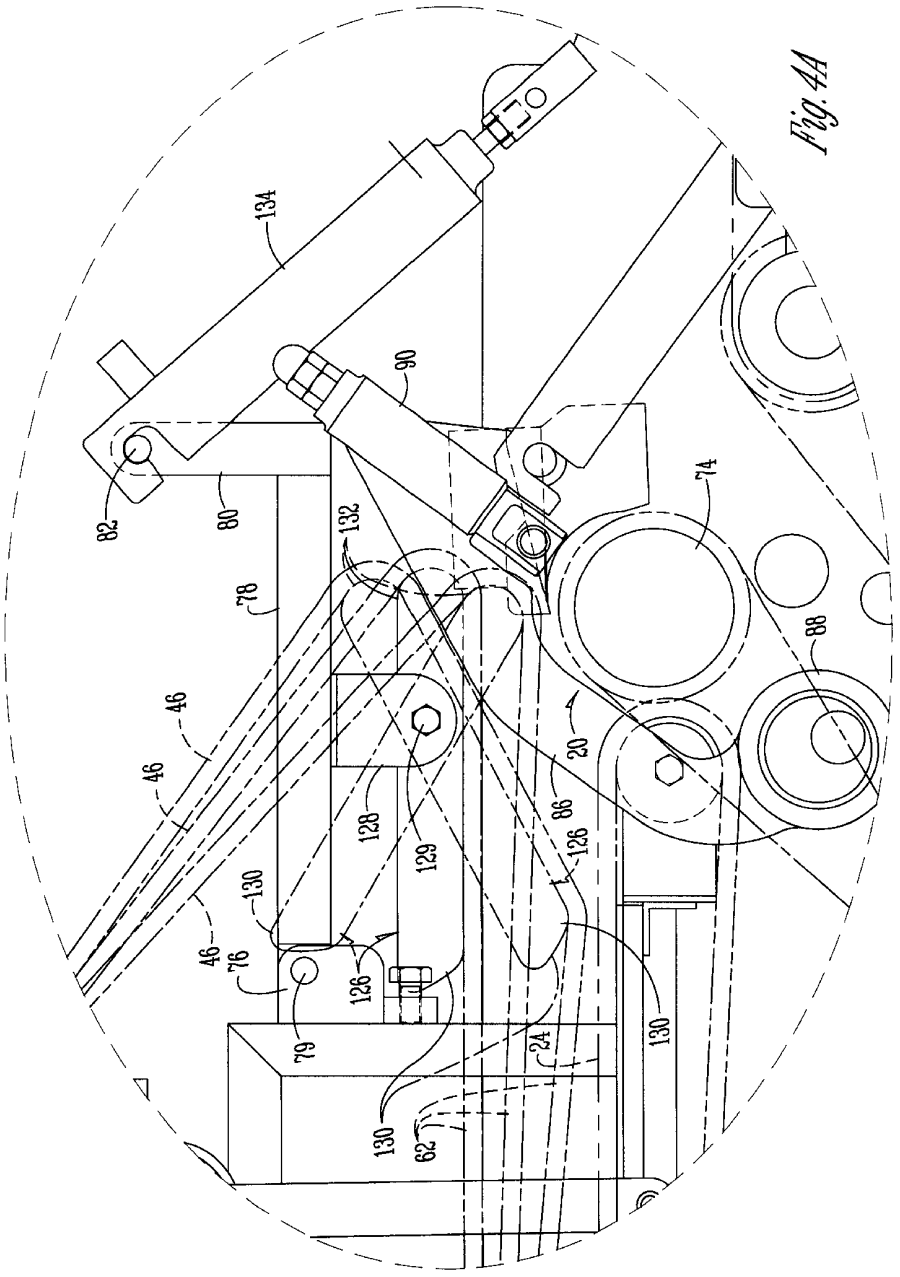
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Fig. 4A

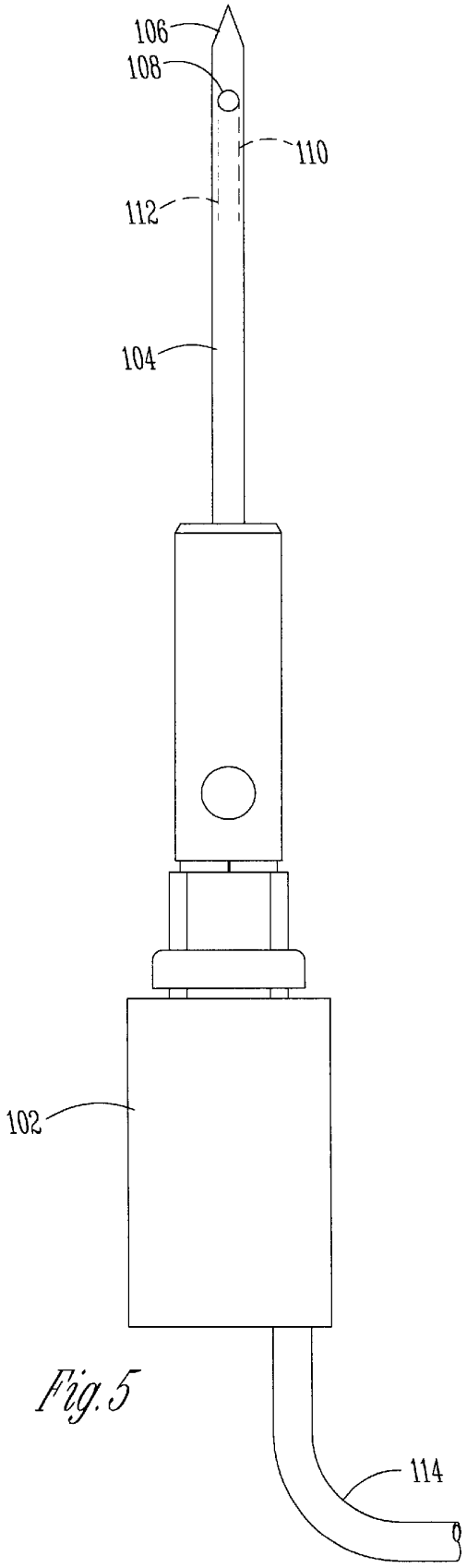


Fig. 5

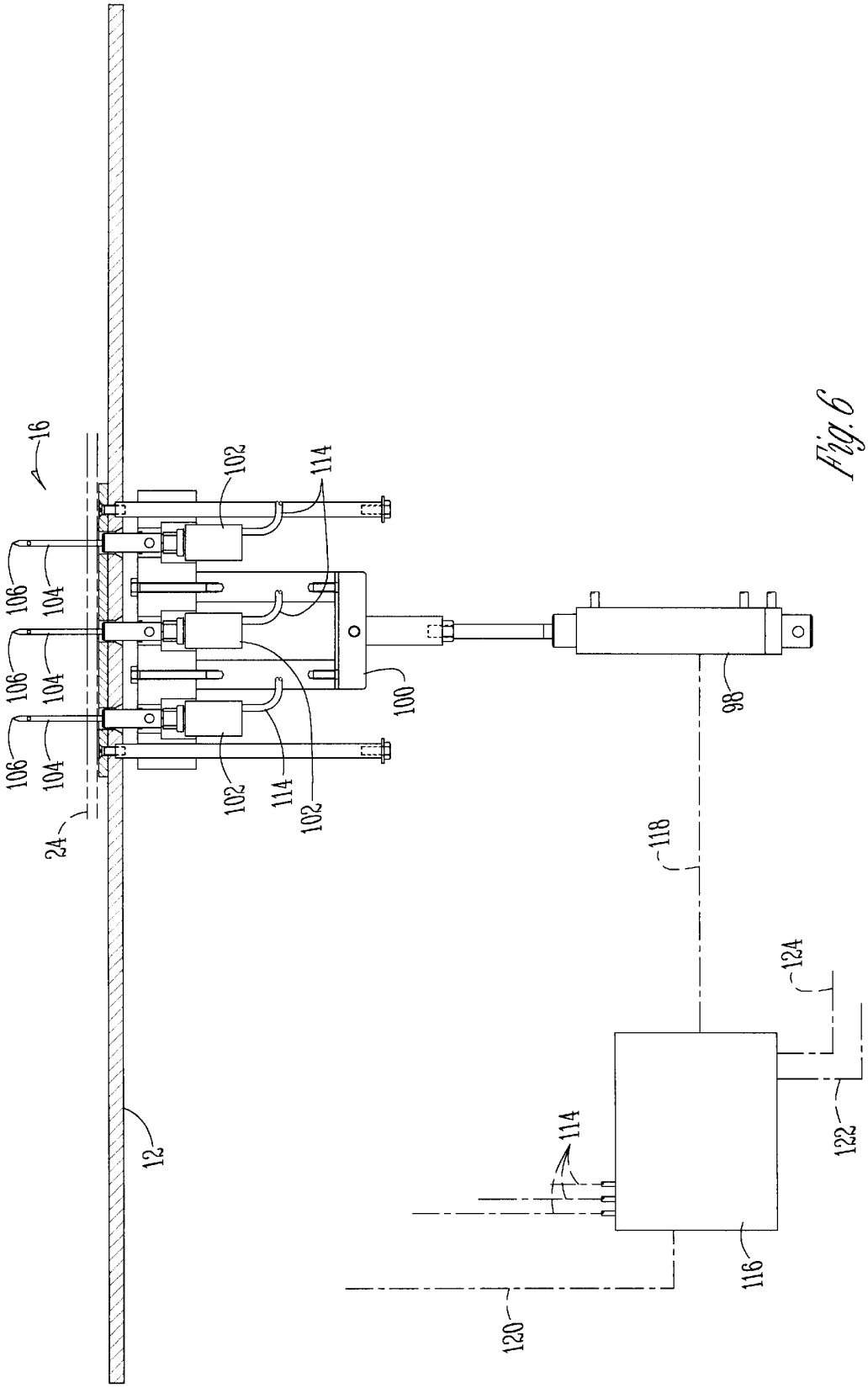


Fig. 6

# METHOD AND APPARATUS FOR REMOVING FAT FROM MEAT CUTS

## BACKGROUND OF THE INVENTION

In the production of processing meat cuts, such as pork butts, existing specifications require that sufficient fat be removed from the butt to expose six to eight square inches of lean meat, while leaving ⅛th to ¼th of an inch fat cover on the remaining curved surface of the meat cut.

Existing machines and methods for achieving the above specification involve safety hazards and inaccurate cutting which results in waste of meat product. Further, more than one trimming operation is normally required to achieve the needed specification. Existing processes are labor intensive.

Until now, the process of removing an optimal amount of fat from meat cuts such as pork butts has required a person who makes repeated cuts until the desired amount of lean meat is exposed. Often this results in waste, as it is impossible to tell without cutting into it at what depth the lean starts and the fat stops.

Previous attempts at automating this process have met with failure because of the variation in fat cover on the meat cuts. The fat cover on meat cuts typically has a layer of lean running through it, which starts about halfway between the neck and the back which is called the false lean. The fat cover is normally thinnest at the neck edge and fattest at the back edge. It is customary when preparing such meat for sale to remove a wedge-shaped piece of fat in order to expose the "false lean". Typically in the industry, enough fat should be removed to expose at least six square inches of lean meat.

It is therefore a principal object of this invention to provide an apparatus for removing a portion of fat from meat cuts which is safe, accurate, and efficient both from a standpoint of time and labor involved.

It is a further object of the invention to provide for the photometric determination of the layers of fat and lean within individual pieces of meat for the purpose of guiding the automated removal of optimal amounts of unwanted material by means of an optical device located within a specially constructed probe.

These and other objects will be apparent to those skilled in the art.

## SUMMARY OF THE INVENTION

A method for removing a portion of fat from meat cuts involves placing the meat on a longitudinal conveyor, pressing sensor probes into the meat to measure the thickness of fat and the location of lean therein, and then withdrawing the sensor probes therefrom. An electronic signal is transmitted from the sensor probes to a controller and encoder to determine the depth from the outer lower surface of the meat through a layer of fat therein to a layer of lean. Data taken from the foregoing step determine the desired position of the cutting blade. A predetermined amount of fat is thereupon cut from the meat by the blade. The method is used to determine in meat the layer thicknesses by recording at uniform intervals during the penetration into the meat the reflectance values. The reflectance values are mapped against the distance traveled by the probe will show segment thickness.

An apparatus for removing a portion of fat from meat cuts includes a frame and at least one sensor probe including fiber optics to permit scanning of the interior of a meat cut penetrated by the probe. Power for moving the probe into the meat is mounted on the frame along with a skinning blade mounted in a path of movement of a meat cut on the frame.



A controller on the frame takes data from the sensor probe and determines the linear depth of fat material on the meat cut and lean material in the meat cut. The controller then determines the operating position of the blade and positions the blade to effect the removal of the desired amount of fat.

More specifically, a meat piece is conveyed on a conveyor belt towards the cutting device. The frame supports the probes beneath the conveyor of the meat. As soon as the meat rides over the probe path, the meat pauses, an air cylinder activates and the probes penetrate the meat. The optic fibers for reception and transmission of the signals are threaded through the probes. The probes have a probe window at the distal end. An LED sends light through a first set of fibers in the probes. The receiving signals picked up by the receiving optical fibers send a message to the controller which analyzes the signals. The probes take measurements while they are engaged with the meat piece both on the up and the down stroke. They are immediately withdrawn and the meat piece travels further into engagement with the skinning mechanism. The signal analysis generates a message, which is used by the blade control device to raise or lower the blade from the pulling surface of the skinning mechanism, resulting in the removal of a piece composed primarily of fat.

The difference in reflective potential between the fat and lean muscle is distinct enough that a simple probe containing optical fibers can easily distinguish between them. This information is relayed to a controller which controls the contours of a blade which is in a skinning machine well-known in the industry.

The controller makes a determination based on the registration of a large number of values of reflection from a single wavelength at intervals of depth in the piece of meat. In addition, all values are used and inserted in to a suitable equation or equation system, which is a multi-variable algorithm for the calculation of layer thicknesses.

The multivariable algorithm includes a preset offset distance which accounts for the distance between the cutting blade and toothroll in the minimum cutting position, and a variable offset which can be modified by the operator to customize the product appearance according to this customer specifications.

In addition, the algorithm includes other variables to vary the desired cutting depth at different times during the cut. For example, the cutting depth may be decreased during the first one-third of the meat to increase the resulting fat depth on the finished product. During the second one-third of the meat the cutting depth may be at the calculated depth. During the last one-third of the meat, the cutting depth may be increased to remove more fat in that area.

The meat may be placed at different lateral locations on this conveyor belt to allow a portion of the meat to be cut by the curved section of the blade rather than this flat section. This varies the depth of fat removed from the outside edges of the meat, and allows meat cuts from both the left and right sides of the hog, for example, to be defatted in one machine.

The cutting device includes a toothroll, shoe and curved blade holder. The blade holder is fastened to a short section of shoe. The blade holder provides the desired curved cut, while the shoe/toothroll provides the means to pull the meat through the blade. The blade height adjusting mechanism is actuated electromechanically. The gripper roll and exit conveyor drive rotate continuously. The conveyor system must move the meat through the stations, and present it to the cutting device. It indexes, so the meat is stationary when being probed. The conveyor belt is modular to ensure

positive indexing. The stations are marked by blue segments on the belt. The stations are a set distance apart. During indexing, the belt accelerates for a set distance, moves at a constant speed a set distance (the approximate length of the meat cut), then decelerates a set distance. The maximum, constant speed of the conveyor matches the speed of the toothroll while the meat is moving through the cutting device. The conveyors must hold the meat securely during probing, and maintain its position through the cutting device so that the depth cut is consistent with the depth measured by the probe. A pivoting, flat top plate positioned just ahead of the blade alternately presses the front end and the back end of the meat into the shoe/toothroll/blade to ensure that the meat gets a good start and finish. An alternate pivoting, curved top plate is used to press the outside edges of the meat into the toothroll for better cutting performance.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view and partial sectional view of the apparatus of this invention;

FIG. **2** is an enlarged scale layout of the power train of the apparatus of FIG. **1**;

FIGS. **3**A–**3**D are schematic elevational views showing the sequential steps of the method of this invention as practiced on the apparatus of this invention;

FIG. **4** is an enlarged scale perspective view of the cutting station of the device in FIG. **1**;

FIG. **4**A is an enlarged scale side elevational view of the cutting station as shown in FIGS. **1** and **2**;

FIG. **5** is an elevational view at an enlarged scale showing one of the probe sensors; and

FIG. **6** is an enlarged scale side elevational view of the apparatus at the sensor station of this invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The machine **10** has a frame **12**, (FIG. **1**), with a loading station **14**, a probing station **16**, a waiting station **18**, and a skinning station **20** (FIGS. **3**A–**3**D).

With reference to FIG. **2**, a conveyor belt **22** is mounted on frame **12** and has a top horizontal portion **24**. A horizontal transverse roll **26** is mounted adjacent the loading station **14** to support and reverse the direction of conveyor belt **22**. The belt **22** then extends to roll **28** and extends therearound and departs in a downwardly direction towards roll **30**. A conventional piston-belt-type tightener **31** is associated with roll **30** to selectively tighten or change the attitude of belt **22**.

The belt **22** then departs roll **30** and extends upwardly and forwardly to roll **32** which is slightly below and forwardly of roll **34**. The belt extends around roll **32** and thence rearwardly and then again forwardly as it extends around roll **34**. The belt then extends to forward roll **36** and departs roll **36** back in a horizontal direction towards the point beginning at roll **26**. A motor **38** (FIG. **2**) is mounted on frame **12** and is connected by belt **39** to the roll and drive pulley **34** via pulley **40** on the motor.

With reference to the upper portion of FIG. **2**, a chain **42** extends from roll and drive pulley **34** upwardly around a roll and drive pulley **44**. A conveyor belt **46** extends around roll **44** and departs therefrom in a forwardly and downwardly direction to extend around roll **48**. The belt **46** then extends rearwardly to extend around roll **50**, and departs roll **50** in a forwardly horizontal direction. Belt **46** engages a plurality of rolls **52** which are mounted on the lower end of piston assemblies **54** which are mounted on downwardly extending brackets **56**. Air piston **58** is parallel to the vertical air pistons **54** and is operatively connected to roll **50**. Pistons **54** and **58** serve to raise and lower the belt **46** with respect to the horizontal portion **24** of belt **22** which extends thereunder. Belt **46** then extends forwardly from rolls **52** to extend around plate **126**, whereupon the belt then extends rearwardly and upwardly to its point of beginning at roll **44**. A conventional piston-belt tightener **61** (FIG. **2**) is associated with roll **48** to facilitate the adjustment of the tension on conveyor belt **46**. Roll **48** serves also as a pivot point for the upward and downward movement of the belt **46** by the pistons **54** and **58**. The lower horizontal train of belt **46** as seen in FIG. **2** is identified by the numeral **62**.

A motor **64** is mounted on frame **12**, (FIG. **2**), and has an output drive pulley **66**. A belt **68** extends from pulley **66** and extends forwardly and upwardly to extend around pulley **70**. The belt **68** then extends rearwardly and downwardly around pulley **72**, and thence upwardly and forwardly around a drive pulley (not shown) on gripper roll **74** which is a part of the skinning station **20** as will be discussed hereafter.

Brackets **76** (FIG. **4**) are spaced apart and are secured to frame **12** and are pivotally secured to arm **78** by the rearward ends of the arms through the function of conventional connecting pins **79**. A vertical arm segment **80** extends upwardly from the forward end of the arm **78** (FIGS. **2** and **4**). A transverse rod **82** extends between the upper ends of arm segments **80**. Separate springs **134** are secured to the rod **82** and extend forwardly to frame **12** to yieldingly prevent the upward pivotal movement of arms **78** on pins **79**.

A pair of blade arms **86** (FIG. **4**) are attached at their lower ends to sleeve **88** (FIG. **2**) which are mounted on rotatable cams (not shown) which can raise or lower the blade arms. Blade mounts **90** are an integral part of arms **86** and conventionally are connected to the ends of curved blade holder **92** (FIG. **4**). A blade **94** (FIGS. **3**C and **3**D) is secured to the blade holder **92** and is conventionally associated with arcuate-shaped shoe **96** to perform the skinning operation (FIGS. **3**C and **3**D).

As shown in FIG. **2**, a piston assembly **98** is shown in the lower portion of that FIG. and is vertically disposed and is operatively connected to bracket **100**. Three probe sensors **102** are vertically disposed on bracket **100** and extend upwardly therefrom and terminate in elongated probe spikes **104** (FIGS. **5** and **6**). The spikes terminate at their upper ends in points **106**. Each spike has a window opening **108**. As shown in FIG. **5**, two sets of optical fibers **110** and **112** extend through probes **102** and spikes **104** and terminate immediately adjacent the window opening **108**. Optical fibers **110** are connected to a source of light in the sensor **102** to illuminate the area just outside the spike and outside the window opening **108**. Optical fibers **112** have the ability to receive light that is reflected from the lean and fat portions of the meat cut being treated. The light coming from fibers **110** and reflected onto the fibers **112** from the lean and fat surfaces are returned to sensor **102** which sends a signal through lead **114** (FIG. **5**) to a controller **116** (FIG. **2**) including a computer. With reference to FIGS. **2** and **6**, a lead **118** connects controller **116** with the piston assembly **98**. Lead **120** extends from controller **116** to a slidable door **121**/A and linear actuator **121** (FIGS. **2** and **3**C) located just forwardly of loading station **14**. Lead **120** also connects controller **116** to pistons **54** and **58**. Lead **122** connects controller **116** with motor **38** (FIG. **2**). Lead **124** connects controller **116** with motor **64**.

With reference to FIG. **4**A, a top feed plate **126** of rectangular and generally flat construction is rotatably sup-

ported by ears **128** on arm **78** (FIG. **4**). An encoder (not shown) measures the position of the probes and transmits this measurement to the controller. Pins **129** effect the pivotal connection between plate **126** and the ears **128**. Feedplate **126** has a leading end **130** and a trailing end **132**. A spring cylinder **134** has an upper end that hooks on rod **82** and a lower end secured to the frame **12** and serves to hold feedplate **126** down on the meat cut.

The feedplate **126** is normally in the horizontal position shown by the solid lines in FIG. **4**A. The lead end **130** pivots upwardly as the meat product endeavors to pass thereunder on conveyor **24**. This causes the trailing end **132** to move to a level lower than the pin **129** whereupon it exerts force on the meat product as that product moves into contact with the gripping roll **74** and the blade **94**. The continued longitudinal movement of the meat towards the blade then causes the meat product to push upwardly on the depressed trailing end **32** which causes the plate **126** to move to the position shown in FIG. **4**A where the end **130** is depressed or lowered. The engagement of the product by the lower end portion **130** of the plate member serves to exert additional longitudinal boost to the meat product as it is moving upwardly and over the blade **94** and gripping roll **74** at the skinning station **20**.

In operation, a meat cut A (FIG. **3**A) is placed on the conveyor belt **22** at the loading station **14**. The controller **116** has the ability to index the movement of conveyor **22**, and the conveyor is motionless at this point in time. The door **121** is in an open position. The bracket **100** is in its lower position shown in FIG. **3**D so that the probe spikes **104** are withdrawn and the points **106** of the spikes **104** are at a level below the lower horizontal portion **24** of belt **22**.

The controller **116** thereupon actuates motor **38** to cause conveyor belt **22** to advance in a clockwise direction as seen in FIG. **2** whereupon the meat cut A is moved to the probing station **16** (FIG. **3**B). The controller then closes door **121**A, and actuates the piston assembly **98** which causes the bracket and sensors **102** to rise whereupon the probe spikes **104** penetrate the meat cut A as shown in FIG. **3**B. The pistons **54** and **58** are also actuated by the controller **116** to press down on the meat cut A as shown in FIG. **3**B while the probe spikes **104** are penetrating the meat A. At the same time, meat cut B can be placed on the loading station **14**.

The probe spikes move quickly upwardly and thence downwardly out of the meat product. The sensor **102** works in the manner described and permits the optical fibers **112** to receive the reflected light from optical fibers **110** through the window opening **108**, with the reflected light being of varying intensity depending on whether the light is reflected from fat or lean meat. A signal from the reflected light through fiber optics **112** is transmitted through line **114** to controller **116** and the encoder (not shown) so that the relative thickness of the fat and lean meat is determined by the controller. Obviously, the conveyor **22** is motionless during the time when the penetration of meat cut A is penetrated by the probe spikes **104** at the probing station depicted in FIG. **3**B.

The probe spikes **104** move quickly into and out of the meat cut and assume the position generally shown in FIG. **3**A at a point below the conveyor belt **22**. The controller **116** then opens the door **121**, and advances the conveyor belt **22** to the position shown in FIG. **3**C where the meat cut A is moved to the waiting station **18**, and the meat cut B is moved from the waiting station **14** to the probing station **16**. A new meat cut C can be placed at the loading station **14** during this same period of time. FIG. **3**D shows how the controller **116** further indexes the conveyor belt **22** after the above described description of the components in FIG. **3**C. This causes the meat cut A to move to the cutting station **20**; the door **121** opens to receive the meat cut C; and the meat cut B moves towards the waiting station **18**. It should be noted that the controller also causes the lower horizontal portion **62** of belt **46** to engage the top of meat product A as it moves into the cutting station (FIG. **3**D). At the same time, the feedplate **126** engages the meat cut A and performs its boosting function of pushing the meat A through the skinning station as described heretofore.

Critical to the foregoing process is that the controller **116** receives a signal generated from fiber optics **112** to cause the blade **94** to cut the meat cut A passing through the skinning station **20** at a sufficient depth that the fat will be removed at a depth to expose at least six square inches of lean meat. The blade **94** will be at the appropriate depth by virtue of the measurements of sensor **102** transmitted to controller **116** and the encoder (not shown) to cause the blade **94** to be at a depth calculated by the controller. The controller carries out a calculation and transmits a signal to cause a cam shaft (not shown) to rotate within sleeves **88** causing blade arms **86** to adjust the height of blade holder **92** and blade **94** to a depth with respect to gripper roll **74** to cause the blade to be positioned at the correct height.

It is therefore seen that this invention will achieve at least all of its stated objectives.

What is claimed is:

**1**. A method for removing a portion of fat from meat cuts, comprising,

placing a meat cut on a longitudinal conveyor, pressing sensor probes into the meat cut to measure the thickness of fat and the location of lean in the meat cut, and then withdrawing the sensor probes from the meat,

taking an electronic signal from the sensor probes and determining the depth from an outer lower surface of the meat cut through a layer of fat in the meat cut to a layer of lean in the meat cut,

taking data from the preceding step and adjusting the height of a blade to a predetermined height with respect to the meat cut to remove a portion of fat from the meat cut to expose a given area of lean, and

cutting the portion of fat from the meat cut,

the data is acquired by first optic fibers carrying light internally to the probes being pressed into the meat cut to emit light on an internal part of the meat cut into which the probe is being pressed, and second fiber optics in the probe to receive light from the first fiber optics that are reflected from the meat cut.

**2**. The method of claim **1** wherein the meat cut is placed on a loading station of a longitudinal conveyor, longitudinally moving the meat cut with the conveyor to a probing station; stopping the longitudinal movement of the meat cut, and pressing the sensor probes into the meat cut at the probing station.

**3**. The method of claim **2** wherein the meat cut is pressed against the conveyor at the probing station and the probes are pressed into the meat cut from below.

**4**. The method of claim **1** wherein the meat cut is detained at a waiting station while the blade is being adjusted.

**5**. The method of claim **1** wherein the meat cut is compressed while the portion of fat is being cut from the meat cut.

**6**. An apparatus for removing a portion of fat from meat cuts, comprising,

a frame,

at least one sensor probe having an elongated probe spike and including fiber optics to permit scanning of the interior of a meat cut penetrated by the probe spike,

a probing station on the frame,

means for moving the probe spike of the sensor probe into and out of a meat cut at the probing station,

an elongated skinning blade mounted on the frame,

a control on the frame operationally connected to the sensor probe for receiving data from the sensor probe to determine the linear depth of fat exterior material on the meat cut, and

means on the control for evaluating the data to determine the operating position of the blade to effect the removal from the meat cut of a predetermined amount of fat, and for moving the blade to that operating position.

**7**. The apparatus of claim **6** wherein a continuous conveyor is on the frame for intermittently moving a meat cut from the probing station to a position for being cut by the blade.

**8**. The apparatus of claim **6** wherein the control is operatively connected to the conveyor for moving the meat cut.

**9**. The apparatus of claim **8** wherein a meat cut on the conveyor can first be moved from a loading station to the probing station, and thence to a waiting station; and thence to a cutting station, with the blade being positioned at the cutting station.

**10**. The apparatus of claim **6** wherein hold down elements are adjustably mounted on the frame above the probe station and a cutting station, with the blade being positioned at the cutting station, the control being operationally secured to the hold down elements to cause them to be intermittently engageable with a meat cut at the probe and cutting stations.

**11**. The apparatus of claim **9** wherein the control indexes the movement of the conveyor intermittently to move a meat cut on the conveyor from one station to the next succeeding station.

**12**. The apparatus of claim **9** where a pivotal plate is mounted on the frame adjacent the cutting station to engage a meat cut passing therethrough to provide an additional impetus to the meat cut to move into engagement with the blade and through the cutting station.

**13**. A probe for measuring the depth of fat and lean portions in a meat cut, comprising,

an elongated housing having first and second ends,

a hollow probe spike extending longitudinally outwardly from the first end of the housing and terminating in a sharpened outer end,

a window opening in the spike adjacent its sharpened outer end,

a first set of optic fibers in the housing extending into the spike and having outer ends terminating adjacent the window opening,

the first set of optic fibers having inner ends in communication with a light source to transmit light through the first set of optic fiber to illuminate through the window the fat and lean portions of a meat cut into which the spike penetrates,

a second set of optic fibers in the housing having inner ends connected to a sensor, and outer ends terminating adjacent the window in the spike to receive light reflected from the fat and lean portions transmitted to the portions from the outer ends of the first set of optic fibers, to permit the sensor to signal the computer when the probe encounters lean meat within the meat cut.

**14**. The apparatus of claim **6** wherein the skinning blade is mounted in a curved blade holder attached to a shoe assembly at a skinning station, a blade height adjusting mechanism on the frame operatively connected to a control mechanism, and a gripper roll and shoe assembly on the frame adjacent the skinning blade, the speed of movement of the conveyor and gripper roll being substantially equal, and the conveyor engageable with a meat cut at the skinning station to hold the meat cut in a constant orientation while being moved through the skinning station so that the depth of cut is consistent with the depth measured by the probe.

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