United States Patent

Zwiep et al.

[15] **3,657,771**

[45] **Apr. 25, 1972**

[54] **METHOD FOR REMOVING AN ANIMAL FOOT IN THE VICINITY OF THE TARSUS JOINT**

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[22] Filed: **Feb. 26, 1970**

[21] Appl. No.: **14,503**

[52] **U.S. Cl.** ..... **17/52**, 17/1 R

[51] **Int. Cl.** **A22c 17/06**

[58] **Field of Search** 17/1, 11, 12, 23, 52

[56] **References Cited**

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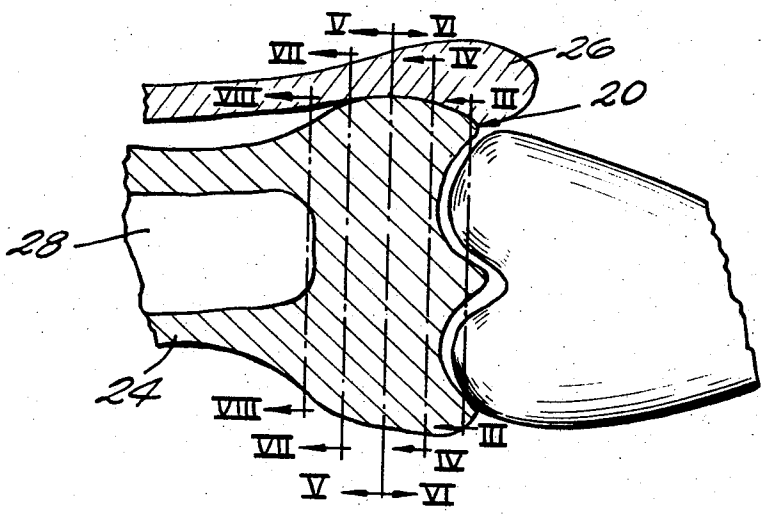
[57] **ABSTRACT**

A method of severing a portion of an animal leg uniformly at a fixed point near a joint such as the tarsus joint with respect to a reference position, the medial axes of the portions to be severed being generally aligned, the method comprising the steps of bending the joint so that the medial axes of the portions form an angle of approximately 90°, and severing the portion at a point spaced a predetermined distance along the medial axis of one of the portions from the intersection of the two medial axes. No matter what size the leg, the cut will occur at the same fixed point utilizing the same predetermined distance. To allow the joint to bend after rigor mortis has set in, a preliminary partial cut is made, which, in case of a foot removal, is of either the hamstring or the tuber calcis bone.

15 Claims, 19 Drawing Figures



Patented April 25, 1972 3,657,771

7 Sheets-Sheet 1

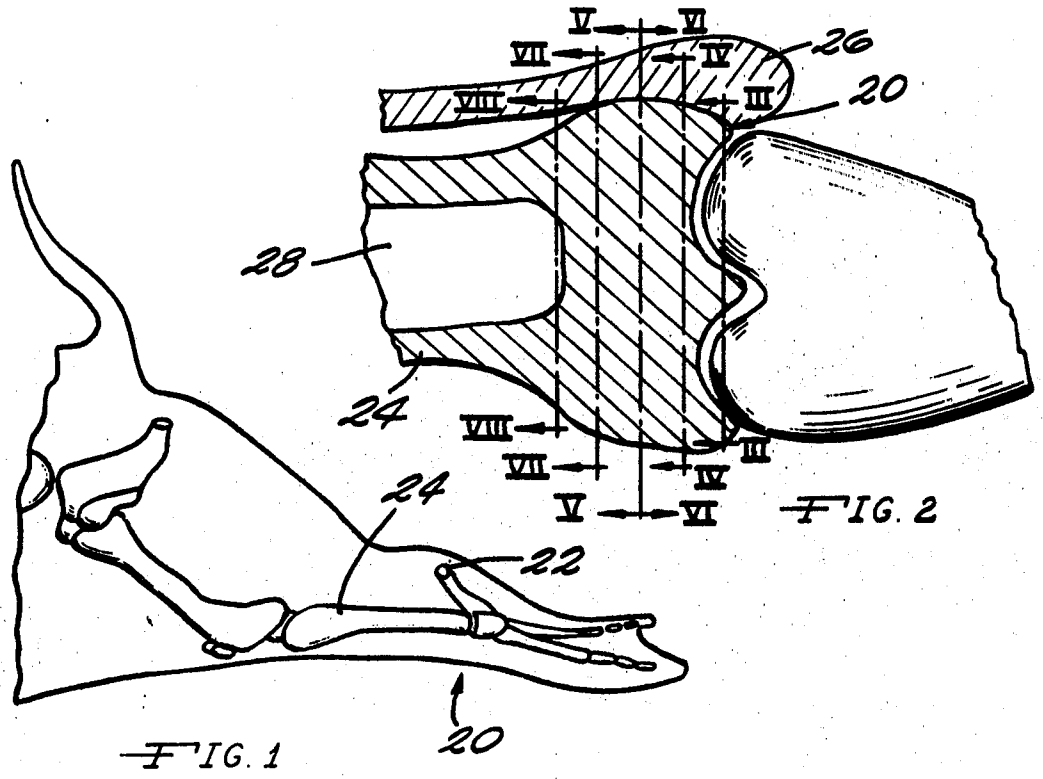


FIG. 1

FIG. 2

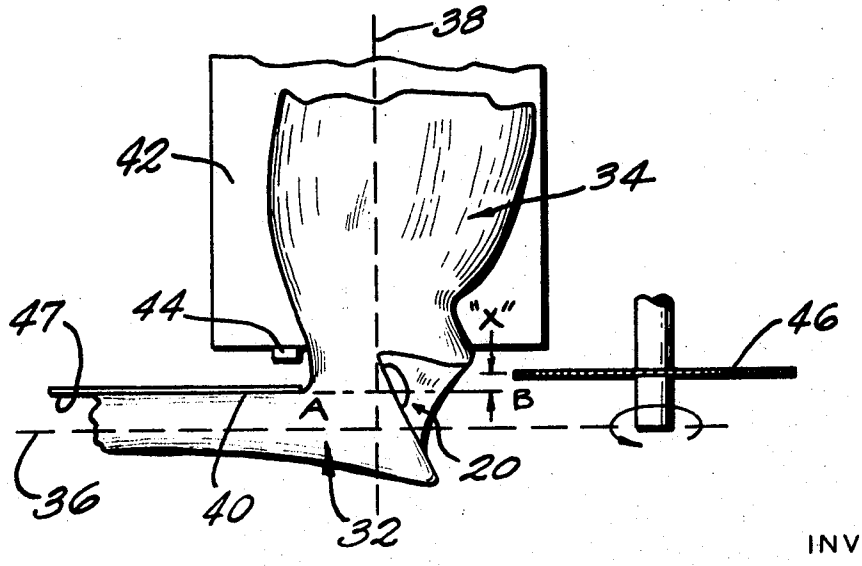


FIG. 13

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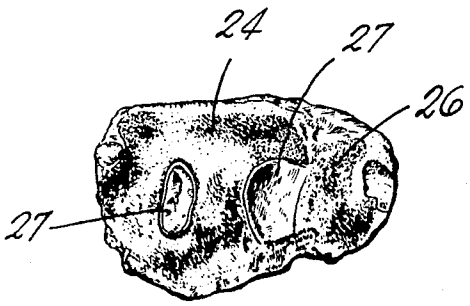

FIG. 3

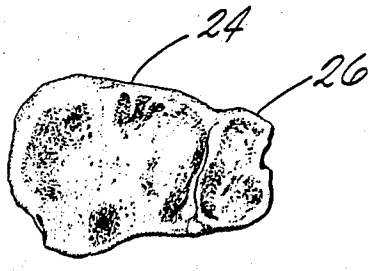

FIG. 4

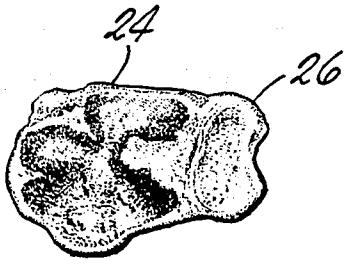

FIG. 5

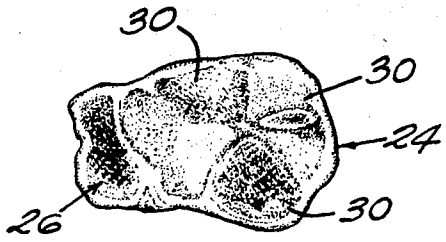

FIG. 6

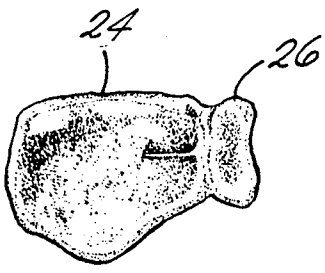

FIG. 7

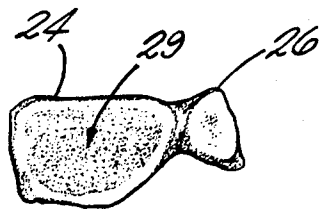

FIG. 8

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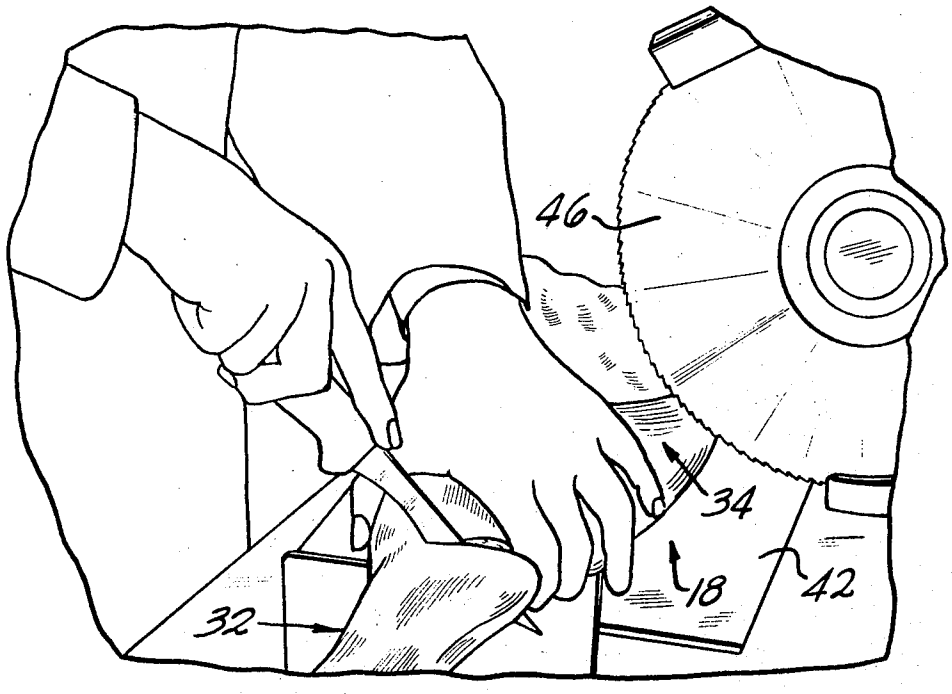

FIG. 9

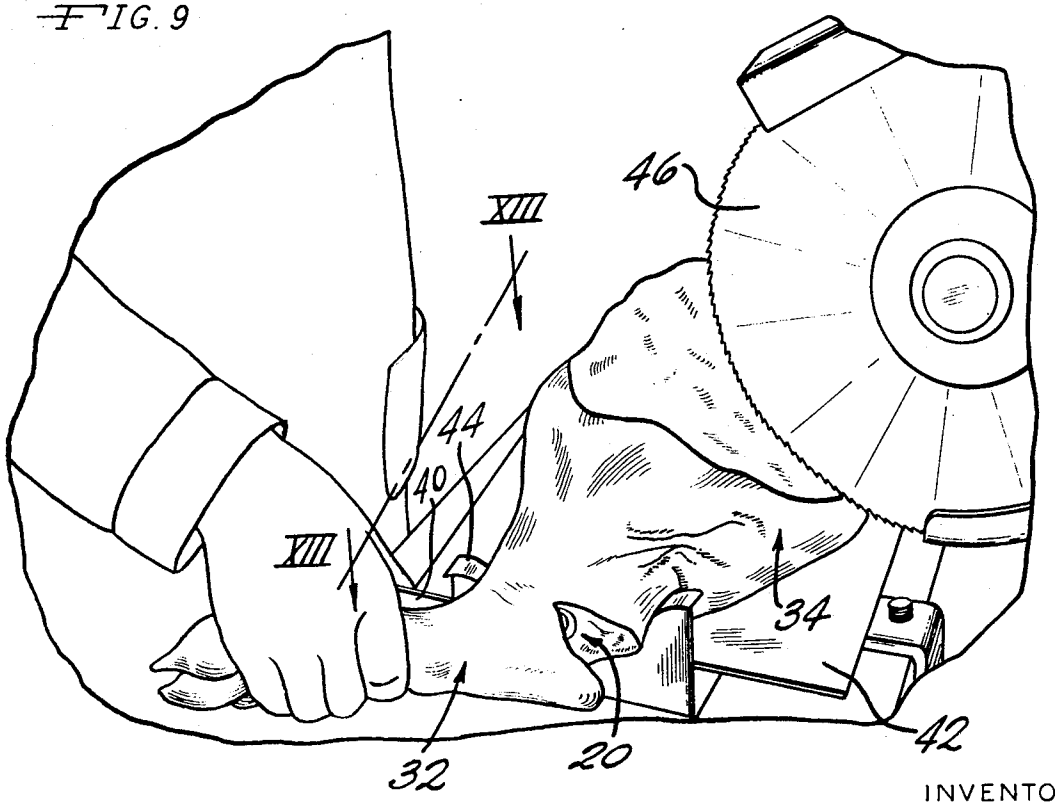

FIG. 10

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FIG. 11

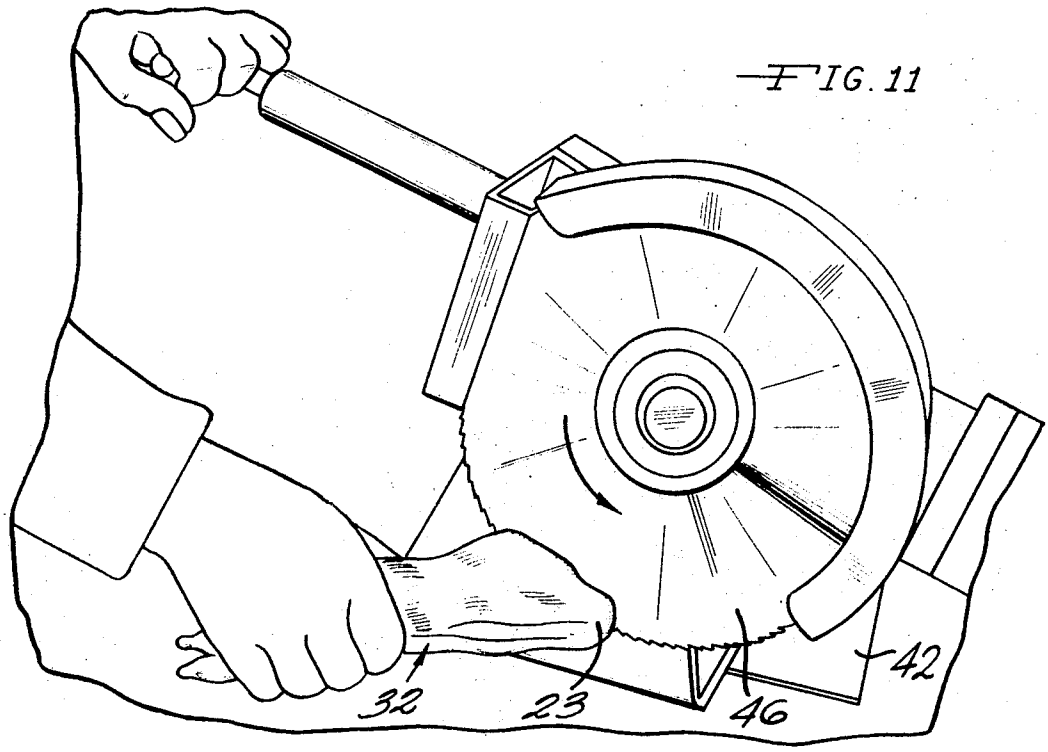
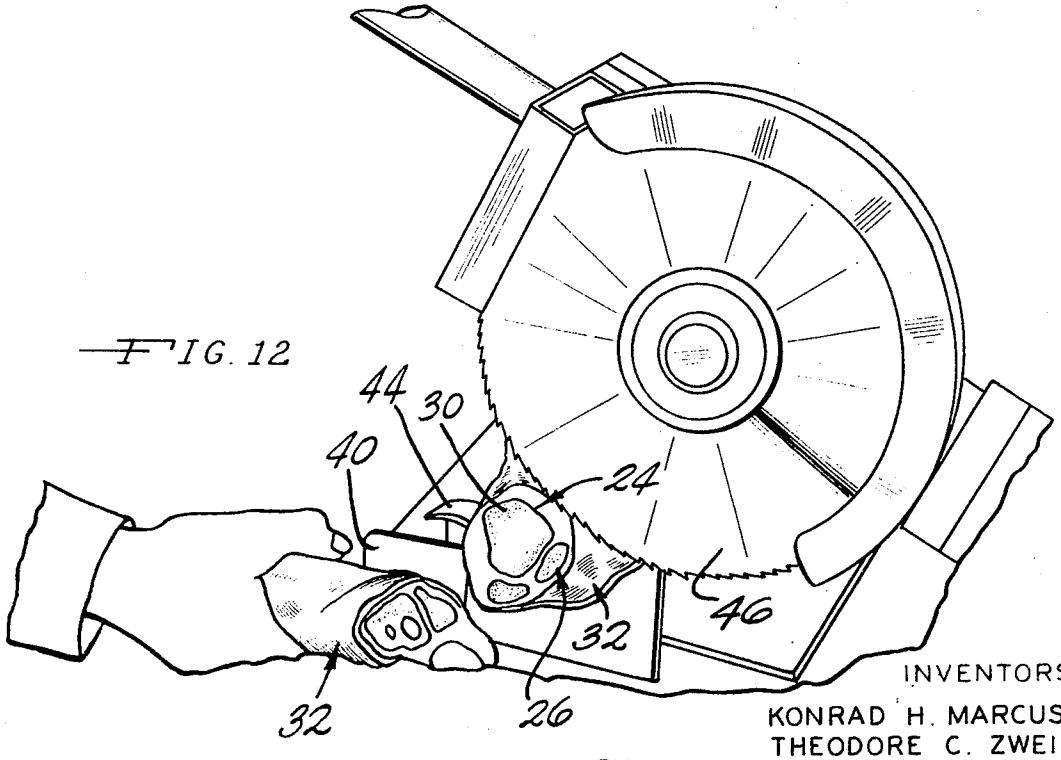


FIG. 12



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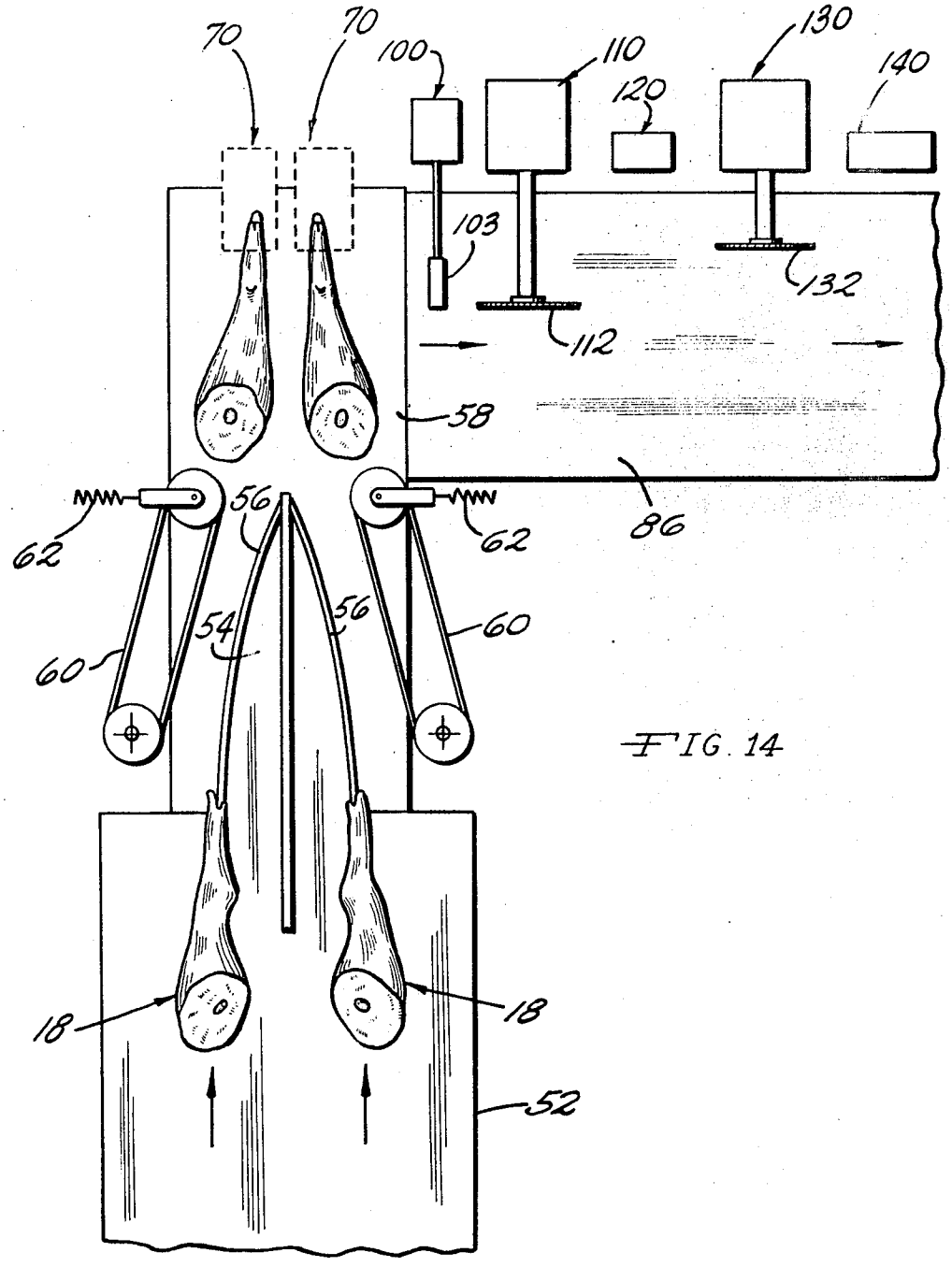

FIG. 14

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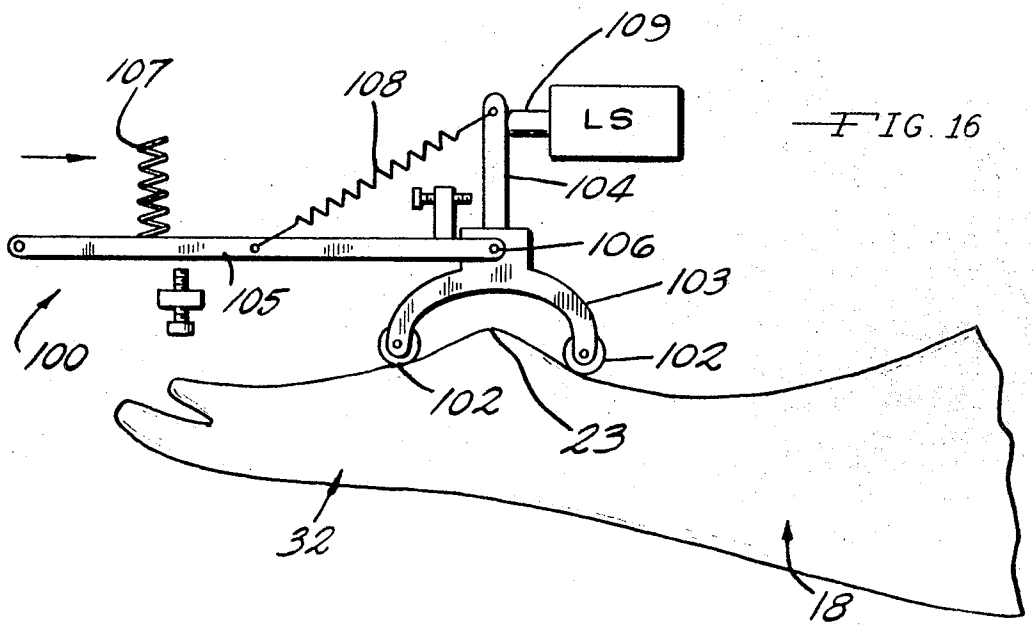

FIG. 16

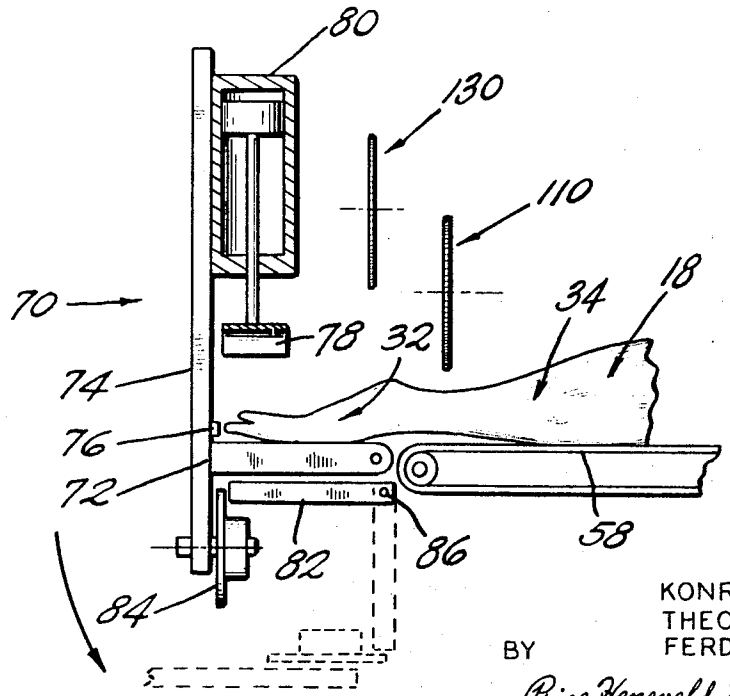

FIG. 15

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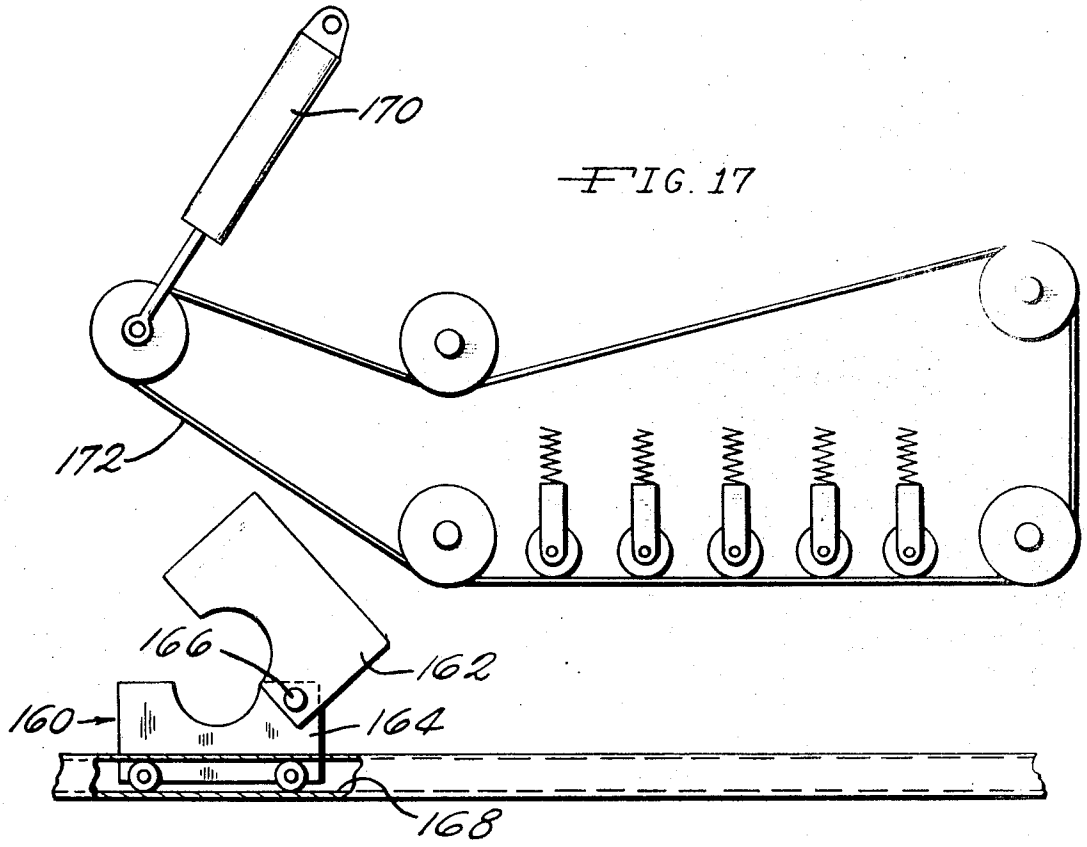

FIG. 17

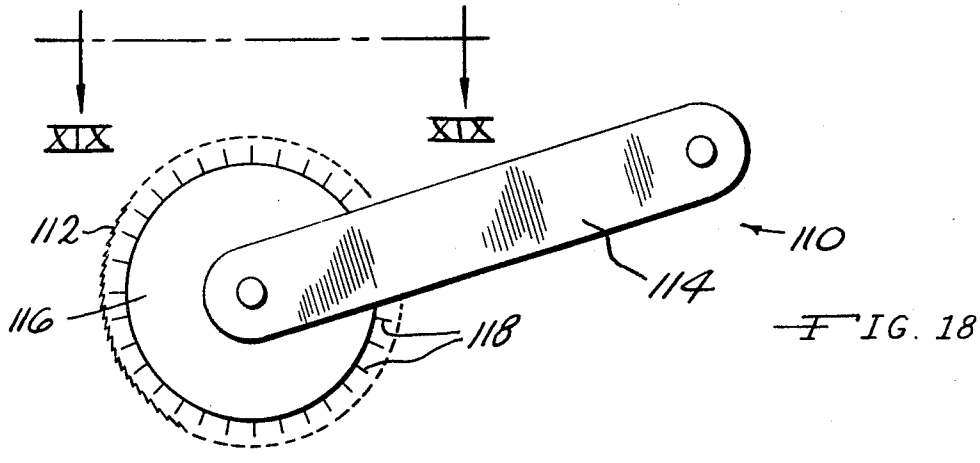

FIG. 18

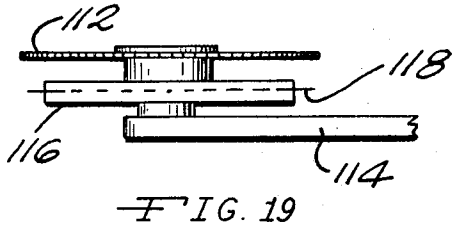

FIG. 19

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METHOD FOR REMOVING AN ANIMAL FOOT IN THE VICINITY OF THE TARSUS JOINT

Apparatus is provided for accomplishing the above method automatically, utilizing either an approximate 90° rotation of the foot clamp from the support for the rest of the leg, or the foot clamp is moved away from said support so as to cause the leg to bend approximately 90° with respect to its original position. The clamp may be either hydraulically actuated or closed by a belt drive. A sensing mechanism for the preliminary hamstring cut can be utilized to determine the presence of the heel of the foot, the mechanism comprising a pair of rollers spring biased out of a plane paralleling the leg support, which rollers ride up over the heel of the foot so as to actuate a limit switch.

BACKGROUND OF THE INVENTION

In cutting off portions of the leg of an animal, such as in a meat packing factory or a butcher shop, there is always the problem of locating the proper position for the cut. The problem is particularly acute in the case of pigs, wherein the foot must be removed from the leg to provide hams. There has long been desired a standard location for the cut, which is in the vicinity of the tarsus joint, inasmuch as the tendency of the seller is to cut too far down on the foot so as to include more bone in the leg of ham, the bone adding to the weight which determines the price the seller obtains. The buyer of course does not want that much bone inasmuch as it adds to the weight but does not contribute to the meat of the ham, as in the tarsus joint vicinity little useable meat is available. But the problem is not solely the tendency of the seller to cut the bone too long. The problem is also the complete uncertainty as to exactly where the cut is made inasmuch as there is no standard reference but merely an educated guess on the part of the cutter. This uncertainty will readily be appreciated when it is kept in mind that the cutter normally faces a wide variety of sizes and weights of hams for which the foot must be removed, ranging anywhere between 10 pounds to 65 pounds. Because of this uncertainty and the fact that to the present day no standard method has been found to cut the foot off a ham, no assurance can be given that the buyer is purchasing a ham with the optimum amount of bone. This is despite the fact that the U.S. Department of Agriculture has been looking for a standard method.

A further problem resides in the fact that apparatus for deboning hams generally require a sufficient amount of tibia bone near the tarsus joint so as to be gripped properly by the apparatus. Legs which are cut too short do not provide such a grasping portion, and furthermore by cutting into the marrow portion of the bone rather than at the solid end portion of the tibia bone, the ham tends to sour or spoil. Also, bone structure is weakened in such short cuts so as to prevent proper functioning in the deboning apparatus.

Finally, the complete lack of a standard has required heretofore that the removal of the foot, or the severing of other portions of the leg, be done by hand inasmuch as automated machine processing requires standard reference positions for the cutting apparatus.

SUMMARY OF THE INVENTION

This invention relates to a method and apparatus which provides the severing of a leg of an animal, such as the ham leg in pork, always at the same location in the bone regardless of the variation in the weight or size of the leg. Specifically, the invention provides a process and the means for accomplishing it of removing a portion of a first animal leg in the vicinity of a joint such as a tarsus joint at a fixed point with regard to a reference, the medial axes of the two portions to be severed being generally aligned prior to the following steps. The method utilizes thereafter the steps of bending the joint so that the medial axes of the portions are positioned at an angle to each other, such as an approximate 90° angle, and severing the portions at a point spaced along the medial axis of one of the portions a predetermined distance from the intersection of the medial axes. It has been found that an effective amount of bending for all legs is conveniently obtained by bending said joint so that the angle between the two parts of the leg forming the joint is approximately 90°, the inside surface of the part to be severed establishing a reference position, parallel to which the cut can be made. The process further includes the steps of taking a second leg of significantly different size and weight than the first leg after the first leg severing step, reorienting the medial axes of the second leg as with the first leg by bending the second leg joint an effective amount; and severing the second leg portion at the same spaced point in the second leg as in the first leg. Where necessary, a preliminary step includes the step of partially cutting into a portion of the leg to free the joint for the bending, so as to overcome the effects of rigor mortis.

Accordingly, it is an object of the invention to provide a process and apparatus which will uniformly cut off a portion of an animal leg always at the same location in the vicinity of a joint regardless of the variance in size and weights of legs provided for severance.

It is a further object of the invention to provide a process and apparatus of the above character wherein the severance is of a foot of a pig, the severance occurring at the cloverleaf cross section in the tibia bone.

It is a related object of the invention to provide a process and apparatus of the above character which will eliminate the need for a human operator providing the cutting or severing.

It is still another object to provide an apparatus and process of the above character which will allow commodity markets to establish a standard cut for such things as hams, thereby providing uniformity and certainty so that buyers are given the optimum buy.

Other objects and advantages will become apparent upon reference to the following drawings and detailed discussion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially sectioned, elevational view of a slaughtered pig illustrating the bones of a leg prior to the severing of the foot in accordance with the invention;

FIG. 2 is a fragmentary side elevational view, partially schematic and partially in section, illustrating the general position of the bones in the leg at one stage in the process;

FIG. 3 is a sectional view taken approximately along lines III—III of FIG. 2 and illustrating a cut of the bones only which is considered to be too long on the leg, to the detriment of the buyer;

FIG. 4 is a sectional view taken along lines IV—IV of FIG. 2 and illustrating a cut which is acceptable;

FIGS. 5 and 6 are sectional views taken along lines V—V and VI—VI of FIG. 2, respectively, representing the position known as a cloverleaf cross section;

FIG. 7 is a sectional view taken along lines VII—VII of FIG. 2 and illustrating another acceptable cutting position;

FIG. 8 is a sectional view taken along lines VIII—VIII of FIG. 2 and illustrating an unacceptable short position;

FIGS. 9 through 12 are perspective views illustrating steps in one embodiment of the process of the invention;

FIGS. 13 is a fragmentary, partially schematic plan view taken approximately along the lines XIII—XIII of FIG. 10;

FIG. 14 is a schematic plan view illustrating one embodiment of the apparatus for practicing the invention;

FIG. 15 is a fragmentary elevational view, partially schematic, illustrating the clamping mechanism utilized in FIG. 14;

FIG. 16 is a partially schematic fragmentary elevational view illustrating the sensing mechanism utilized in FIG. 14;

FIG. 17 is a schematic illustration of still another embodiment of the apparatus which can be utilized to practice the invention;

FIG. 18 is an elevational view of the tendon or hamstring cutter which may be utilized in the invention; and

FIG. 19 is a plan view of the cutter illustrated in FIG. 18 and taken generally along the lines IXX—IXX.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention provides a method and apparatus for obtaining a reference position for severing a portion of a leg in the vicinity of a joint, the same reference position being utilized regardless of the size of the leg. The invention is particularly useful in the severance of the foot of a pig from the leg of ham.

FIGS. 1 through 8 illustrate the general nature of the problem in cutting off the foot of a ham. FIGS. 1 and 2 show a portion of a ham on each side of the tarsus joint 20, the tarsus joint being the joint between the foot and the tibia and fibula bones. Thus, FIGS. 1 and 2 illustrate the tibia bone 24, the tarsus joint 20, the fibula bone 26, and the tuber calcis bone 22 forming the heel 23. FIGS. 3 through 8 show various cuts through the tarsus along the planes as shown in FIG. 2. For example, FIG. 3 illustrates a cut which is too long on the leg, the cut being through a portion of the joint 20 itself, and which is unacceptable inasmuch as in this region the fibula bone 26 and tibia bone 24 are fused. This region is readily identified by the presence of the condyles 27. The cut shown in FIG. 8 is also unacceptable inasmuch as it is too short, there being only a reduced cross section of the bone available for grasping by the deboning machine, and also there being insufficient bone structure due to the presence of the wall of the marrow cavity 28 (FIG. 2), which may cause ham souring. The marrow cavity wall alone apart from the bone structure shown in FIGS. 3 through 7 is not capable of sustaining stress, and is thus incapable of functioning properly in the deboning machine. Although the wall of the cavity parallel with section line VIII—VIII is shown in FIG. 2 as a finite surface, it appears that there is no clear demarcation of the beginning and end of that wall. However, it is clear that the portion of the "bone" designated as 29 (FIG. 8) is so porous and weak structurally that air can be readily blown through it.

FIGS. 4 through 7 illustrate acceptable cuts, an approximate eighth of an inch spacing occurring between each one and between each of the other cuts represented by FIGS. 3 through 8. The cut represented by the cross sections shown in FIGS. 5 and 6 is the ideal cut, the cut occurring at the point commonly called the cloverleaf in the tibia bone, the cloverleaf being identifiable from the three-lobes 30 in the tibia bone 24, as shown in FIG. 6. It is not clear what causes the formation of the cloverleaf, it being thought that each of the darker areas represent areas of bone and blood density differing from that of the lighter areas. The blood apparently is denser and the bone less dense in those areas which are darker. In any event, it has been found that by utilizing the method or the apparatus of the invention, 95 percent of the cuts will occur at the cloverleaf cross section.

FIGS. 9 through 13 illustrate the general process of the invention, the illustration depicting again a pig rear leg wherein the foot 32 is to be removed from the ham 34 of the leg. Initially, the medial axis 36 of the foot 32 and the medial axis 38 of the remainder of the leg 34 including the tibia are approximately aligned (FIG. 13), inasmuch as the pig carcass is hung prior to the butchering in such a way that rigor mortis causes the leg to set in this line of position. The presence of rigor mortis also requires a preliminary step so as to allow the bending operation which occurs thereafter. Thus, a partial cut is made as shown in FIG. 9 so as to cut either the hamstring or the tuber calcis bone itself, thereby allowing the tarsus joint 20 (FIG. 10) to rotate with the tuber calcis bone pivoting with the foot 32 out of the way. To establish a reference position on the leg 18 for the cutting step, the tarsus joint 20 is bent a substantial amount preferably to form an angle of approximately 90° between the medial axis 36 and 38 (FIG. 13). The reference position is the top of the foot 32, the top of the foot being defined as the surface opposite to the sole of the animal's foot, hoof, claws, or whatever type of appendage the leg of the animal has. In this case, the foot is what is bent 90° from the axis of the tibia bone, the top of the foot pressing so that it abuts flush against a rest 40 which is mounted in a plane approximately perpendicular to the axis of the tibia bone. The rest 40 is a sheet metal plate made, for example, from "14" gauge metal which is spaced from the table 42 upon which the leg 18 was originally positioned, a secondary rest 44 supporting the inside of the joint 20. The foot 32 is then completely removed from the leg 34 by severance, a rotating saw 46 or any other cutter being brought in to cut in a plane parallel to the plane of the rest 40. Line AB represents an extension of the surface 47 of rest 40, and the cut by the saw is made at a fixed distance "X" from the plane represented by the line AB, which is the plane of the top of the foot 32. It has been found that the distance "X" is preferably approximately three-eighths of an inch so as to obtain the cloverleaf cut discussed above. Surprisingly, it has been discovered that using these dimensions and procedure, it does not matter what the size or weight of the leg 18 is. In sizes ranging from 10 pounds to 45 pounds, the cut almost always comes out at the cloverleaf cross section. One explanation for this might be that establishing the reference position by the bending of the joint approximately 90° takes into account the fact that the anatomy of the leg 18 requires that the cloverleaf will always be in the same point relative to the bend regardless of the varying sizes of the leg.

It will be readily appreciated from FIGS. 12 and 13 that the saw cut, provided in this instance by the circular saw 46, proceeds until the saw is between the two rests 40 and 44.

Although the steps shown in FIGS. 9 through 13 utilize a hand bending of the foot, it will be readily appreciated that a pivoted bar could be utilized to force the foot to bend up against the rest 40.

APPARATUS

FIG. 14 represents apparatus for accomplishing the aforedescribed method in an automatic manner. A pair of ham legs 18 are pushed by means (not shown) axially along a platform 52, the platform having a tongue 54 which is cut away at edges 56 so as to cause the hams to rotate outwardly as they drop onto a conveyor mechanism 58. Driven belts 60 spring biased toward each other by a mechanism 62 urges the hams inwardly towards the center of the belt 58 to the position shown at the top of the conveying means 58, where a clamping device 70 for each ham is positioned at the end of the conveyor 58. The clamping device comprises (FIG. 15) a rest 72 initially positioned in the same plane as the conveyor 58, a back plate 74 rising vertically from the rest 72 having thereon both a sensing switch 76 and a clamp 78. When the foot 32 of the leg 18 strikes the sensing switch 76, the clamp 78 of the clamping means 70 is actuated by a cylinder 80 so as to firmly hold the foot with its top flush with the surface of the rest 72. A drive by a pulls the clamping mechanism 70 along a rail 82 by a means of wheels 84 journalled to the clamping means 70. The entire rail 82 is pivotable about a shaft 86, the pivoting action occurring as described hereinafter.

The clamping means 70 proceeds (FIG. 14) to carry the hams at right angles to the initial direction of travel established by the conveying means 58, the hams now being carried under various stations by the clamping mechanism and by a second conveyor means 86 which supports the remainder portion 34 of the leg 18. These stations are the sensing stations 100, the cutter 110, the bending station 120, the tarsus cutter 130, and the unclamping station 140.

The sensing station is shown in FIG. 16 and utilizes a mechanism for determining the location for the tendon or the hamstring cut. Although the cut can be made any place above the heel 23 of the leg 34, it is necessary for automatic operation to sense a relatively fixed position for each leg. Accordingly, the sensing station 100 comprises means for detecting the termination of the tuber calcis bone which in fact forms the heel 23. Specifically, the detecting means as shown in FIG. 16 includes a pair of rollers 102 rotatably mounted on a frame 103, the frame 103 being pivotally mounted on a lever 105 at a pivot 106. A preloading spring 107 presses against the

top of the lever **105** to bias it downwardly against the incoming leg **18**. A spring **108** is attached at its ends to both the lever **105** and a finger **104** extending from the frame **103** to bias the finger so as to normally position the rollers **102** in a non-horizontal plane which is non-parallel to the orientation of the leg **18**. To sense the change in position of the plane of the rollers **102** into a plane parallel to the orientation of the leg **18**, a limit switch **109** is positioned adjacent to the finger **104**. Thus, when the rollers ride up and over the heel **23**, the finger **104** activates the switch **109**. The entire sensing station **100** is mounted for movement towards and away from the position of the leg **18** held by the clamping means **70**. This mounting, not shown, also supports the cutter station **110**, the entire mounting moving toward the conveyor means **86** until the limit switch **109** is activated by the finger **104**. At this point, a signal is directed to the cutter so as to cut a portion of the leg **18** so as to sever the hamstring or tendon, or as an alternative described above, the tuber calcis bone.

The mechanism shown in FIGS. **18** and **19** can be utilized to limit the depth of cut of the cutter **110**. The cutter is a rotating saw **112** mounted on an arm **114**, the saw being positioned adjacent to a depth gauge wheel **116** having teeth **118** spaced around its periphery. The function of the teeth is to allow the depth gauge wheel and the blade to penetrate only a fixed distance, the distance being sufficient to cut the tendon or the tuber calcis bone, as desired.

The bending station **120** comprises simply a camming mechanism for rotating the clamping means **70** about the pivot **86**, thereby bending the tarsus joint so that the foot **32** is approximately 90° downward from the position it occupied during the orientation stage. In this position, the foot is now ready for severance by cutting station **130**, because the top of the foot as pressed flush against the clamp has established a reference position. The cutting station **130** comprises a saw or cutter **132** (FIG. **14**), such as a circular saw, which is spaced a distance, which may be adjustable, from the surface of the support **72** in its downwardly rotated reference providing position shown in dotted lines in FIG. **15**. For example, the distance could be three-eighths of an inch as in the case of the method described above. The saw completely penetrates through the foot so as to sever it from the leg. Thereafter, the conveyor **86** moves the leg and foot to the unclamping station **140**, where the cylinder **80** is deactivated so as to allow the foot **32** to be discarded.

FIG. **17** illustrates an alternate embodiment for carrying out the invention, the apparatus as shown in FIG. **17** being designed to allow the remainder of the leg **34** rather than the foot **32** to pivot from its original position, thereby establishing the angle of approximately 90° at the tarsus joint. Specifically, in the case of the embodiment of FIG. **17**, the clamp **160** comprises two "*c*" sections **162** and **164** which pivot at **166**, the clamp **160** being mounted on a track **168** with clamps **162** and **164** spring-biased into an open condition. An orienting conveyor similar to conveyor **58** moves the leg, with the top of the foot down, in the direction perpendicular to track **168** until a sensing switch is activated when the foot of the leg is in proper position within the clamp **160**. At that time, a cylinder **170** is activated so as to lower a drive belt **172** in contact with the clamp **162**, thereby closing the clamp means **160** flush onto both the top and bottom of the foot. The belt **172** continues to carry the clamp **160** along the track **168**, the sensing stations **100** and **110** being utilized as in the previous embodiment to cut the hamstring or the tuber calcis so as to allow the tarsus joint to bend even after rigor mortis has set in. As the belt **172** continues to carry the clamp further along beyond the cutter station **110**, the support underneath the leg terminates, so that only the foot **32** is held horizontal as initially oriented, the leg **34** thereby pivoting downwardly under the action of gravity so as to establish the approximate 90° bend. In this case, the severance cut is made by a saw oriented horizontally rather than vertically as in the embodiment shown in FIGS. **14** and **15**. The cut of the saw is thus made at a fixed distance from the top of the foot, the reference position, held in the clamping means **160**.

The belt **172** is an endless belt which is driven by a plurality of rollers as shown in FIG. **17**, the belt carrying the clamp to a final station which is the point at which the belt leaves the vicinity of the track **168**, thereby opening the clamp and allowing the foot which has been severed from the leg to be removed from the clamping means **160**.

As in the case of the method described in connection with FIGS. **9** through **13**, utilizing the aforedescribed apparatus in FIGS. **14** through **19** will insure that the cut occurs almost invariably at the cloverleaf section of the tibia bone regardless of variance in size of the legs **18** which are fed into the apparatus.

It would be readily appreciated that other embodiments of the aforedescribed apparatus can be utilized within the scope of the invention. For example, the reference position on the leg need not be the top of the foot but can rather be the null point of the bending of the foot. That is, a point occurs above the plane of rotation of the foot and specifically above the tarsus joint wherein no or a minimum of rotation occurs when the foot is bent. This point can be determined by a sensing means positioned aligned approximately with the axis of the tarsus joint, two adjacent rotating surfaces causing the foot to bend back and forth with respect to the leg until the null point is located. The tarsus cutter can then be positioned to cut a fixed distance from that null point.

The embodiments of the invention in which an exclusive property of privilege is claimed are defined as follows.

1. The process of severing the foot portion of a mammal leg from an other portion connected thereto by a tarsus joint, each of said leg portions before the following steps are performed thereon having their medial axes generally aligned, the process comprising the steps of: bending said joint and thereby causing said portions to be positioned with their medial axis at an angle to each other; and severing said leg at a point spaced along the medial axis of said other portion a predetermined distance from the intersection of said medial axes.

2. The process as defined in claim **1**, wherein said point of severance is the cloverleaf cross section in the tibia bone.

3. The process as defined in claim **1**, and further including, as a step prior to the bending step the step of partially cutting into a portion of the leg to free said joint for said bending, so as to overcome the effects of rigor mortis.

4. The process as defined in claim **3**, wherein said partial cutting step for freeing said joint includes the step of cutting through the hamstring.

5. The process as defined in claim **3**, wherein said partial cutting step includes the step of detecting the termination of the tuber calcis bone at its end opposite to where it joins the tarsus joint.

6. The process as defined in claim **5**, wherein said partial cutting step occurs above the tuber calcis bone of said leg.

7. The process as defined in claim **1**, wherein said bending step includes the step of bending said joint so that said medial axes are positioned at an angle of approximately 90°.

8. The process as defined in claim **7**, wherein said bending of said joint comprises the step of bending said foot portion approximately 90° about said joint with respect to the position said portion previously occupied.

9. The process as defined in claim **8**, wherein said step of bending said foot portion is continued until the top of said foot portion to be removed abuts flush with a rest positioned approximately 90° with respect to the original orientation of the medial axis of said leg.

10. The process as defined in claim **1**, wherein said predetermined distance is approximately three-eighths of an inch.

11. A method for uniformly removing the feet from various sized legs of a mammal at the approximate vicinity of the cloverleaf cross section of the tibia bone, the method comprising the steps of:

a. orienting each of said legs in a prescribed direction;

b. bending the joint between said foot and the remaining portion of said leg an effective amount so that each is positioned in different planes to establish a reference plane for said foot; and

c. severing each said foot from each remaining portion of said leg after the bending step at a point slightly spaced from the said reference plane.

12. The method as defined in claim 11, wherein said severing step is accomplished by cutting through each said leg at a distance of approximately three-eighths of an inch from said reference plane.

13. The method as defined in claim 12, wherein said cutting occurs through said remaining portion.

14. The method as defined in claim 11, wherein said bending step includes the step of bending the joint between each said foot and said leg so that the planes in which they are positioned are approximately perpendicular to each other.

15. The method as defined in claim 11, wherein said severing step is accomplished by cutting along a plane parallel to said reference plane.

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