

[54] **RAPID SLICING MACHINE**

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2,752,968	7/1956	Toby et al.	146/94
2,126,458	8/1938	Englen	146/94
3,587,688	6/1971	Toby	146/94

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[51] Int. Cl. **A01j 21/00**

[58] Field of Search..... 31/5; 146/94

[57] **ABSTRACT**

A method and apparatus for rapidly slicing a mass of material to obtain slices of controlled weight.

[56] **References Cited**
UNITED STATES PATENTS

3,605,837 9/1971 Lambert et al. 146/94

19 Claims, 20 Drawing Figures

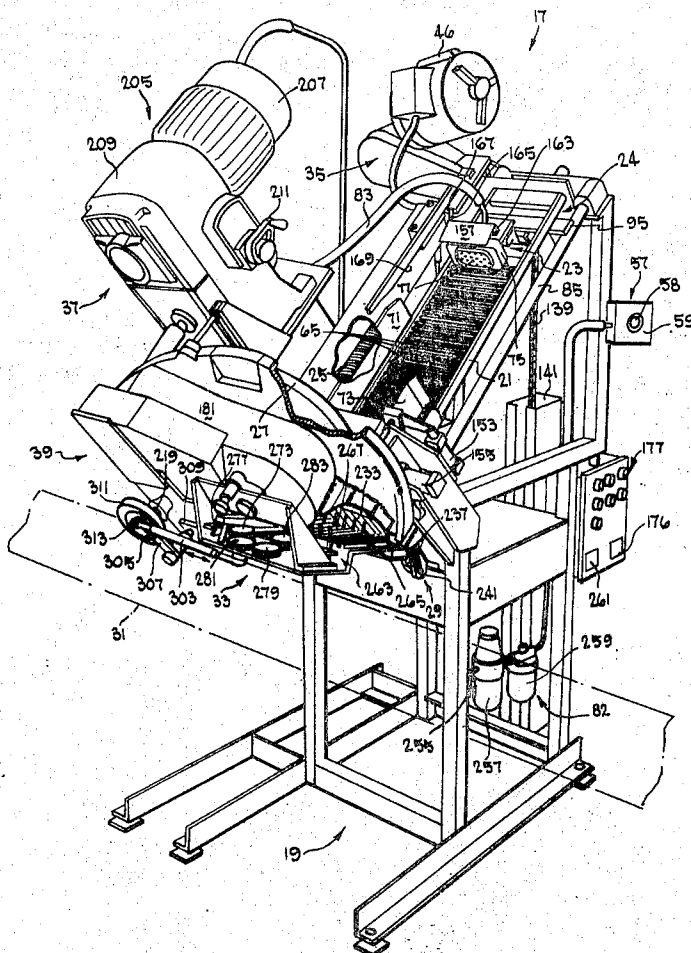
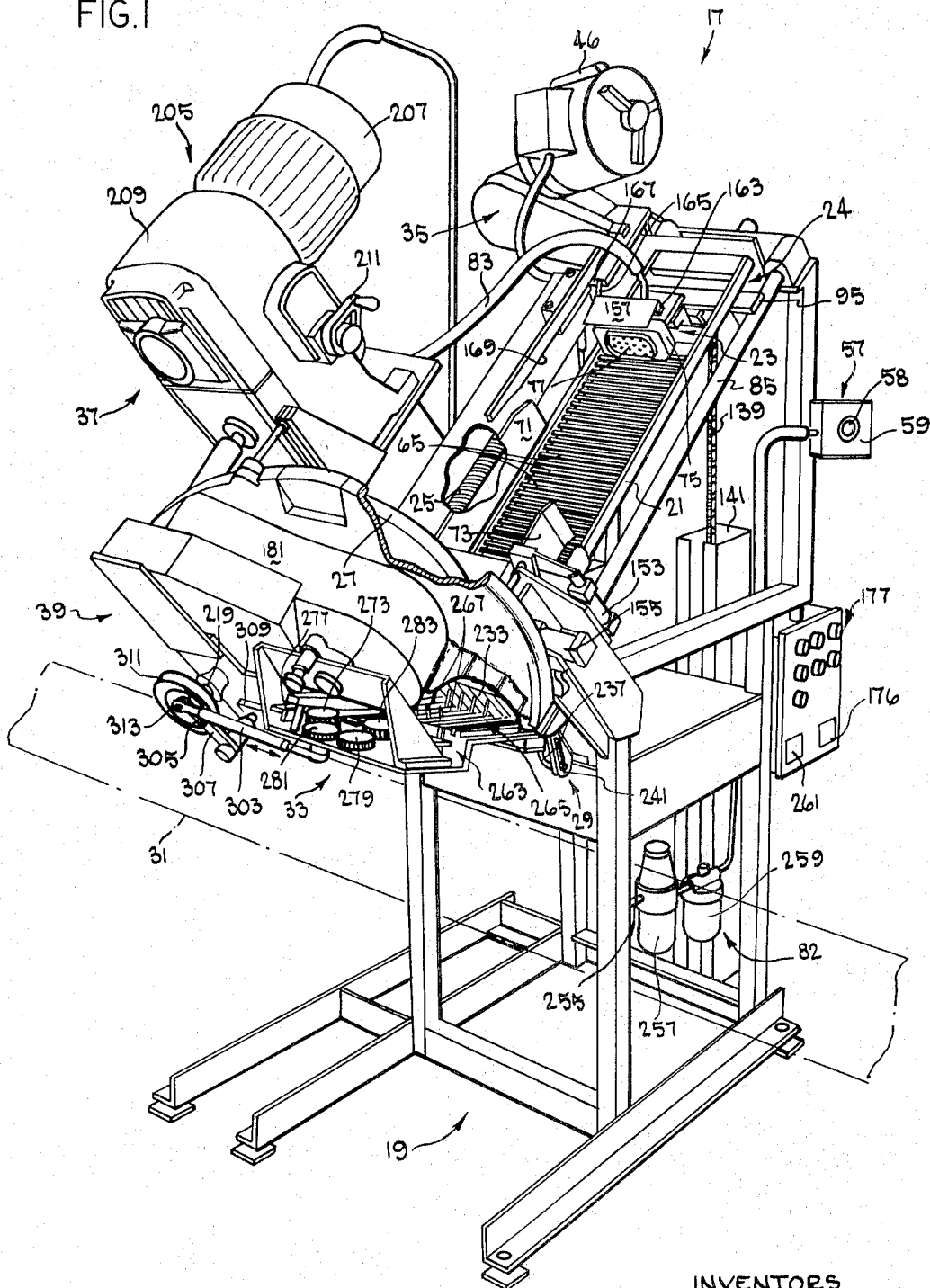


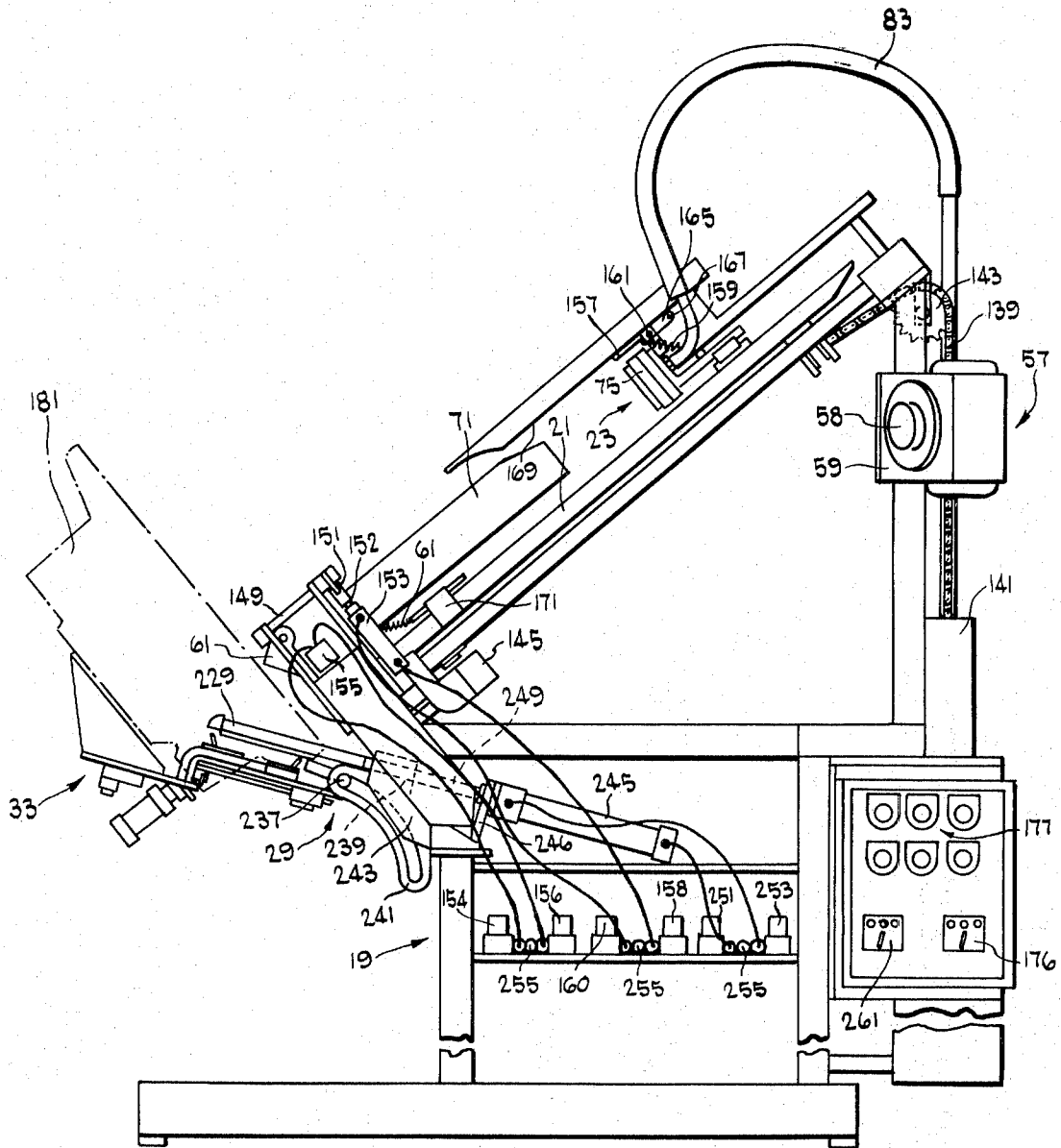
FIG. 1



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FIG. 2



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FIG. 3

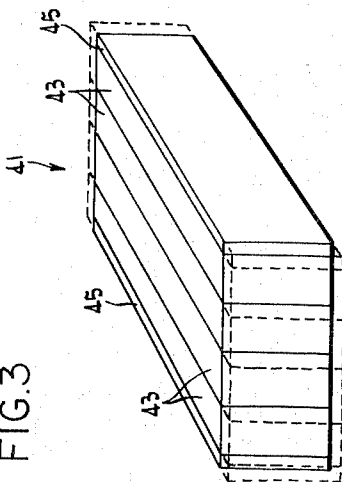


FIG. 7

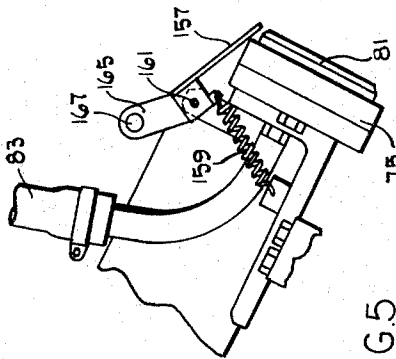


FIG. 4

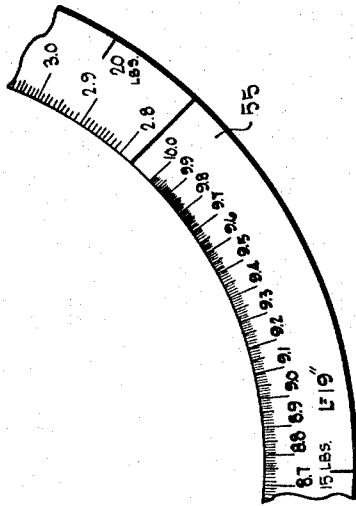


FIG. 5

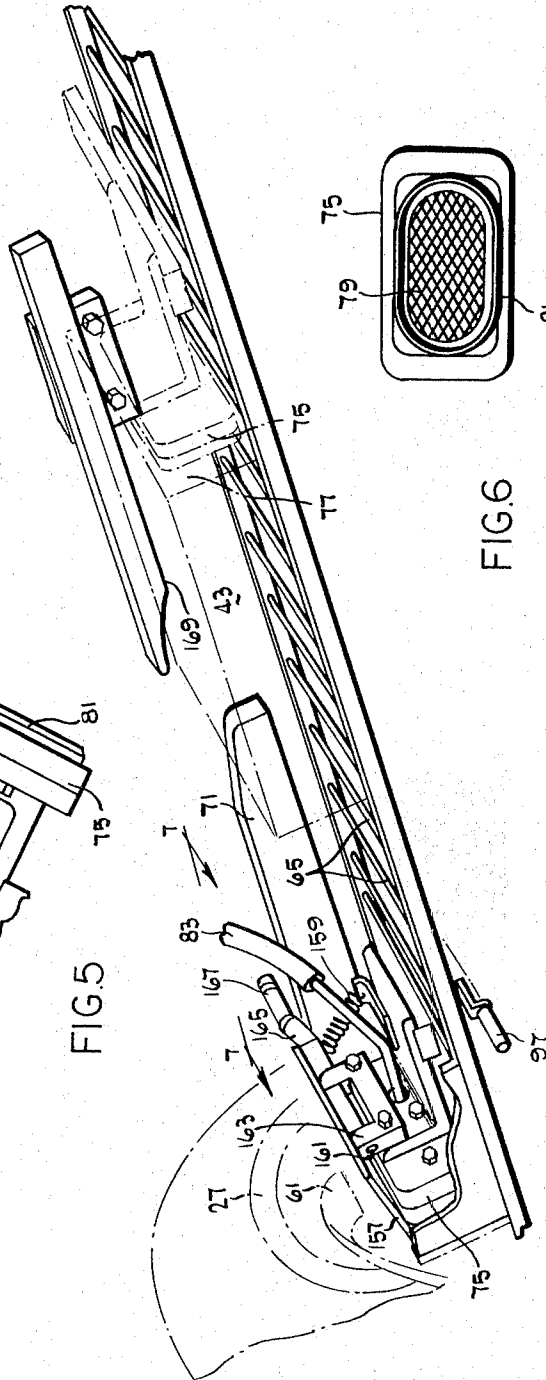
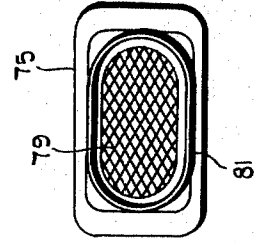


FIG. 6



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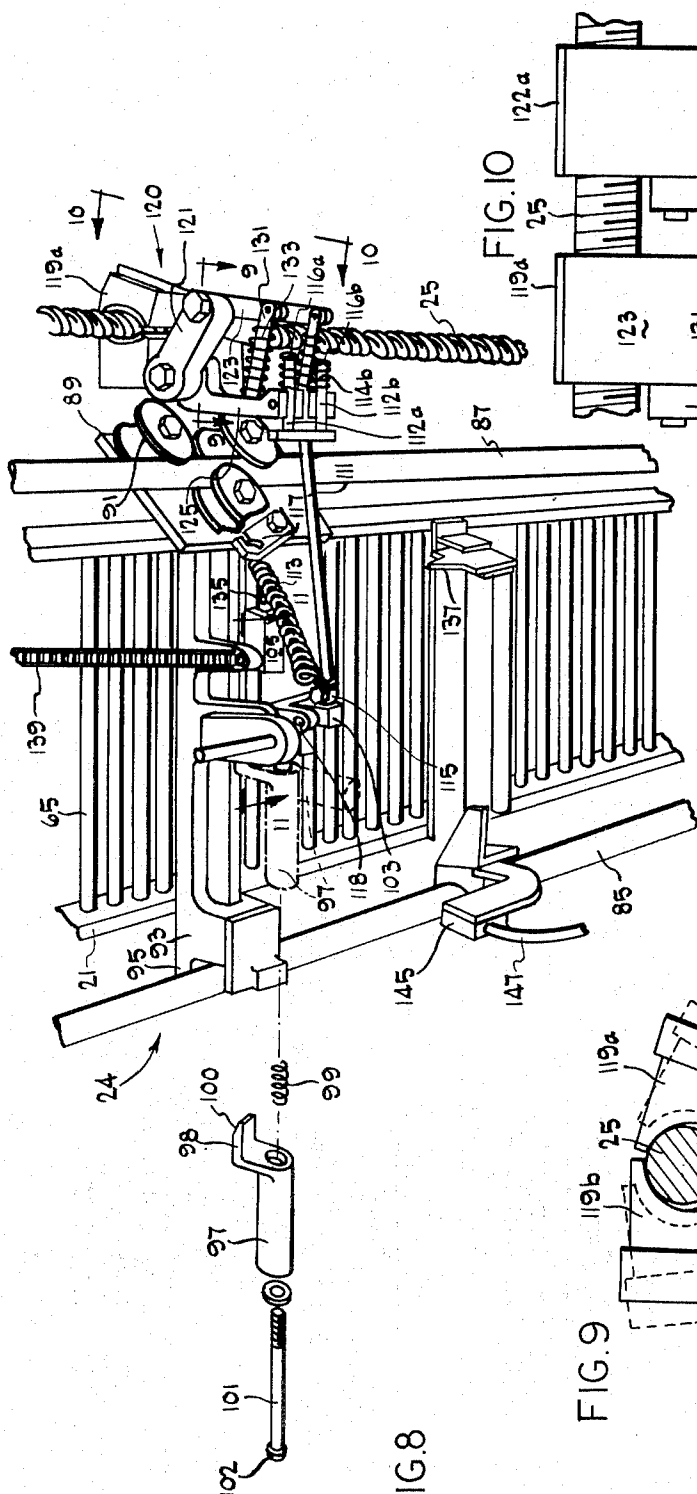


FIG. 8

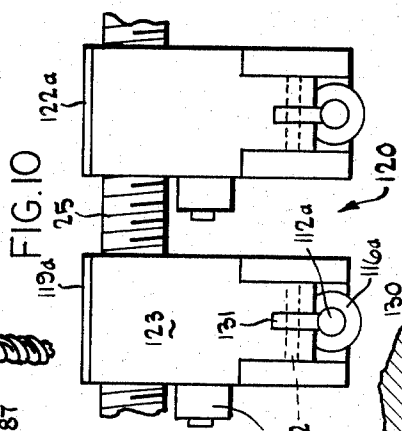


FIG. 10

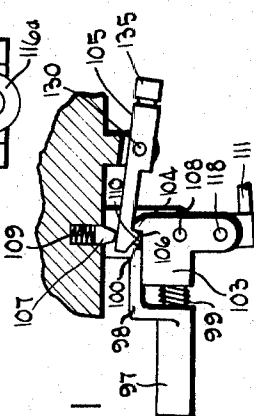


FIG. 11

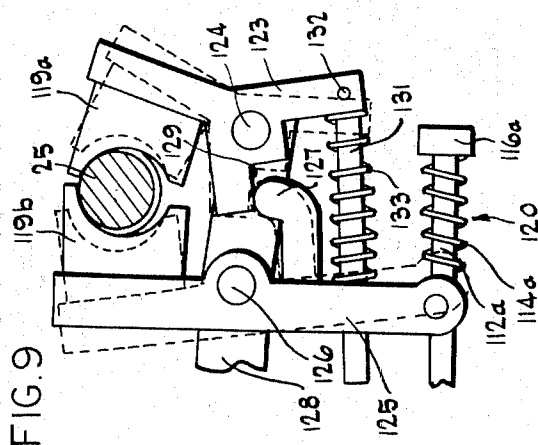
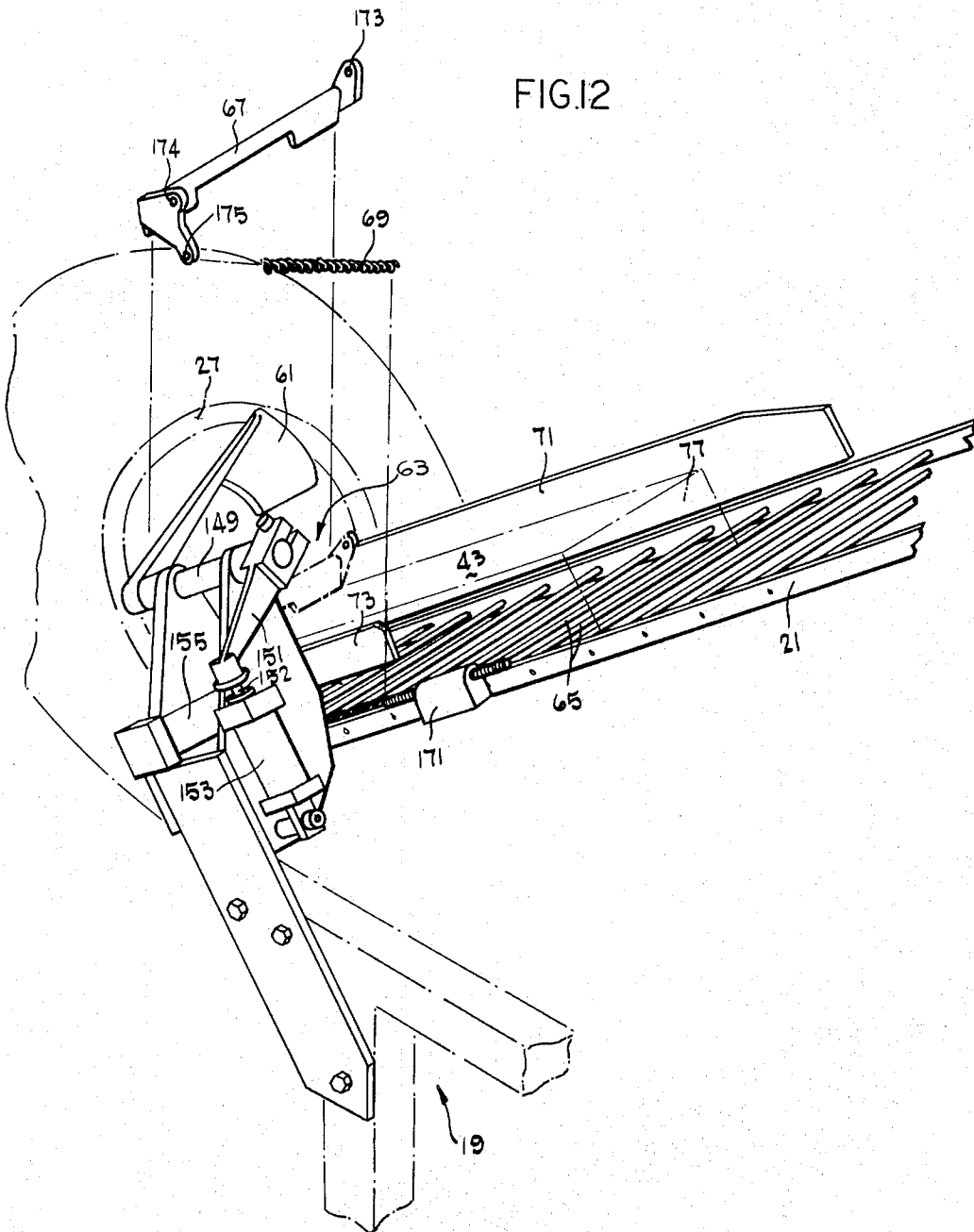


FIG. 9

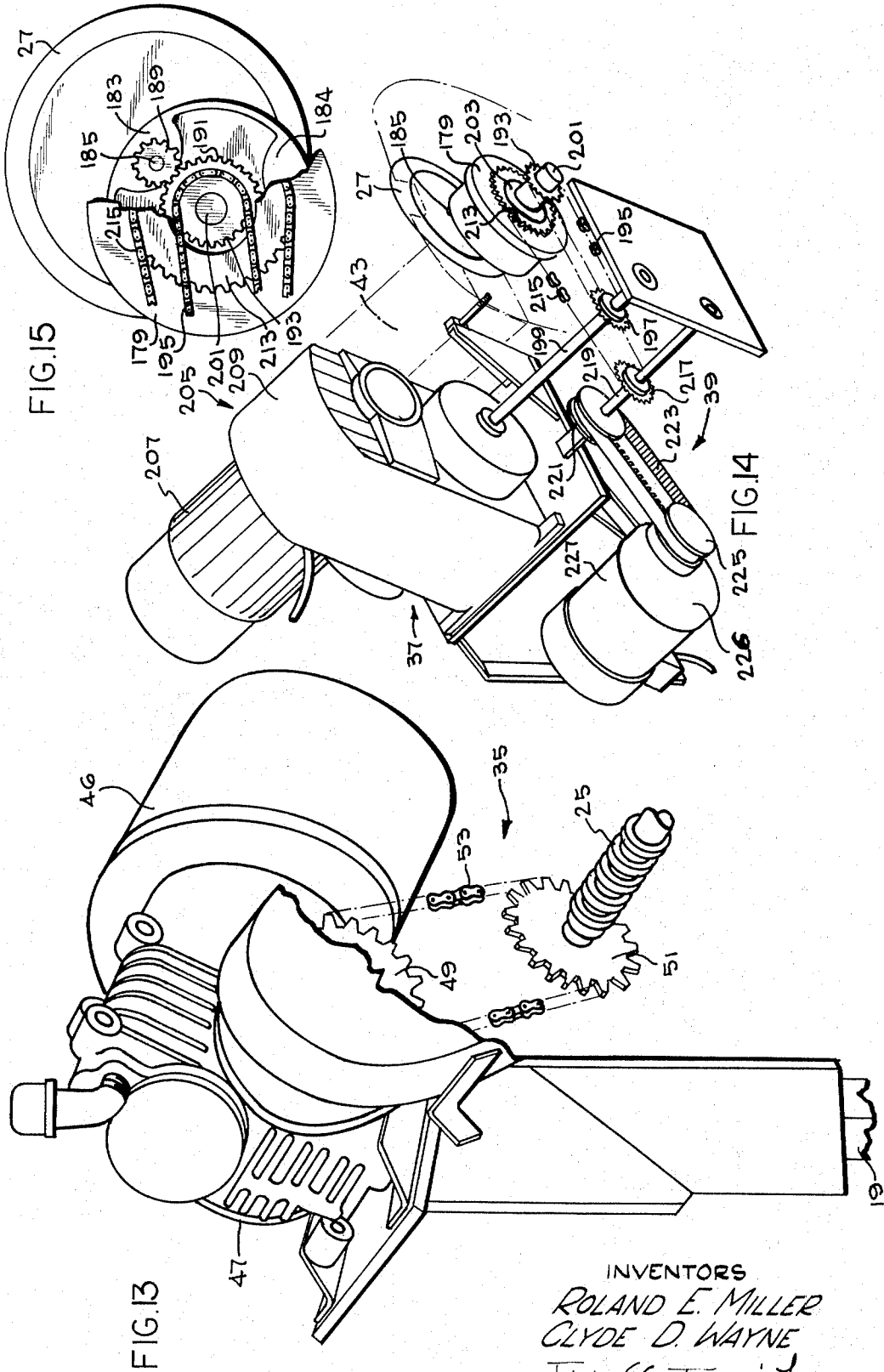
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FIG. 12



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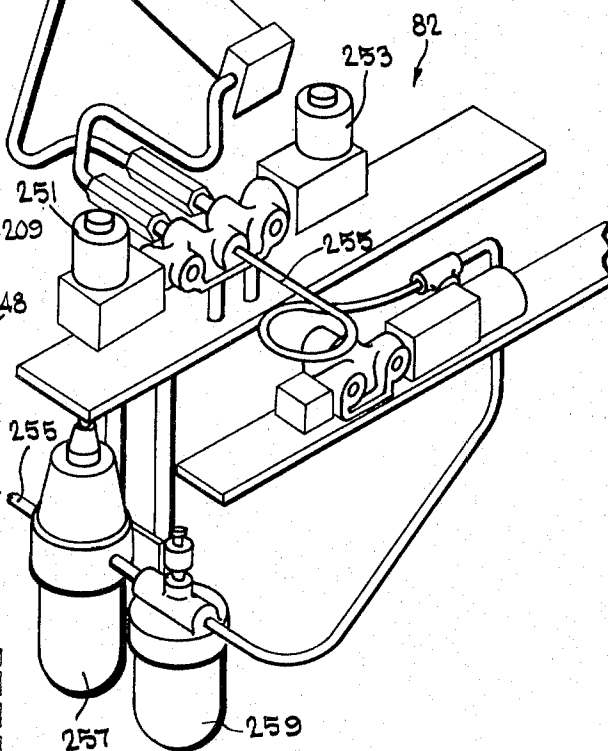
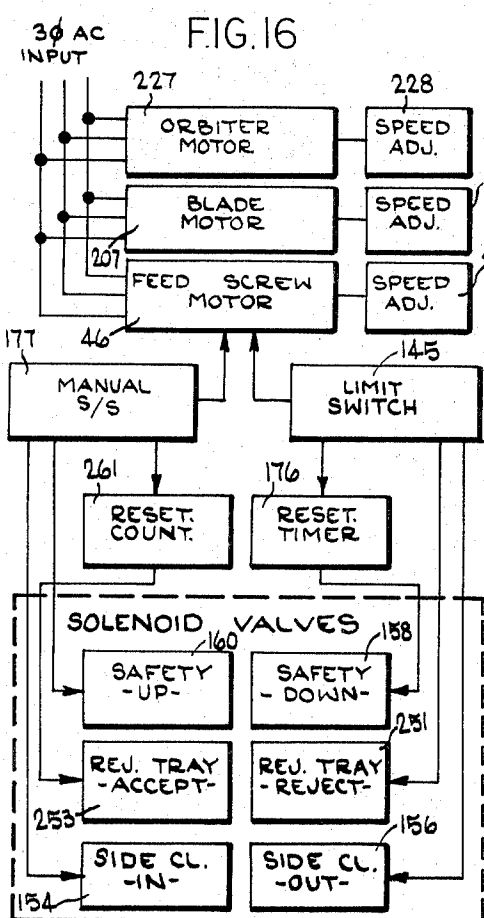
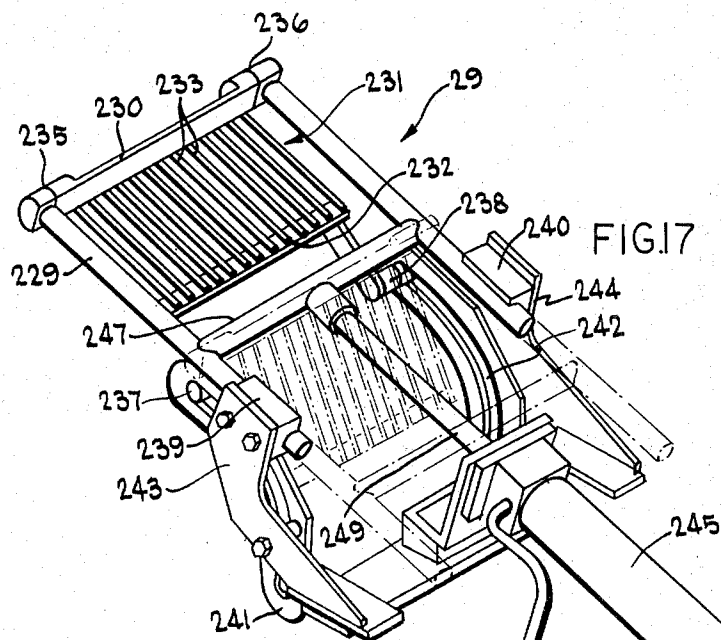
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FIG.18

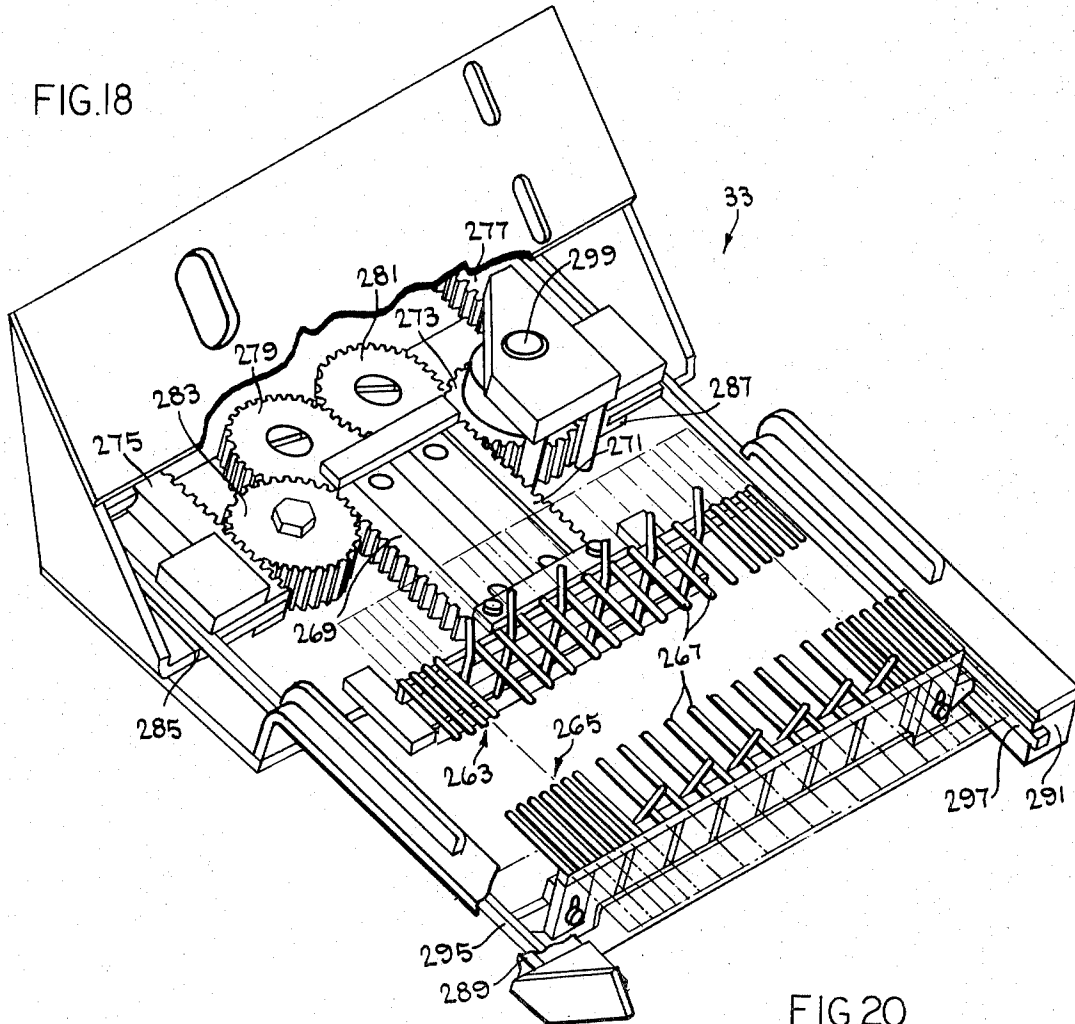


FIG.20

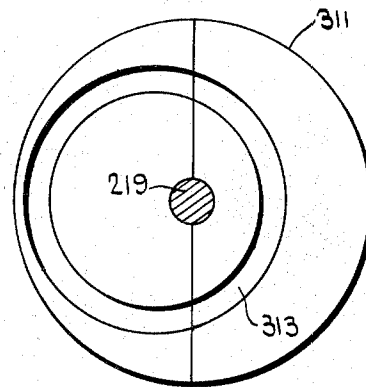
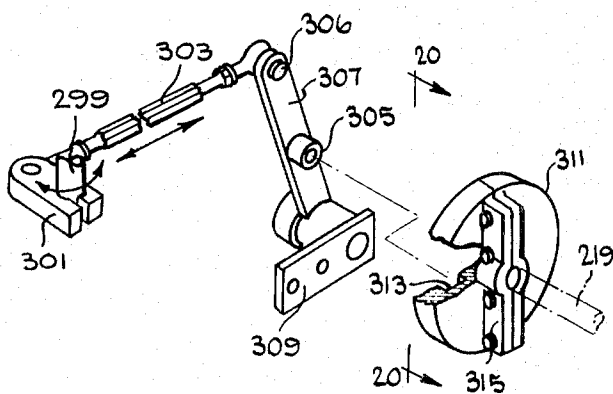


FIG.19



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RAPID SLICING MACHINE

This invention relates generally to a method and apparatus for slicing material. More particularly, it relates to a method and apparatus for producing slices from a mass of material of nonuniform density, such as cheese, and rapidly laying them down on a conveyor. The method and apparatus also provide slices which are of controlled weight.

Various commercial slicing machines are available for intermittently slicing material to obtain a predetermined number of slices of the material for packaging. A slicing machine of this type is shown and described in U.S. Letters Pat. No. 2,752,968, which is directed primarily to a machine for slicing material having an effective amount of compressibility, such as meat loaf. An object of that machine is to prevent the compressibility of the material from affecting the uniformity of the slices. The meat loaf is fed toward the slicing blade for a set number of revolutions of the blade and then is prevented from advancement so that a stack of previously cut slices can be manually or mechanically removed. As disclosed in this patent, machines of this type generally include a slicing head having a cutting blade, a material advancing mechanism for moving the material to be sliced into the path of the blade, and a counter for indicating when a predetermined number of slices has been cut. The slicing head generally comprises a rotating cutter blade and a rotating head or counter weight with which the blade is operatively connected, the axis of rotation of the blade being radially offset from the axis of rotation of the head so that upon simultaneous rotation of the head and blade, the blade will follow an orbital path and inflict a slashing cut upon the material. Both the blade and the rotating head are driven by a common means. The material is advanced by a material clamping means operatively connected to a lead screw, which rotates intermittently so that the material is advanced only when the blade is in a position in its orbital path remote from the material. At the time the slice is being made, the lead screw is idle and the material advance is temporarily interrupted. Because of the compressibility of the material being cut, an auxiliary feed mechanism near the blade works in cooperation with the lead screw to advance the leading portion of the mass of material being cut. Thus, a pulling force at the head end of the mass of material cooperates with a pushing force exerted by the clamping means to advance all of the material uniformly along its path into a position for cutting. The counter generally is operatively connected to a slice accumulator, which transfers a stack of a predetermined number of slices to a scale for weighing and subsequent packaging. Normally, provision is made for the counter to initiate a pause in the slicing of the material so that there is sufficient time between the slicing of successive stacks of slices for stack removal, weighing and the like. Thus, the operation of such machines is made intermittent by operation of both the lead screw and the counter.

The present invention has particular application in a system of packaging articles individually rather than in stacks. Such a system is desirable for the packaging of individually wrapped slices of cheese, which are readily saleable because of the ease with which they may be used in the preparation of food, both domestically and commercially. Yet, high costs are usually incurred in

producing and wrapping individual slices. It is desirable, therefore, to increase the speed of a system of slicing and packaging to produce a larger quantity of the individually wrapped articles per unit of time. The machines heretofore available were limited in their capability of high speed operation, and so the present invention provides a high speed slicing apparatus for such a system. Further, these machines were limited in their adaptability for slicing materials which from time to time differ in density, and so the present invention provides a slicing apparatus adaptable for such materials and capable of producing controlled weight slices from such materials.

It is an object of the present invention to provide an improved slicing apparatus and method for slicing material.

A more particular object is to provide an apparatus and method for producing controlled weight slices for packaging from materials having densities that differ from time to time.

It is another object of the present invention to provide a slicing apparatus which has improved slicing action.

It is yet another object of the present invention to provide a slicing apparatus having an increased output of slices per unit of time.

It is still another object of the present invention to provide a slicing apparatus having means for efficiently depositing slices on a conveyor.

These and other objects of the invention are more particularly set forth in the following detailed description and in the accompanying drawings of which:

FIG. 1 is a perspective view of the slicing apparatus according to a preferred embodiment of the invention further illustrated by partially exposed inner portions and a portion of a receiving conveyor in phantom;

FIG. 2 is a fragmentary side view of the slicing apparatus of FIG. 1;

FIG. 3 is a perspective view of a block of material of nonuniform density, such as natural cheese, cut into bars and trimmed to given dimensions in part preparation for producing slices of controlled weight by the slicing apparatus;

FIG. 4 is a front view of a portion of a dial face for directly converting the weight of a bar of the material of FIG. 3 to a number for setting the material advance speed of the slicing apparatus;

FIG. 5 is an enlarged perspective view of a portion of FIG. 1 illustrating a vacuum head to hold a bar of material of FIG. 3 while the bar is being fed to the blade for slicing;

FIG. 6 is a front view of the vacuum head of FIG. 5;

FIG. 7 is a fragmentary side view of the vacuum hold assembly taken along line 7—7 of FIG. 5;

FIG. 8 is an enlarged perspective view of a portion of FIG. 1 from a different angle illustrating a carriage drive assembly for the vacuum head of FIG. 5;

FIG. 9 is a sectional view of a feed screw engaging mechanism taken along line 9—9 of FIG. 8;

FIG. 10 is a fragmentary side view of the feed screw engaging mechanism taken along line 10—10 of FIG. 8;

FIG. 11 is a sectional view of a feed screw release taken along line 11—11 of FIG. 8;

FIG. 12 is an enlarged perspective view from a different angle of a portion of FIG. 1 along with an exploded view of a portion thereof illustrating a hold on assembly

to hold down a bar of the material of FIG. 3 during slicing;

FIG. 13 is an enlarged perspective view of a portion of FIG. 1 further illustrated by a partial broken away portion of a feed screw drive assembly for the carriage drive of FIG. 8;

FIG. 14 is an enlarged perspective view of a portion of FIG. 1 from a different angle further illustrated by a partial exploded view of a portion of a slicer drive assembly;

FIG. 15 is a front view of a rotating head of FIG. 14 with a broken portion exposing interior gears and blade shaft mounting;

FIG. 16 is a block diagram illustrating the interrelation of the electrical parts of the slicing apparatus;

FIG. 17 is an enlarged perspective view of a portion of FIG. 1 illustrating a reject tray assembly;

FIG. 18 is an enlarged perspective view of a portion of FIG. 1 illustrating a shuttle gate assembly to control the discharge of slices onto the receiver conveyor;

FIG. 19 is an enlarged perspective view of an oscillation mechanism for imparting motion to the shuttle gate assembly of FIG. 18; and

FIG. 20 is a face view of a cam taken along line 20—20 of FIG. 19 and illustrating the eccentric cam track of the cam.

Broadly, the preferred embodiment of the present invention slices bars of material that may differ in density from one another, such as bars of natural cheese. The apparatus is provided with means for slicing these bars in a continuous, high speed manner. Moreover, adjustments permit the accommodation of the apparatus to the slicing of different types of materials of nonuniform density, such as various types of cheese. The slices are discharged toward a receiver, such as a lug conveyor. The first few slices of each new bar are automatically intercepted and retracted to a separate receptacle, permitting orientation between the new bar and the blade. The slices discharged thereafter are accepted. Weight of the slice is more critical than size, since downstream of the slicer the slices will be individually wrapped and packaged together in pre-weight printed wrappers. In contemplation of this, the present invention provides a method of preparing the bars of material to be sliced in accordance with material density and relating the density of each bar to a setting on the apparatus that will cause the slice thickness to be adjusted in an inverse relation to the density of the material being sliced. The fall of each discharged slice is controlled to uniformly space and align the slices from the high speed apparatus on the conveyor in anticipation of the subsequent wrapping and packaging.

Briefly, FIG. 1 illustrates an apparatus 17 for slicing material. This apparatus is supported on a frame 19. A surface, such as product tray 21, for supporting the material is inclined with respect to the horizontal. The material is movable over the product tray 21, and the movement is controlled by a vacuum hold assembly 23 which is operatively connected to a carriage drive assembly 24. An endless feed member, such as a feed screw 25, advances the carriage assembly with the vacuum hold assembly and material toward a knife, such as a rotating blade 27. As hereinafter shown, the rotating blade 27 rotates simultaneously along different axes causing the blade to follow an orbital path during its rotation upon its own axis and to inflict a slashing cut upon the material being sliced rather than a straight

slicing cut. A predetermined number of first slices of a new bar of material being cut fall onto a reject tray assembly 29. This reject tray is then retracted to permit subsequent slices to be discharged toward a receiver, such as a conveyor 31. Intermediate the rotating blade 27 and the conveyor 31 is a shuttle assembly 33, the purpose of which is to temporarily intercept the falling slices to evenly space and align them as they drop onto the conveyor 31. Three independent drive assemblies are provided on the apparatus 17. A feed screw drive assembly 35 is adjustable to control the speed of rotation of the feed screw 25. A slicer blade drive assembly 37 is adjustable to control the speed of rotation of the blade 27. A slicer orbital drive assembly 39 (FIG. 14) is adjustable to drive the rotating blade in its orbital path.

More particularly, beginning with the preparation of the material, in FIG. 3 there is shown a mass of the material to be sliced, represented as a block 41. Since the slicing apparatus of the present invention produces slices of controlled weight from material of nonuniform density, the block 41 represents material of nonuniform density. The block is cut into a plurality of bars so that an adjustment in the advancement speed can be made for each bar permitting the speed to be appropriate for the density of a particular portion of the material being sliced. The apparatus for accomplishing this is described in detail later.

One material having nonuniform density is natural cheese, wherein gases internally of the cheese create cavities of differing sizes spaced irregularly throughout the mass. Moreover, the density will vary among different types of natural cheese. Hence, it is desirable to provide the present slicing apparatus with flexibility so that different types of natural cheese can be sliced and the slices individually wrapped economically. Further, groups of individually wrapped slices can be packaged in pre-weight printed overwraps.

An example of product preparation for use on the slicing apparatus is as follows: A cheese block having an average size of approximately 8 inches by 16 inches by 20 inches is removed from a cooler and taken to a cheese cleaning room. In the cleaning room the cheese block is unwrapped and cleaned. The block is then cut into four bars 43, each three and two-thirds inches wide. Slabs 45 on each side of the block, each approximately two-thirds of an inch wide, remain after the bars are cut. The bars are then trimmed to an exact length of nineteen inches and to a height falling within a range of 8 inches maximum and 6 $\frac{3}{4}$ inches minimum. Bars having a height less than the minimum of 6 $\frac{3}{4}$ inches are not used in the natural cheese slicing operation. The dotted lines at each end of the block in FIG. 3 indicate that in trimming the bars to the exact length of nineteen inches a cut is taken at both ends of the block.

When trimming Swiss cheese, a minimum cut is taken at one end to expose as few holes in the cheese as possible. This permits the vacuum holder, which will be explained in detail later, to perform properly in the slicing apparatus. Consequently, the trim cut taken at the opposite end, which is the slice starting end, will be larger and more holes will be exposed.

The preceding example illustrates a method of producing bars of substantially uniform size. The density of the bar is then a function of the weight of the bar; i.e., a bar of a given size having less weight than another bar of the same size is less dense than that other bar.

Conversely, a bar having more weight than another bar of the like size is more dense than that other bar. By relating inversely the advancement speed of the bar to the density of the bar, a thinner or a thicker slice, as appropriate, results in slices of controlled weight. Thus, if a lighter bar is fed at a faster rate, a thicker slice will compensate for the less dense material, and conversely, if a heavier bar is fed at a slower rate, a thinner slice will compensate for the more dense material. This, of course, assumes that the orbital speed of the knife is constant. As will be seen later, a slice is produced on each revolution of the knife in its orbital path, and so at a constant orbital (slicing) speed, the thickness of the slices depend upon the speed at which the material being sliced is advanced. Alternately, the speed of advance could be held constant and the orbital (slicing) speed could be adjusted to change the slice thickness.

Cheese varies in density from block to block and bar to bar. This invention makes possible the cutting of slices of controlled weight from cheese which differs substantially in density. The controlled weight slicing can be readily and easily achieved in commercial plants. The heretofore provided systems have not permitted such handling of cheese and have particularly not been adapted to Swiss cheese with the characteristic "eyes" or "holes" in the cheese.

The slice weight control is accomplished in the present invention by provision of an adjustable speed control in the feed screw drive assembly 35. As can be seen in FIG. 13, an adjustable speed motor 46 provides input power to a gearhead 47 having a right angle shaft orientation, that is, the output of the gearhead is at right angles to the motor axis. A drive sprocket 49, connected to the output of the gearhead 47 provides rotary motion to a driven sprocket 51 through a chain 53. The driven sprocket 51 is connected to the feed screw 25 and causes its rotation. It is apparent that by adjusting the speed of motor 46, the speed of rotation of the feed screw 25 will be adjusted in direct relation thereto.

It is recognized that several means are available for adjusting the speed of the feed screw 25. In the preferred embodiment of the invention, an adjustable frequency AC drive is used. The motor 46 is an AC synchronous motor, controlled by an adjustable frequency AC supply 48 (FIG. 16). This adjustable frequency AC power may be obtained from a motor-alternator set or a static supply, such as a rectifier-inverter or a wave-converter. The preferred embodiment utilizes a rectifier-inverter. Such systems are commercially available. Another well-known type of electrical speed adjusting device that could be used is an adjustable voltage DC drive controlling a DC motor. Also, various mechanical and hydraulic speed adjusting devices could be utilized for controlling the speed of rotation of the feed screw 25.

After the block of material 41 has been cut and trimmed into the bars 43, each bar is separately weighed on a dial scale (not shown), which simultaneously translates the weight of the bar into a dial setting for the adjustable material advancement speed system. In FIG. 4 there is shown a segment of a dial face 55 as utilized on the dial scale. The indicia for speed adjustment begin at 2 8/10 and continue around the circular dial scale in a counterclockwise direction to ten. Correlating inversely with these indicia are weights ranging from approximately 14 pounds to approximately 20 pounds. Dial setting ten corresponds to a bar

weighing approximately 14 pounds, whereas dial setting 2 8/10 corresponds to a bar weighing approximately 20 pounds. It is believed to be impractical to slice bars registering more than 10 on the dial scale or bars registering less than 2 8/10 on the dial scale for natural cheese slice production. At the time each bar is weighed, the dial setting correlating thereto is marked on the heel of the bar. Note that it is not the weight of the bar that is marked on the heel. Of course, it is apparent that the weight of the bar could be used directly by calibrating the adjustable speed control of the machine in indicia of weight rather than orbitory numbers.

An example of a commercially available dial scale to do this weighing is "Readac" Number 9806, multiple turn dial scale with a total capacity of 30 pounds and a dial calibrated in six pounds by one-quarter ounce graduations. This device is a product of the Exact Weight Scale Company. A special dial face having calibrations as indicated in FIG. 4 is mounted over the dial face provided with the dial scale to read directly the setting indicia marked on the heel of each bar. The operator of the slicing apparatus reads the value on the heel of the bar at the time he is loading the slicing apparatus and adjusts a knob 58 to a setting on a slicer dial face 59 (FIGS. 1 and 2) corresponding to this value. The knob and the dial face are part of a manual control 57 for the adjustable frequency supply 48. The dial face 58 has indicia thereon corresponding to the indicia of the dial face 55 of the dial scale. The lighter weight bars use a higher dial number on the slicing apparatus to produce a faster feed or material advancement rate, and the heavier bars use a lower dial number for a slower advancement rate.

To load the slicing apparatus 17, a bar 43 is placed by an operator on the inclined product tray 21, which comprises rollers 65. In FIG. 12, this bar 43 is shown in phantom. The bar is permitted to rest against a product safety stop 61, which in FIG. 12 is illustrated in its raised position. When lowered, this safety stop 61 prevents the bar of material 43 from contacting the rotating blade 27. The leading edge of the bar is in the control of a hold on assembly 63, which comprises a holding bar 67 held down by a spring 69. The holding bar 67 rests on the bar of material 43 and holds it securely against the rollers 65 of the inclined product tray 21 during slicing. The vacuum head assembly 23 (FIG. 7) is next brought into engagement with the heel 77 of the product bar 43. A side plate 71 and a side clamp 73, to be explained in detail hereinafter, are adjusted after the bar of material is snugly against the safety stop 61 and engaged by the vacuum head assembly.

The vacuum head assembly 23 comprises a vacuum head 75, a front screen 79, and a blade 81, the blade 81 being in the form of an oval or closed loop, which can best be seen in FIG. 6. The screen 79 forms a back stop for the bar 43. The blade 81 projects normal to the plane of the screen 79, so that when the vacuum head 75 is forced into engagement with the heel 77, a seal is formed within the closed loop of the blade 81. A hose 83 connects the vacuum head 75 to a vacuum source (not shown). When the vacuum is turned on after the vacuum head 75 has been engaged with the heel 77, the vacuum assembly 23 has control of the bar 43 during advancement of the bar along a path into a position to be cut by blade 27, holding the bar from being pulled into the blade. Using this vacuum device to hold the bar

reduces product waste by minimizing the portion of the bar that is otherwise unavailable for slicing because of interference with the slicing blade by conventional gripper elements. To place the carriage 89 in operative engagement with the feed screw 25, the operator pulls up a handle 97 (FIG. 8). The engagement mechanism is subsequently detailed.

As mentioned previously, the vacuum hold assembly 23 is supported by the carriage drive assembly 24. The detail of the carriage drive assembly is best seen in FIG. 8. The carriage drive assembly 24 is supported by and movable along carriage support rods 85 and 87. The primary support for the carriage drive assembly 24 is the carriage 89 having a plurality of rollers 91 mounted thereon. These rollers have a concave surface for maintaining a rolling engagement with the carriage support rod 87. Attached to the carriage 89 and oriented transversely to the product tray 21 is a carriage bar 93. The end of the carriage bar 93 remote from the carriage 89 is provided with a yoke-shaped extension 95 which is engageable with the carriage support rod 85 for sliding movement therealong.

Means for causing operative engagement and release of the feed screw 25 is provided on the bar 93. This means comprises a handle 97 slidably connected with block 103 by a mounting means, such as a bolt 101. The detail of this arrangement is best seen in FIG. 11. The handle 97 is counterbored to permit a compression spring 99 to fit therein over the bolt 101. The opposite end of the compression spring 99 rests against the block 103 and urges outwardly the handle 97 against the retaining force of a head 12 on the bolt 101. The handle 97 is provided with an extension 98 having a tapered cam surface 100 overlying a portion of the block 103. The block 103 has a hook portion 104 engageable by a latch 105, which also has a hook portion 106. Immediately above the latch 105 near the end having the hook portion 106 is a plunger 107 directed against that portion of the latch 105 by a compression spring 109. The block 103 is rotatably mounted at a pivot point 108. As can be seen in FIG. 11, when the block 103 is rotated so that the hook portion 104 is vertical, the hook portion 106 of latch 105 engages the block 103 and retains it in this position by the force on latch 105 of the plunger 107 exerted through the urging of the spring 109. Normally, the handle 97 is maintained in an inoperative position by the urging of the compression spring 99, but by axially depressing the handle, the cam surface 100 will engage a complementary surface 110 of the latch 105. Such a depression of the handle 97 will force the disengagement of the hook portions 106 and 104. This, of course, is accomplished against the urging of the plunger spring 109. Upon disengagement, the handle 97 may be rotated with its associated block 103 about the pivot point 108. This alternate position of the handle 97 is shown in phantom in FIG. 8. Rotatably mounted to the lower portion of the block 103 at a pivot point 118 is a pull rod 111. A collar 115 is adjustably mounted on the pull rod 111 near the pivotal connection 118. To this collar 115 is connected one end of an extension spring 113. The other end of the extension spring 113 is hooked over a stud 117 mounted on the carriage 89. It can be seen in FIG. 8 that the block 103 will be in its latched condition against the urging of the spring 113 in its extended condition. Hence, upon disengagement of the latch 105 with the block 103, the spring 113 causes a rotation of

the block 103 in a counterclockwise direction, as viewed in the drawing, about its pivot point 108. When this occurs, the pull rod 111 is caused to move toward the feed screw 25.

The pull rod 111 is in the form of a T with the cross member being at the end opposite from the pivotal connection 118. A pair of pull rod extensions 112a and 112b are spaced apart from each other and project from the cross member of pull rod 111 away from the pull rod. On these extensions are pull rod extension compression springs 114a and 114b retained on their respective extensions by pull rod extension collars 116a and 116b. These extensions are operatively associated with a feed screw engaging mechanism 120, which is fully described hereinafter.

This feed screw engaging mechanism 120 provides a positive, stable means for engaging and releasing the feed screw under the difficult mechanical conditions encountered in rapidly advancing material for rapid slicing. The mechanism 120 includes two pair of opposing half nuts, the pairs axially adjacent one another along the feed screw 25. One pair of opposing half nuts is 119a and 119b as seen in FIG. 9. The other pair is identical with the first pair and is axially aligned and adjacent the first pair as shown in FIG. 10. Referring again to FIG. 9, the half nuts 119a and 119b are attached to the supports 123 and 125 respectively. The support 123 is rotatably mounted about the pivot point 124; and the support 125 is rotatably mounted about the pivot point 126. These two pivot points are provided by a link 121 and connected to a bracket 128. The bracket 128 is securely attached to the carriage 89 (FIG. 8), thereby integrating the feed screw mechanism 120 with the carriage 89. The half nut support 125 has a finger 127 extending inwardly toward the support 123 just below the pivot point 126. Projecting from the support 123 inwardly toward the support 125 is an extension having a lower surface 129 substantially on the center line of the pivot point 124. The finger 127 is in slidable contact with the surface 129. When the support 125 rotates in a counterclockwise direction about its pivot point 126, the finger 127 moves upwardly exerting an upwardly directed force against the surface 129, which causes a clockwise rotating of the support 123 about its pivot point 124. It will be understood that the movement just described causes the pair of half nuts 119a and 119b to move away from one another and, consequently, away from the feed screw 25. Near the lower end of the support 123 is a pivotal connection point 132 for a compression spring guide rod 131 having therearound a compression spring 133. The compression spring guide rod extends inwardly toward the support 125 and is slidably engageable therewith, while the compression spring 133 is restricted by the support 125. Hence, the compression spring 133 urges the lower portions of the supports 123 and 125 apart. Such urging tends to rotate the support members about their respective pivot points. This brings the portions of the support members above the pivot points toward one another, causing the pair of half nuts 119a and 119b to come together and engage the feed screw 25. The finger 127 does not prevent this movement, because as the support member 125 pivots in a clockwise direction about its pivot point 126, the finger 127 moves downwardly. As this occurs, the surface 129, with which the finger 127 is slidably in contact, moves downwardly, permitting the counterclockwise rotation of the sup-

port 123 about its pivot point 124. Whether, therefore, the feed screw engaging mechanism 120 engages or disengages the feed screw 25 is determined by the movement of the pull bar extension 112a, which is pivotally attached at the lower extremity of the support member 125. The pair of half nuts axially aligned with and adjacent the pair just described has an identical structural arrangement thereto. It will be remembered that the pull rod 111 is T-shaped and has a pair of extensions projecting from the cross member of the T. In FIG. 9 it is seen that the extension 112a is operatively associated with one pair of half nuts. In like manner, the other pull rod extension 112b is operatively associated with the other pair of half nuts. Since both of the extensions are commonly connected to the cross member of the pull rod 111, any movement of the pull rod 111 causes movement in unison of the two pair of half nuts.

To summarize the operation of the carriage drive assembly 24 as viewed in FIG. 8, handle 97 is normally in a vertical position, and the block 103 is normally unlatched. For operation, the handle is rotated to the horizontal position and the block is engaged by the latch 105. Because the pull rod 111 is pivotally connected to the block 103, the pull rod 111 through its extensions 112a and 112b then exerts a force on the lower portion of the support 125 of the feed screw engaging mechanism 120, which force causes a clockwise rotation of the support 125 about its axis 126. In response to this clockwise rotation, the opposing support member 123 is caused to rotate about its pivot point 124 in a counterclockwise direction by the urging of the compression spring 133. Such movement causes the half nuts to come together around, and consequently engage, the feed screw 25. On the other hand, when the handle is axially depressed, the inclined surface 100 on the handle extension 98 causes disengagement of the latch 105 from the block 103 permitting the extension spring 113 to rotate the block 103 and the associated handle 97 in a counterclockwise direction about the pivot point 108. This movement causes the pull rod 111 to move the lower portion of the support member 125 so that the support rotates in a counterclockwise direction about its pivot point 126. As this occurs, the finger 127 causes the surface 129 on an extension of the support 123 to move upwardly and rotate clockwise the support 123 about its pivot point 124. Hence, the half nuts move away from one another and disengage the feed screw 25.

The feed screw 25 always rotates in the same direction. When the feed screw engaging mechanism 120 is engaged with the feed screw 25, the carriage will advance toward the rotating blade 27. At the conclusion of slicing the bar of material 43, it is necessary to reverse the movement of the carriage 89 so that it will move the vacuum hold assembly 23 back up the inclined tray 21 to a position where a new bar can be loaded. A means for manually disengaging the carriage 89 from the feed screw 25 by axially depressing the handle 97 has already been described. The present apparatus has in addition an automatic release of the feed screw engaging mechanism 120 to permit return of the carriage 89 to a load-unload position on the tray 21 without an operator's intervention.

The operation of the automatic release is best seen in FIG. 8. At the end opposite the hook portion 106 of the latch 105 is a roller 135. As the slicing operation progresses and the heel 77 engaged by the vacuum head 75

approaches the rotating blade 27, the roller 135 comes into engagement with a cam surface 137, which is inclined to force the roller downwardly. Returning to FIG. 11, it will be noted that as roller 135 is moved downwardly a clockwise rotation of latch 105 occurs about the pivot point 130. Such a rotation forces disengagement of the hook portion 106 from the hook portion 104 of the block 103. All of this, of course, is against the urging of the plunger compression spring 109. The forward movement of the carriage and the subsequent engagement of roller 135 with the cam surface 137 creates a greater force than that exerted by the compression spring 109 and, consequently, disengagement occurs. As previously explained, when disengagement occurs, the feed screw engaging mechanism 120 releases the feed screw 25. Hence, advancement of the carriage 89 ceases. When the feed screw engaging mechanism 120 is thus disengaged from the feed screw 25, the carriage 89 is retracted to its uppermost position so as to facilitate the removal of the heel of the previous bar and the placing of a new bar on the tray for engagement with the vacuum hold assembly 23. This retraction is accomplished by means of a weight (not shown) attached to a chain 139, one end of which is attached to the carriage bar 93 (FIG. 8). The weight is channeled within a weight guide 141. Intermediate portions of the chain 139 engage and are guided by a sprocket 143 (FIG. 2).

Coordinated with the mechanical action just described is disengaging the feed screw 25, is the interruption of the electrical circuit to the feed screw drive motor 46. This interruption is accomplished by a proximity limit switch 145 (FIG. 8) which is actuated by the carriage bar 93. When actuated, a set of normally closed contacts (not shown) within the proximity limit switch 145 is opened, and the control circuit of the motor 46, connected by lead wires in the cable 147 is opened. Limit switches and their use in conveyors are well-known, and commercial devices are available for this purpose. The limit switch 145 and the cam surface 137 are both independently adjustable for timing their respective responses with the cutting of the last desired slice.

As previously mentioned, a bar 43 of material to be sliced, such as a bar of natural cheese, is placed on the rollers 65 of the inclined product tray 21 with the head of the bar resting by force of gravity against the safety stop 61, which is journaled on one end of a shaft 149. At the other end of the shaft 149 is a lever 151 connected to a piston rod 152 of a cylinder 153. It is the actuation of the cylinder 153 that determines the position of the safety stop 61. When the rod 152 is extended from the cylinder 153, the safety stop 61 will be in a position intermediate the head of the bar 43 and the rotating blade 27. Conversely, when the piston rod 152 is retracted into the cylinder 153, the safety stop 61 is raised out of its position intermediate the product bar 43 and the rotating blade 27. The position of the rod 152 in the cylinder 153 is controlled by a safety "up" solenoid 160 and a safety "down" solenoid 158 (FIG. 2), the operation of which is explained later in connection with the block diagram of FIG. 16. At this time, the product bar 43 is free to move along its path on the product tray 21 to a position where the head of the product bar 43 intercepts the rotating blade 27 for slicing. The side guide 71 is manually adjustable, and the operator adjusts it to center the product bar 43 on

the product tray 21. The side clamp 73, on the other hand, is actuated by cylinder 155. The cylinder 155 is controlled by a side clamp "in" solenoid valve 154 and a side clamp "out" solenoid valve 156 (FIG. 2), the operation of which is also explained later in connection with the block diagram of FIG. 16. When the side clamp 73 is in position against the side of the product bar 43, the product bar then has a restricted path of movement along the inclined product tray 21 toward the rotating blade 27. The hold bar 67 is urged into position across the top of and against the product bar 43 by the extended spring 69. As the slicing of the product bar 43 progresses and the vacuum hold assembly 23 approaches the rotating blade 27, it can be seen in FIG. 7 that a plow 157 overhead of the vacuum head 75 has its forward end pulled downwardly by the urging of a spring 159. The plow is rotatably connected at pivot points 161 of a U-shaped mounting bracket 163 (FIG. 5). Extending from the pivot point 161 opposite the vacuum head 75 is a cam follower support 165 on which is rotatably mounted a cam follower 167. When the product bar 43 is first loaded on the apparatus 17 for slicing, the vacuum head 75 is away from the rotating blade, as best seen in FIG. 2. At this point, the cam follower 167 is in contact with and rolls along a cam surface 169. In this position, the plow 157 is in a raised position away from the vacuum head 75, permitting the loading of a new product bar 43. As the slicing progresses and the vacuum hold assembly 23 is advanced toward the rotating blade 27, the cam follower 167 eventually clears the cam surface 169 and no longer restrains rotation of the plow 157 about its pivot point 161 by the urging of the spring 159. Consequently, the front edge of the plow 157 is lowered to rest on the heel 77 of the product bar 43, thus presenting an inclined surface to the hold bar 67. This inclined surface has the effect of a plow and lifts the hold bar from the product bar 43 against the urging of its spring 69. As can be seen in a fragmentary exploded view of FIG. 12, the hold bar 67 is rotatably mounted at pivot points 173 and 174. The hold bar spring 69 has one end connected to a spring adjusting mechanism 171 and the other end connected to an extension 175 of the hold bar 67. The raising of the hold bar 67 from the product bar 43 at the conclusion of slicing is adjusted to occur simultaneously with the release of the carriage 89 from the feed screw 25 and the turning off of the feed screw motor 46. At the same time, the proximity limit switch 145, which opens the control circuit to the feed screw drive motor 46, causes the activation of the cylinder 155 to release the side clamp 73 from the side of the product bar 43. The product bar is thus free to travel with the carriage away from the rotating blade 27 to the load-unload position. As this occurs, the cam follower 167 reengages the cam surface 169 and lifts the plow 157. The operator then removes the remains of the product bar 43 just sliced and replaces it with a new product bar. The same action which causes the activation of the cylinder 155 starts the timing of an adjustable timer 176 (FIG. 2). After a predetermined time delay, the timer closes a circuit to a safety "down" solenoid valve 158 to extend the rod 152 of the cylinder 153 to lower the safety stop 61. The time delay assures removal of the heel from the blade 27 before lowering the safety stop.

Summarizing the operator's steps in loading the apparatus for slicing, he places a bar of material 43 on the

rollers 65 of the inclined product tray 21. The product bar rests by gravity against the safety stop 61, which, among other things, prevents the product bar from prematurely entering into the slicing stage. The operator pushes the vacuum head 75 into sealed engagement with the heel 77 of the newly positioned product bar 43 and turns on the vacuum at a manual pet cock (not shown). He then adjust the far side guide 71 for centering the product bar 43 on the inclined tray 21, and enables the side clamp 73 to move against the side of the product bar by actuating the cylinder 155. He then engages the carriage with the feed screw by lifting the handle 97. As a result of the method of product bar preparation mentioned previously, a feed rate dial setting appears on the heel of each product bar 43, and it is the duty of the operator when loading the slicing apparatus to observe this rate number and set the manual control 57 accordingly. Once the feed rate has been set, the operator is then ready to depress the feed start button at the start-stop station 177 (FIGS. 2 and 16) to start the slicing operation. It will be seen in the block diagram in FIG. 16 that pressing the start button not only turns on the feed screw drive motor 46 but also energizes a safety "up" solenoid valve 160, which actuates the cylinder 153 to raise the safety stop 61 and clear the path for slicing. The block diagram of FIG. 16 is detailed hereinafter.

As mentioned previously, two independent systems drive the rotating blade 27. This blade has both a rotary motion about its own axis and an orbital motion about a separate axis. By causing the blade 27 to follow an orbital path simultaneously with its rotation upon its own axis, it inflicts a slashing cut upon the product bar 43 rather than a straight slicing cut. Moreover, the speed of rotation of the blade 27 on its own axis is adjustable, and this adjustment is independent from the speed of orbital rotation. Reference is now made to FIGS. 14 and 15 to see how this is accomplished. The hub of the drive system for the rotating blade 27 is the rotating head 179. On the complete slicing apparatus 17 of FIG. 1, this rotating head is found under a safety cover 181. Referring to FIG. 15, near the peripheral inside surface of the rotating head 179 is a boss 183 extending internally of the periphery. Through this boss and parallel to the axis of rotation is a hole (not shown) of sufficient size to hold a sleeve insert (not shown) for journalling the blade shaft 185. The blade shaft 185 is long enough to project exteriorly of the housing of the rotating head 179. The rotating blade 27 is connected to this exterior end of the shaft 185. On the other end of the blade shaft 185, internally of the rotating head 179, is connected a gear 189. Meshed with this gear 189 is a drive gear 191 mounted on one end of a shaft 201. The shaft is journaled in the center of the rotating head 179 by a bearing 203 and another bearing (not shown). Through a chain 195, the sprocket 193 is driven by another sprocket 197, which is mounted on one end of a drive shaft 199. The drive gear 191 is coaxial with the rotating head 179, but is rotatable independently of it.

It can be seen that the drive system for the blade 27 is the driving sprocket 197, the chain 195, the sprocket 193, the gear 191, the gear 189, and the shaft 185. This drive system causes the rotation of the blade 27 about the axis of its own shaft 185. By adjusting the speed of rotation of the driving sprocket 197, the speed of rotation of the blade 27 will be adjusted accordingly. This adjustable speed is accomplished by the adjustable

speed drive assembly 205, which, in the preferred embodiment of the invention, comprises a motor 207 mounted on and integrally associated with a sheave housing 209. The speed adjustment is accomplished by the well-known system of variable pitch sheaves located within the sheave housing 209. A crank 211 for manually adjusting the pitch of the sheaves can be seen in FIG. 1. Thus, speed adjustments are made mechanically by changing the ratio of the driving to the driven sheaves. The shaft 199 is the output shaft of the adjustable speed drive assembly 205. The drive sprocket is mounted on and receives its rotary motion from this shaft. An important reason for being able to adjust the speed of rotation of the blade about its own axis is that it permits the slicing apparatus to accommodate different materials, such as different cheeses, as well as cheese having differing densities, and still maintain a high speed, stable output of slices.

A second power source and drive mechanism is independent of the adjustable speed drive assembly 205 just described and drives the rotating blade 27 in its orbital path. Returning once more to FIGS. 14 and 15, it can be seen that there is a driven sprocket 213 mounted on the rotating head 179. This sprocket is also coaxial with the center shaft 201 and the gear 191, and it is driven through a chain 215 by a sprocket 217, which is mounted on a drive shaft 219. This drive shaft is secured to the main apparatus frame and has mounted thereon a timing belt pulley 221. This pulley is driven by a timing belt 223 which receives its motive power from the drive pulley 225 mounted on the output shaft (not shown) of a motor 227. The motor 227 includes a gearhead 226, the output shaft of which is parallel to the main shaft of the motor. Thus, the rotating head 179 is caused to rotate by the motor 227 through the pulley 225, the timing belt 223, the pulley 221, the shaft 219, the sprocket 217, the chain 215, and the sprocket 213. In FIG. 15, it can be seen that when the chain 215 causes the head 179 to rotate, the shaft 185, which is the axis of rotation of the blade 27, itself rotates about the center shaft 201 in an orbital manner. It is thus possible for the blade 27 to rotate about its own axis 185 and the center axis 201 simultaneously.

A product bar 43 is shown in phantom in FIG. 14. The blade 27 makes one slice for each of its orbital rotations about the center shaft 201. Hence, by adjusting the speed of the orbital drive assembly 39, the number of slices per unit of time can be controlled. Such control is desirable, for example, for coordinating the slices produced with the receiver or conveyor 31. The means for adjusting the speed of the orbital drive can be any of those previously suggested for the feed screw drive motor 46 or its output, and thus have a relatively broad adjustment range, or it can simply be an adjustable pitch pulley to change the effective radius of the pulley for incremental adjustments of speed within a narrow range. The belt 223 is a timing belt, which, like a gear, prevents slippage between elements and assures a constant relation of speed between the driven element and the driving element. Thus, the blade 27 is driven through the material at the same rotational speed that it has free of the material.

It can be seen in FIG. 15 that the rotating blade 27 appears to unbalance the rotating head 179. If this unbalance occurred, it would cause inordinate and uneven wear on the bearing 203 (FIG. 14) and the shaft 201, and an increase of load on the motor 227. To

counterbalance the blade 27, a weight 184, extending inwardly of the periphery of the rotating head 179 generally opposite the boss 183, is disposed such that its center of gravity is diametrically opposite the shaft 185 an equal distance from the center shaft 201.

Another way to effect a balance about the shaft 201 is to increase the diameter of the rotating head 179 to support two rotating blades through bosses, each similar to the boss 183. These bosses could be opposite one another on a common diameter equidistant from the center shaft 201. The diameter of the rotating head 179 then would have to be at least sufficiently large to permit both blades to lie in the same general plane without touching each other. Further, mechanical considerations may cause the need to space the blades so that they do not touch an extension of the center shaft 201, which in the present instance does not extend externally of the rotating head 179 on the blade side. Such provision for dual knives or blades on one rotating head could not only create a natural balance about the center shaft 201, but could double the cuts made on each complete revolution of the rotating head, since one slice would be made on each half revolution. On the other hand, the same number of slices per unit of time could be produced at one half the speed of rotation of the rotating head 179. Thus, further flexibility could be provided in relating the speeds of the various drives of the slicing apparatus.

Reviewing the purpose of the three separate adjustable speed drives, the speed of the feed screw 25 is adjustable to control the thickness of a slice. The speed of rotation of the blade 27 on its own axis is adjustable to accommodate the slicing of materials having different densities, which is particularly desirable for a product such as natural cheese. The orbital drive of the blade 27 is adjustable to control the number of slices cut per unit of time, since one slice is cut for each rotation of the blade 27 in its orbital path.

As mentioned previously, the present invention has an advantage over existing slicing machines in that it continuously feeds and continuously slices a given product bar. The preferred embodiment of the present invention produces 200 slices per minute of a material, such as natural cheese. There is a slight skew to each slice because of the relative movements that occur during continuity of operation. This can be understood by recognizing that while the rotating blade 27 is making a cut, the feed screw 25 is advancing the carriage toward the blade. Hence, the product being sliced is advancing at the same time it is being cut. Because the same relative movements occur during each cutting stroke, however, the slices are uniform relative to each other. The exception is that of the first few slices of a new product bar, from which, because of its squared surfaces come initial slices having a slight wedge shape. Through experiments, it has been found that the slices will be uniform relative to each other after the first three slices. The difficulty in rapid slicing is effectively removing these initial slices from production. To resolve this difficulty, a means is provided for counting and automatically removing to a separate receptacle the first three slices of a new product bar. The means comprises a reject tray assembly 29 and a counter 261, both generally shown in FIG. 2.

Briefly, the purpose of the reject tray is to catch a predetermined number of rejected slices at the beginning of the slicing of a new product bar and to deposit

these rejected slices in a separate receptacle. After a slice is produced, gravity causes it to fall in a path toward the conveyor 31. The reject tray has two positions. In its extended or "reject" position, it intercepts these slices by intersecting the path of the falling slices at a point intermediate the rotating blade 27 and the conveyor 31. After the predetermined number of slices has been caught by the reject tray, the tray is retracted and inclined to such an extent that the intercepted slices will easily slide off the tray into a separate receptacle. The tray then remains retracted to permit subsequent slices to fall freely on the path toward the conveyor 31. This is the "accept" position. As the heel of the product bar approaches the slicing blade and the carriage is stopped from advancing, the reject tray returns to its extended position and remains there to catch the rejected slices from the beginning of the next product bar. Since a slice is produced on each revolution of the rotating blade 27 in its orbiting path, a counter responsive to these orbital revolutions provides a signal at the predetermined count to retract the reject tray to its "accept" position. The counter preferably can be adjusted manually for the count at which the signal occurs. It should automatically reset itself for a new count after the signal.

More particularly, as best seen in FIG. 17, the reject tray assembly 29 includes a reject tray 231 rotatably mounted at one of its ends to a reject tray frame 229 at the pivot points 235 and 236. The frame 229 is slidably mounted in the yokes 239 and 240, which are supported by the brackets 243 and 244. The tray 231 preferably presents little surface area to the slices so that the slices easily slide off therefrom and, to this end, comprises a plurality of rods 233 spaced apart from each other and held together by cross members 230 and 232. The cross member 232 supports the cam followers 237 and 238, which serve to guide the nonpivoted end of the tray 231. The cam followers ride in a pair of arcuate cam tracks 241 and 242, respectively. In FIG. 17, the solid lines representing the tray 231 and the tray frame 229 show the tray assembly in its extended or "reject" position, whereas the dashed lines for the tray and the tray frame show the assembly in the retracted or "accept" position.

As can best be seen in FIG. 2, a first orientation of the reject tray assembly 29 is slightly inclined from a horizontal position. The pivoted end of the tray 231 slides in a plane of this orientation, whereas the opposite end of the tray through the cam followers 237 and 238 riding in cam tracks 241 and 242 is directed downwardly from the plane during the retraction of the tray frame 229. At the fully retracted position, the tray 231 is greatly inclined to the horizontal. This second orientation of the tray 231 permits the slices caught on the tray to easily slide off into an awaiting receptacle (not shown), which is removably placed below the tray 231 for this purpose. Returning to FIG. 17, the retracted or "accept" position of the tray 231 is shown in phantom.

Movement for the tray and frame assembly is initiated in a cylinder 245. Within the cylinder is a piston (not shown) to which is attached a piston rod 249. This piston rod extends outside one end of the cylinder 245 and is connected to a cross member 247 of the tray frame 229. The piston is operated within the cylinder 245 by a fluid means, such as an air supply 255. In the preferred embodiment, the control system for the air includes such well-known features as a filter regulator

257, a lubricator 259, a "reject" solenoid valve 251 and an "accept" solenoid valve 253. When the "reject" solenoid valve 251 is energized the valve is open and permits increased pressure in the base of the cylinder 245, which results in the piston moving the piston rod 249 outwardly. The frame connected thereto likewise is moved outwardly in response to the extension of the piston rod 249. On the other hand, when the "accept" solenoid valve 253 is energized, the open valve permits increased pressure at the rod end of the cylinder 245. The pressure thus increasing at this point causes the piston to retract toward the base of the cylinder 245, bringing with it the tray frame 229. As this retraction of the tray frame progresses, the cam followers 237 and 239 are guided by the cam tracks 241 and 242 respectively in an arcuate path downwardly, resulting in the greatly inclined position of the tray to the horizontal. Because the tray is moved out of the path of the falling slices, no further slices are intercepted. Hence, they are "accepted" by being permitted to fall freely toward the conveyor 31. The proximity limit switch 145 provides the signal to actuate the "reject" solenoid 251 for extending the reject tray assembly to the "reject" position, whereas the counter 261 (FIG. 2) provides the signal to actuate the "accept" solenoid 253 for retracting the reject tray assembly to the "accept" position.

The counter 261 is adjustable for presetting the number of slices to be rejected. By a suitable means, this counter is enabled to count the slices by counting each revolution of the rotating head 179. At the conclusion of the preset number of slices selected, the counter 261 provides an electrical signal which actuates the "accept" solenoid 253 to retract the reject tray assembly, in which position it remains until the proximity limit switch 145 provides an electrical signal to actuate the "reject" solenoid 251 to extend the tray to its "reject" position. When the counter concludes its preset count and sends a signal for actuating the "accept" solenoid 253, it resets itself in preparation for the next counting cycle, which occurs at the beginning of the slicing of the next product bar.

Although an air system has been used in the preferred embodiment for actuating the cylinder 245, it is recognized that a hydraulic system or other suitable system could be used for this purpose.

Since the apparatus provides slices at a high rate of speed, a further difficulty is encountered in laying down the slices on the conveyor in a uniformly spaced and oriented manner. A line of uniformly spaced and oriented slices is desirable for a downstream operation, such as wrapping, where repeatability and reliability of positioning of the slices on the conveyor is important, particularly in rapid operations. The slices are inclined as they fall from the rotating blade. Thus, if they were permitted to fall directly to the conveyor, one end of each slice would strike the moving conveyor substantially earlier than the remaining part of the slice and result in an arbitrary bounce of the slices on the conveyor. Moreover, other forces acting upon the slices at the time of the completion of each cut could cause them to fall irregularly oriented with respect to each other. As a result, slices could assume an irregular pattern on the conveyor, both in orientation and in spacing.

To resolve this difficulty, means is provided for controlling the fall of the individual slices onto the conveyor 31. Briefly, this fall control is accomplished by a

shuttle assembly 33 located in the path of the falling slices intermediate the rotating slicing blade 27 and the conveyor 31 under the reject tray assembly 29. A pair of comb-like trays 263 and 265 are slidably mounted in the same plane with each other and are caused to move alternately toward and away from one another to form a shuttle gate action or escapement. The moving of the trays toward one another is timed to engage the falling slice and momentarily arrest its fall. Then the trays move away from each other to let the slice fall upon the conveyor. This momentary arrest both orients the slice in a plane more nearly parallel to the conveyor and times its release to the conveyor. Thus, the slice is substantially parallel to the conveyor upon the approach to the conveyor and is spaced equally with those preceding it on the conveyor.

More particularly, as best seen in FIG. 18, the trays 263 and 265 of the shuttle assembly 33 are each constituted of a plurality of spaced apart tines 267 for the purpose of presenting relatively little surface area to the slice to reduce the effect of frictional forces between the surface area and the arrested slice. With minimized frictional forces, the trays can open after arresting the slice to let the slice continue its fall without either tray exerting an appreciable lateral force upon the slice that might affect its orientation. The tray 265 is slidably mounted in guide blocks 285, 287, 289, and 291. The tray 263 is slidably mounted in similar blocks (not shown) immediately under the shuttle assembly 33. Operation of the shuttle assembly 33 is brought about by a rack and pinion arrangement. The inside racks 269 and 271 are directly connected to the tray 263. The outside racks 275 and 277 are connected to tray 265 through tray drive members 295 and 297 at either end of the tray. The gear 273 drives the assembly. It receives its oscillatory movement, i.e., partial rotation first in one direction and then in the opposite direction, from the shaft 299 on which it is mounted. The gear 273 has sufficient depth to simultaneously mesh with racks 271 and 277 on an upper level and with gear 281 on a lower level. Gear 281 in turn meshes with gear 279, and the gear 279 meshes with the gear 283. The gear 283 likewise has sufficient depth to simultaneously mesh with the gear 279 on a lower level and with the racks 275 and 269 on an upper level. Thus, it can be seen that by applying an oscillatory motion to the shaft 299, a resultant oscillatory motion will occur to the trays 263 and 265, and they will move first toward and then away from one another. It is not necessary that the trays completely close the gap between them when they move toward one another. It is only necessary for them to close sufficiently to intercept and momentarily support the falling slice. The degree to which they close is determined by the characteristics of the material sliced and the amount of support a slice of the material requires for this purpose. The optimum is to present as little surface to the slice as possible consistent with a proper support of the slice. In FIG. 18, the solid lines indicate a closed position of the trays, and the dashed lines show the open position of the trays. Note that the tines 267 are spaced on each tray so that they directly oppose each other on the trays.

How the shaft 299 receives its oscillatory motion can best be seen in FIG. 19. A cam 311 drives the shuttle assembly 33 through an eccentric cam track 313, which guides a cam follower 305 supported on a cam follower bracket 307. The cam follower bracket 307 is

rotatably mounted on a bracket 309, attachable to the slicing apparatus frame. In FIG. 20, there is an enlarged view of the cam 311 illustrating the cam track 313 therein. The cam 311 is mounted on the free end of the shaft 219, and it will be noted in FIG. 14 that this is the same shaft that drives the blade 27 in its orbital path by rotating the head 179 through intermediate chains and sprockets. Thus, by having a common drive for both the rotating head 179 and the cam 311, there is a fixed relation established between these two devices, resulting in a coordination between the gate action of the shuttle assembly 33 and the cutting of slices. Returning to FIG. 20, it will be observed that as the cam 311 rotates on the shaft 219 at the center of the cam 311, the path of the eccentric track 313 is such that a reference point therein substantially movable only in one plane is guided alternately toward the cam center and away from the cam center in a lineal oscillating motion. The cam follower 305 sliding in the cam track 313 receives this motion and imparts it to a cam follower bracket 307 on which it is mounted. An adjustable link 303 is rotatably mounted at the free end of the cam follower bracket 307 at a pivot point 306. The pivot point 306 thereby follows the lineal oscillation of the cam follower 305 and this oscillation is transmitted through the link 303 to a drive arm 301, connected to the oscillatory shaft 299. The lineal oscillations of the pivot point 206 are then transmitted to the shaft 299 in the form of alternating partial rotations of the shaft, first in one direction and then in the opposite direction.

Adjustments in the gap between the trays in the closed position are made at the adjustable link 303. Adjustments in the relation between the closing of the trays to the falling of the slice are made at a mounting bracket 315. Here a change can be made in the relationship of the position of the eccentric track 313 with respect to the position of the rotating shaft 219 and thus with respect to the position in its orbital path of the rotating blade 27, which cuts the slice.

The block diagram of FIG. 16 illustrates the interrelation of the pertinent electrical members of the slicing apparatus. The three phase AC input voltage supplies power to the orbital drive motor 227, the rotating blade motor 207, and the feed screw drive motor 46. Each of these motors has means for adjusting either the speed of the motor itself or the output of the motor. Both the orbital drive motor 227 and the rotating blade motor 207 have well-known motor controls on their respective inputs that start the motors when the main three phase power is applied to the slicing apparatus. These motors run until the entire slicing apparatus is turned off. Generally, therefore, they are running during the normal load-unload operations. The speed adjustment 228 for the orbital drive motor 227 is for the purpose of setting the number of slices per unit of time. Generally, this is only an initial determination, and except for fine speed adjustments for coordination with other drives, the orbital drive is constant speed. The rotating blade motor 207 has an adjustable output speed control 209, which controls the speed of rotation of the blade 27 on its own axis to accommodate the slicing of materials having different densities. Its speed may be adjusted when the type of material being sliced is changed. The feed screw motor 46, does not run all of the time that power is applied to the slicing apparatus, but rather at the command of the operator. Its speed is adjusted by a variable-frequency AC supply 48.

When the operator has loaded the slicing apparatus and has engaged the carriage with the feed screw and applied the vacuum at the vacuum head, he is then ready to press the start button at the start-stop station 177. As seen in FIG. 16, four separate direct actions and one indirect action results: The feed screw drive motor 46 is started by a suitable motor control and begins to advance the carriage 89; the resettable counter 261 is energized to begin its counting cycle, at the conclusion of which it energizes the reject tray "accept" solenoid valve 253 to retract the reject tray assembly 29 to the "accept" position; the safety stop "up" solenoid valve 160 is energized to raise the safety stop 61, which permits the bar 43 to be advanced into the blade 27 for slicing; and the slide clamp "in" solenoid valve 154 is energized to close the side clamp 73 against the side of the bar 43. After one resettable counter 261 has concluded its preset count, it automatically resets itself in readiness for the next counting cycle at the beginning of the next bar.

As the heel of the bar being sliced approaches the blade, the carriage, as explained earlier, is mechanically disengaged from the feed screw. Electrically at this time, the proximity limit switch 145 is actuated by a portion of the carriage 89, and as seen in FIG. 16, four separate direct actions and one indirect action result: the control circuit of the feed screw drive motor 46 is opened to stop the motor; a resettable timer 176 is energized and begins timing a preset delay, at the conclusion of which the safety "down" solenoid valve 158 is energized to lower the safety stop 61; the reject tray "reject" solenoid valve 251 is energized to extend the reject tray assembly 29 to the "reject" position; and the side clamp "out" solenoid valve 156 is energized to remove the side clamp 73 from the side of the bar 43. The time delay provides time for the heel of the product bar to be pulled out of the cutting position by the weight attached to the carriage so that the safety stop has a free path in which to lower. At the conclusion of this preset delay, the timer resets itself in readiness for the next timing cycle at the conclusion of slicing of the next bar. The feed screw drive motor 46 can be manually stopped at any time during its operation by pressing the stop button at the start-stop station 177, which will stop the advance of the material into the blade.

In summary, an apparatus has been provided for cutting slices from a mass of material of nonuniform density and discharging the slices onto a receiver or conveyor. Further, a method of preparing the product to be sliced has been shown in which bars of the product are cut to a specific size and then weighed. The densities, which may vary from one bar to another, will be reflected by weights of the bars. Since it is desirable to provide slices of controlled weight so that they may be individually wrapped and then packaged with an overwrap having a pre-marked-weight thereon, an adjustable rate for the feed of the product bar is provided. A lighter weight bar will be fed to the slicing blade at a faster rate, so that the resulting slice will be thicker. A heavier weight bar will be fed at a slower rate, so that the resulting slice will be thinner. Such adjustments compensate for the differing densities among the product bars to produce slices of controlled weight. A number corresponding to a dial setting for the speed adjustment is marked on the heel of each product bar at the time it is weighed. To permit the blade to effectively slice materials having different densities, the speed of

the rotating blade about its own axis is separately adjustable from the speed of the blade rotating in its orbital path. Generally, it is desirable for the orbital speed to remain constant. A vacuum head is provided to engage the heel of a bar of material to be sliced, such as natural cheese. The vacuum head is carried by a carriage on which means are provided for manually engaging a feed screw at the beginning of the slicing operation, for automatically disengaging the feed screw at the conclusion of the slicing operation, and for manually disengaging the feed screw at any intermediate point during the slicing operation. Because the feeding of the product bar into the blade is continuous, a slight skew results in the slice with respect to the product bar being sliced. The slices become uniform relative to each other, however, after the first few slices are cut from a new product bar. Therefore, means are provided for automatically catching and removing a predetermined number of slices at the beginning of each slicing operation. The removed slices may be deposited in a separate receptacle. The slicing machine provides individual slices rapidly and discharges the slices onto a conveyor. Confronted with a possible need downstream of the slicer for repeatability and reliability of positioning of the slices on the conveyor, such as for wrapping and packaging, a shuttle assembly is provided to act as an escapement and momentarily arrest the free fall of each discharged slice, releasing it in substantially a parallel orientation with respect to the conveyor and in a timed relation with a preceding slice to control the positions of the slices on the conveyor.

Thus, it is apparent that there has been provided, in accordance with the invention, an apparatus for cutting slices from a mass of material of nonuniform density and discharging the slices onto a conveyor that fully satisfies the objects, aims, and advantages set forth above. While the invention is susceptible to other various modifications and alternative constructions that may be apparent to those skilled in the art in view of the foregoing description, only a preferred embodiment has been shown in the drawings and described in detail. Such disclosure is not intended to limit the invention. The aim is to cover all modifications and alternative constructions and methods falling within the spirit and scope of the invention as expressed in the appended claims.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. An apparatus for cutting slices from a mass of material and depositing the slices onto a conveyor, comprising: means for supporting the mass of material to be cut; knife means for cutting slices from the mass of material, said knife means including a rotatable head having an axis of rotation, a rotatable blade journaled on said rotatable head radially offset from said axis of rotation; means for adjusting the speed of rotation of said rotatable head; a carriage assembly mounted for longitudinal movement along said support means; hold assembly means on said carriage assembly adapted for engagement with the rear end of the mass of material to be cut; carriage drive means for continuously driving said carriage assembly along said support means toward said knife means; and means for controlling said carriage drive means to adjust the speed of movement of said carriage assembly.

2. The apparatus recited in claim 1, wherein the conveyor is spaced below said knife means and wherein means are provided intermediate said knife means and the conveyor for orienting and timing the depositing of the slices individually on the conveyor in a predetermined relationship with the conveyor.

3. The apparatus recited in claim 2, wherein said orienting and timing means includes a shuttle gate assembly intermediate said knife means and the conveyor for momentarily intercepting and then releasing the slices as they fall in a path from said knife means to the conveyor, said shuttle gate assembly comprising a pair of opposed trays lying in a common plane, each tray being laterally movable in said common plane in an oscillatory manner relative to the other tray and means for oscillating said trays alternately toward one another intersecting the path and away from one another out of the path in timed relation to the cutting action of said knife means.

4. The apparatus recited in claim 3, wherein said trays comprise spaced apart tines, said tines being of a length that provides a gap between the points of the tines of opposed trays when said trays complete their move toward one another.

5. The apparatus recited in claim 4 further comprising means for adjusting the dimension of said gap and means for adjusting the timed relation between the cutting action of said knife means and the movement of said oscillating trays.

6. The apparatus recited in claim 1, wherein the conveyor is spaced below said knife means and wherein automatic means are provided intermediate said knife means and the conveyor for rejecting a predetermined number of slices from a mass of material being sliced so that the remaining slices from the material are substantially alike.

7. The apparatus recited in claim 6, wherein said rejecting means includes a reject tray assembly intermediate said knife means and the conveyor for intercepting the predetermined number of slices as they fall in a path from said knife means to the conveyor and then removing the intercepted slices out of the path, said reject tray assembly comprising tray means and automatic means for controllably actuating said tray means reciprocally between an extended position intersecting the path and a retracted position out of the path, said tray means when in the extended position being disposed to intercept the predetermined number of slices falling in the path and when in the retracted position being disposed to release the intercepted slices.

8. The apparatus recited in claim 7, wherein said tray means comprises a frame slidably mounted on said apparatus and a reject tray having one of its ends pivotally connected to a portion of said frame and the other of its ends slidably engaged through an attached cam follower to a cam track mounted on said apparatus, the cam track being disposed to cause the orientation of said reject tray to change as said frame slides in its mounting.

9. The apparatus recited in claim 8, wherein said reject tray comprises a plurality of spaced apart rods to reduce the frictional forces between said tray and said slices.

10. The apparatus recited in claim 7, wherein said means for controllably actuating said tray means comprises means responsive to individual slicing cycles for providing a first electrical output signal at the conclu-

sion of a number of slicing cycles equal to the predetermined number of slices to be rejected, means responsive to the exhaustion of the material being cut for providing a second electrical signal, and means responsive to said first and said second electrical signals for alternately retracting and extending said tray means.

11. The apparatus recited in claim 1, wherein said hold assembly comprises a vacuum head housing and a blade in the form of a closed loop attached to the face of said vacuum head housing, said blade being engageable with the rear end of the material and creating a seal within its loop when forced into the rear end of the material.

12. The apparatus recited in claim 1, wherein said carriage drive means comprises a power operated feed screw and at least two pair of opposed half nuts, each pair split around said feed screw and axially adjacent one another, the pairs being operable by a single actuator to cause both engagement with and release of said feed screw by said half nuts to enable positive advancement of said carriage in the engaged condition and to cease advancement of said carriage in the released condition.

13. In an apparatus for cutting slices from a mass of material and depositing the slices onto a conveyor, the apparatus including means for supporting, means for advancing, and means for cutting the mass of material, and the conveyor being spaced below the cutting means, automatic means intermediate the cutting means and the conveyor for rejecting a predetermined number of slices while the conveyor is operating from a mass of material being sliced so that the remaining slices from the material are substantially alike.

14. The rejecting means recited in claim 13, wherein said rejecting means includes a reject tray assembly intermediate the cutting means and the conveyor for intercepting the predetermined number of slices as they fall in the path from the cutting means to the conveyor while the conveyor is operating and then automatically removing the intercepted slices out of the path, said reject tray assembly comprising tray means and automatic means for controllably actuating said tray means reciprocally between an extended position intersecting the path and a retracted position out of the path, said reject tray means when in the extended position being disposed to intercept the predetermined number of slices falling in the path and when in said retracted position being disposed to release the intercepted slices.

15. The rejecting means recited in claim 14 wherein said tray means comprises a frame slidably mounted on the apparatus and a reject tray having one of its ends pivotally connected to a portion of said frame and the other of its ends slidably engaged through an attached cam follower to a cam track mounted on the apparatus, the cam track being disposed to cause the orientation of said reject tray to change as said frame slides in its mounting.

16. The rejecting means recited in claim 15, wherein said reject tray comprises a plurality of spaced apart rods to reduce the frictional forces between said tray and said slices.

17. The rejecting means recited in claim 14 wherein said means for controllably actuating said tray means comprises means responsive to individual slicing cycles for providing a first electrical output signal at the conclusion of a number of slicing cycles equal to the predetermined number of slices to be rejected, means re-

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sponsive to the exhaustion of the material being cut for providing a second electrical signal, and means responsive to said first and said second electrical signals for alternately retracting and extending said tray means.

18. In an apparatus for cutting slices from a mass of material and depositing the slices onto a conveyor, said apparatus including means for supporting, means for advancing, and means for cutting the mass of material, the conveyor being spaced below the cutting means, a shuttle gate assembly intermediate said cutting means and the conveyor for momentarily intercepting and then releasing the slices as they fall in a path from the cutting means to the conveyor, said shuttle gate assembly comprising a pair of opposed trays lying in a common plane, each tray being laterally movable in said

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common plane in an oscillatory manner relative to the other tray and means for oscillating said trays alternately toward one another intersecting the path and away from one another out of the path in timed relation to the cutting action of the cutting means.

19. The orienting and timing means recited in claim 18, wherein said trays comprise spaced apart tines, said tines being of a length that provides a gap between the points of the tines of opposed trays when said trays complete their move toward one another, and further comprising means for adjusting the dimension of said gap and means for adjusting the timed relation between the cutting action of the cutting means and the movement of said oscillating trays.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,797,343

Dated March 19, 1974

Inventor(s) Roland E. Miller and Clyde D. Wayne

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 43, "becaus" should be --because--;
Column 2, line 21, "it" should be --It--;
Column 5, line 32, after "output" insert --shaft--;
Column 6, line 29, "58" should be --59--;
Column 7, line 32, "head 12" should be --head 102--;
Column 10, line 57, "raise" should be --raised--;
Column 11, line 64, "balde" should be --blade--;
Column 12, line 8, "adjust" should be --adjusts--;
Column 14, line 60, "diffulcty" should be --difficulty--;
Column 18, line 28, "206" should be --306--;
Claim 1, Column 20, line 61, "carrige" should be --carriage--.

Signed and sealed this 30th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents