United States Patent [19]

Miller et al.

[11] **3,894,457**

[45] **July 15, 1975**

[54] **METHOD OF RAPID SLICING**

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[73] Assignee: **Kraftco Corporation**, Glenview, Ill.

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[21] Appl. No.: **388,186**

Related U.S. Application Data

[62] Division of Ser. No. 146,286, May 24, 1971, Pat. No. 3,797,343.

[52] **U.S. Cl.** **83/27**; 83/38; 83/77; 83/89; 83/91; 177/120

[51] **Int. Cl.** **B26d 4/22**; B26d 4/56

[58] **Field of Search** 83/27, 38, 77, 79, 89, 83/91, 102; 177/120

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Primary Examiner—Willie G. Abercrombie
Attorney, Agent, or Firm—Fitch, Even, Tabin & Luedeka

[57] **ABSTRACT**

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

7 Claims, 20 Drawing Figures

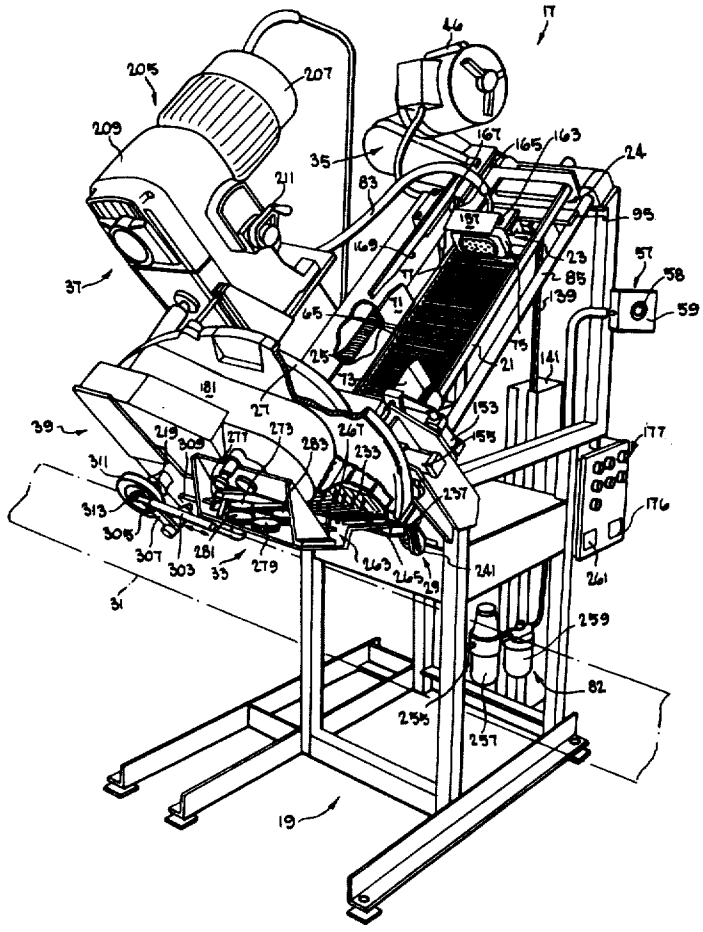


FIG. 1

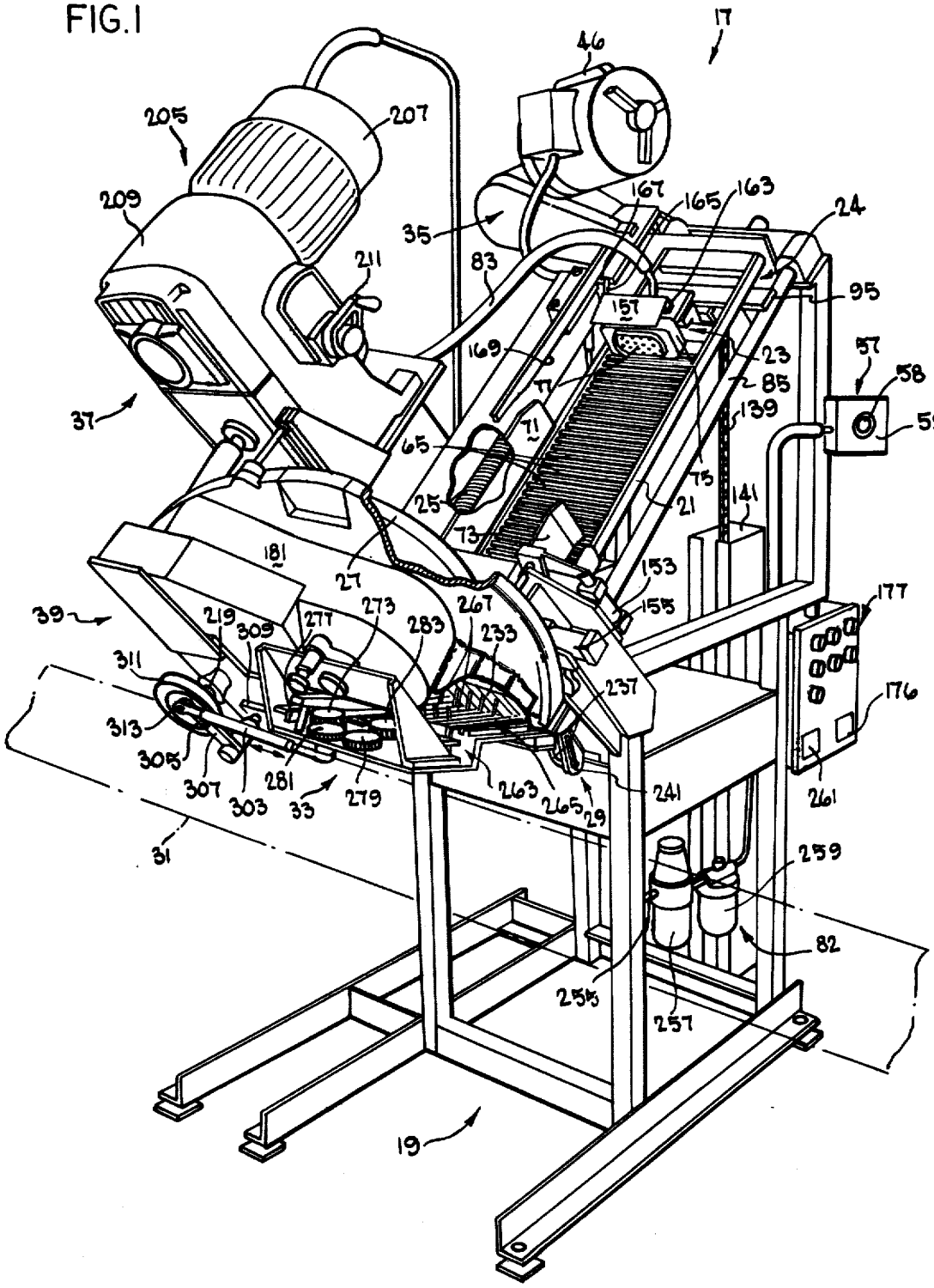
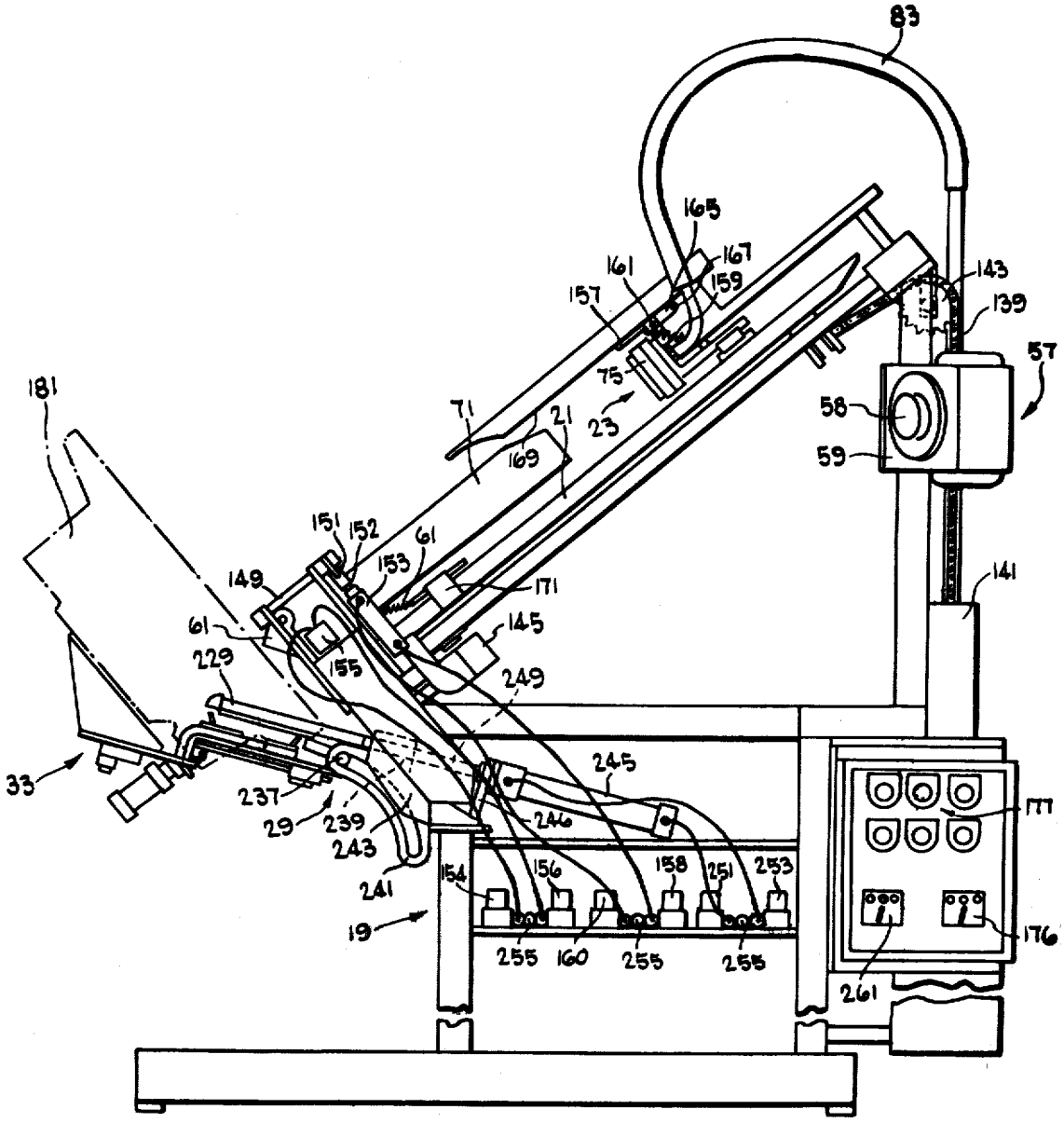

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FIG.2


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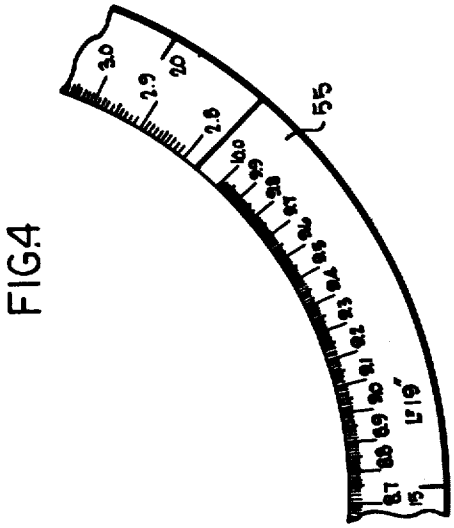


FIG.4

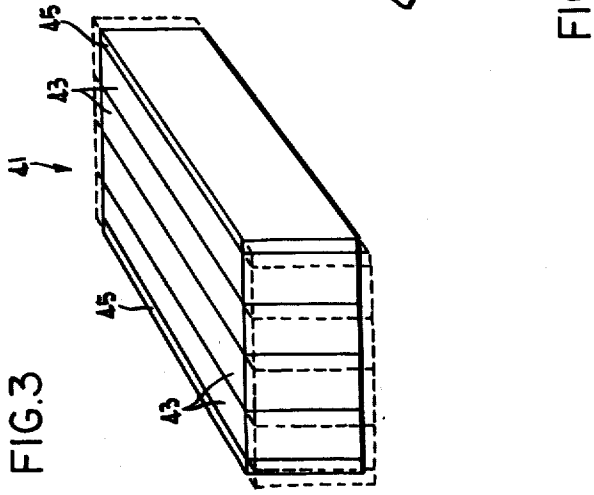


FIG.3

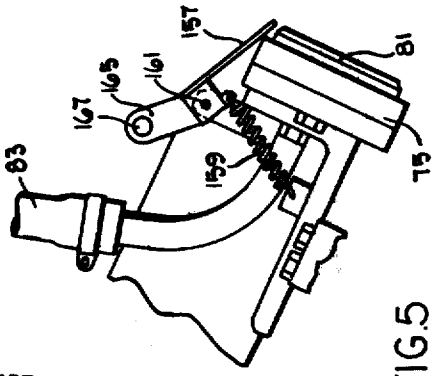


FIG.7

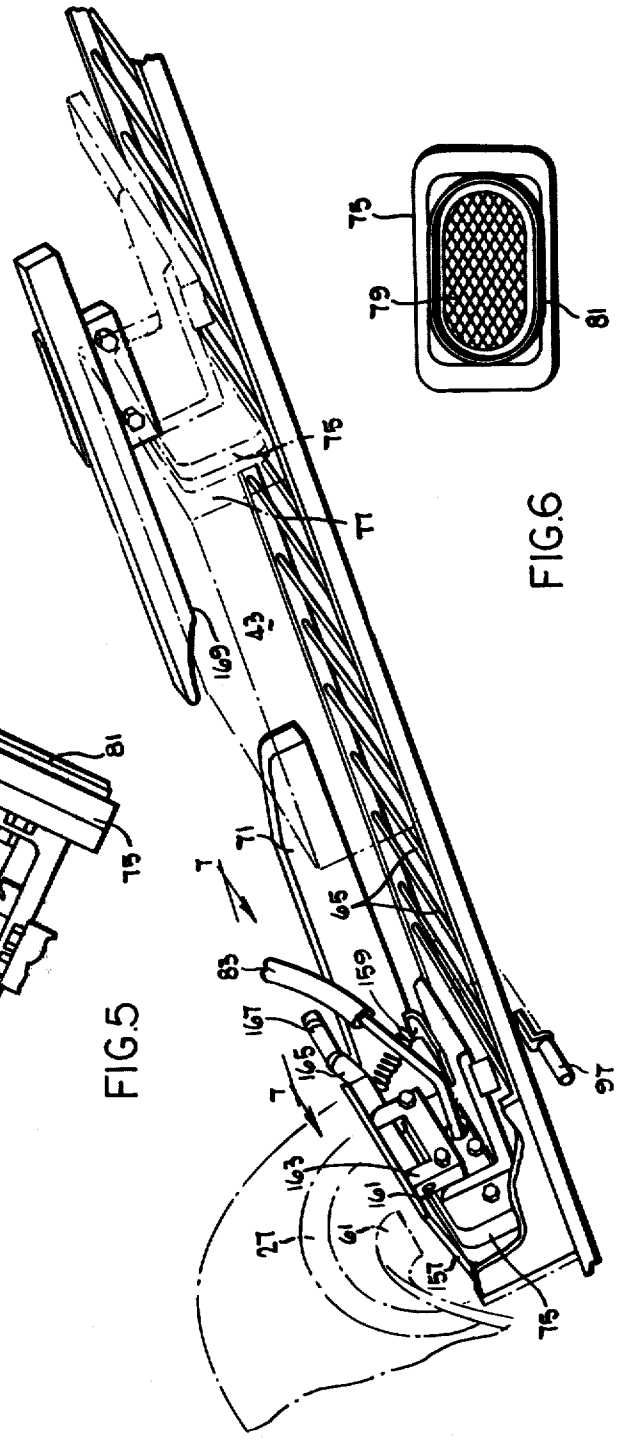


FIG.5

FIG.6

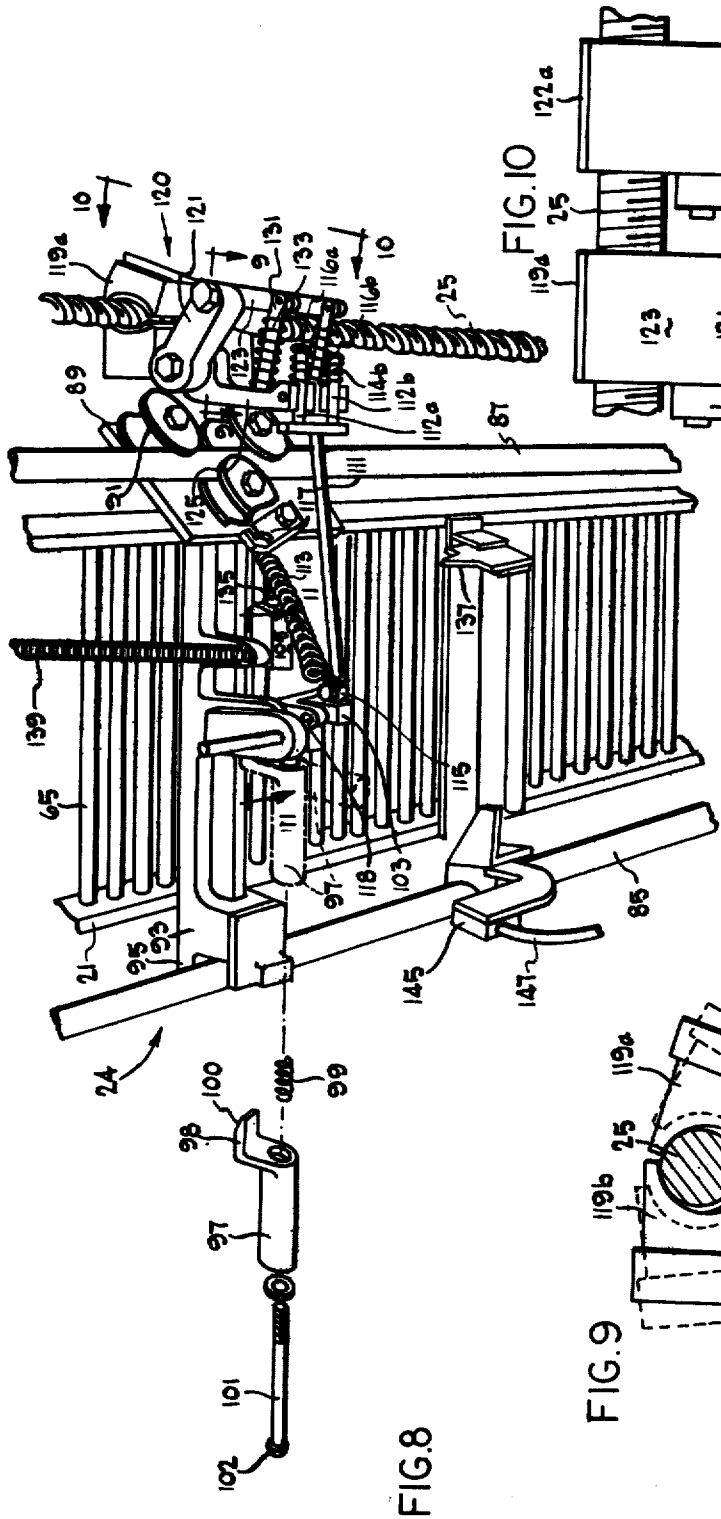


FIG.8

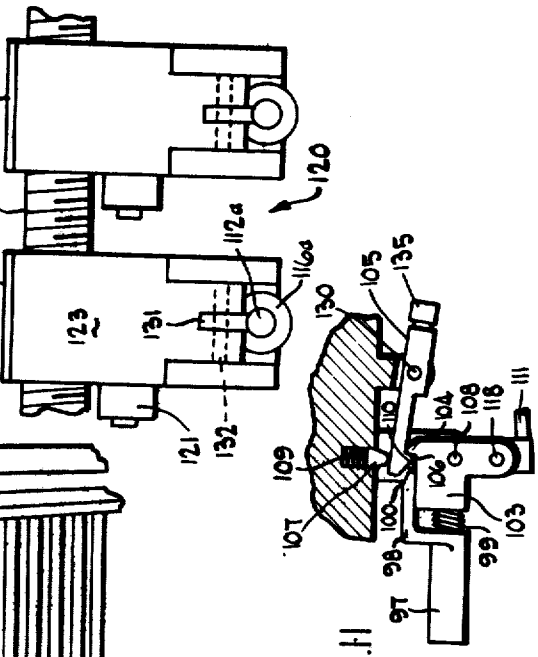


FIG.10

FIG.11

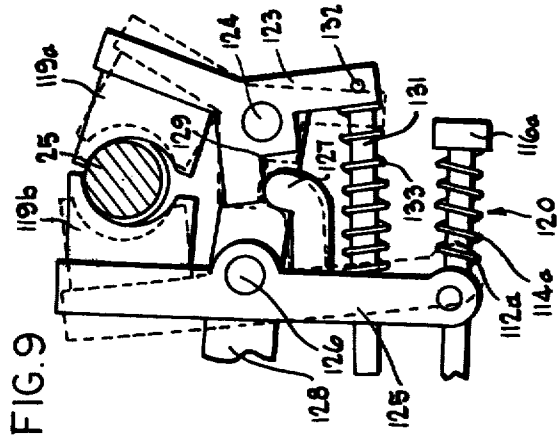
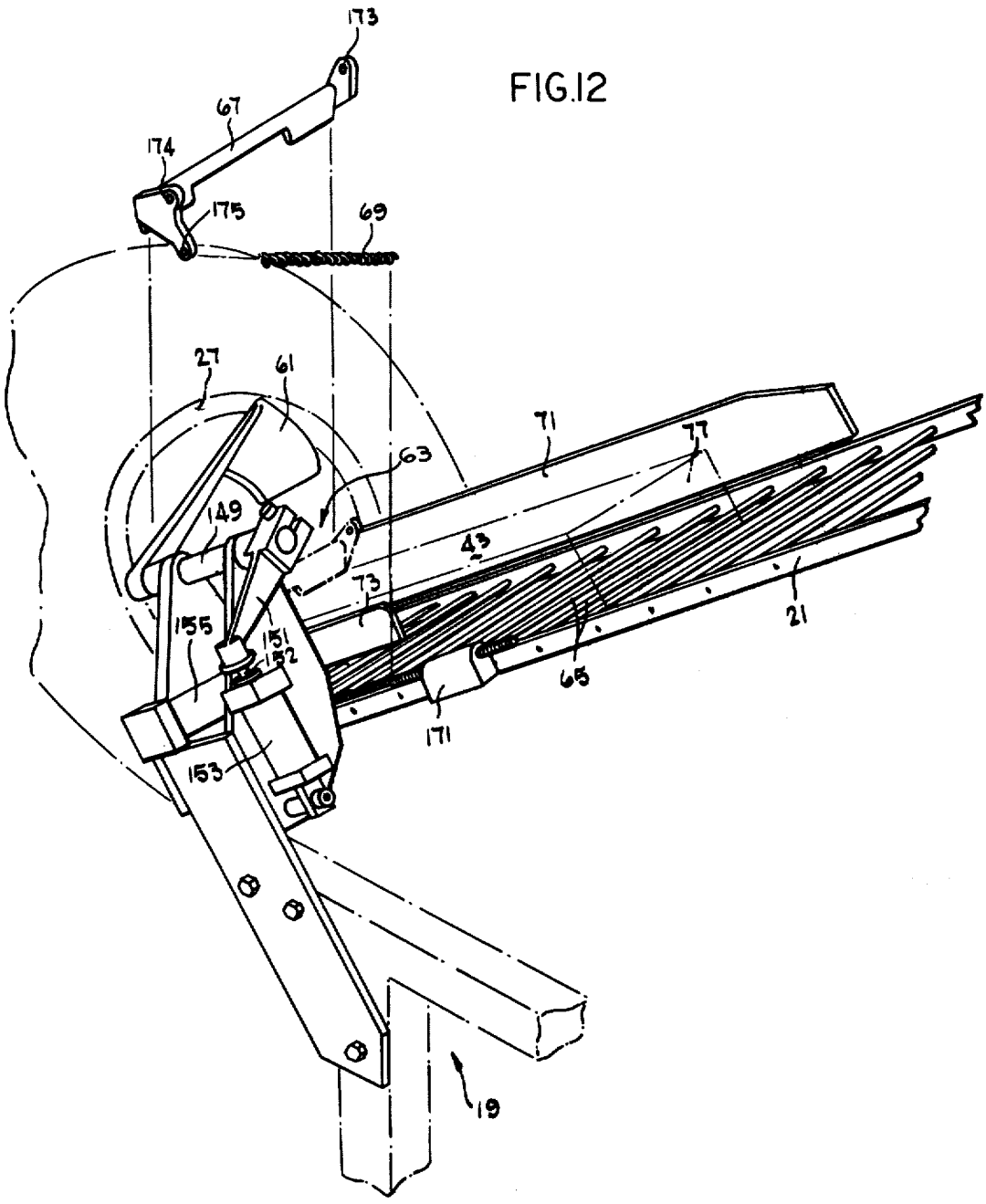
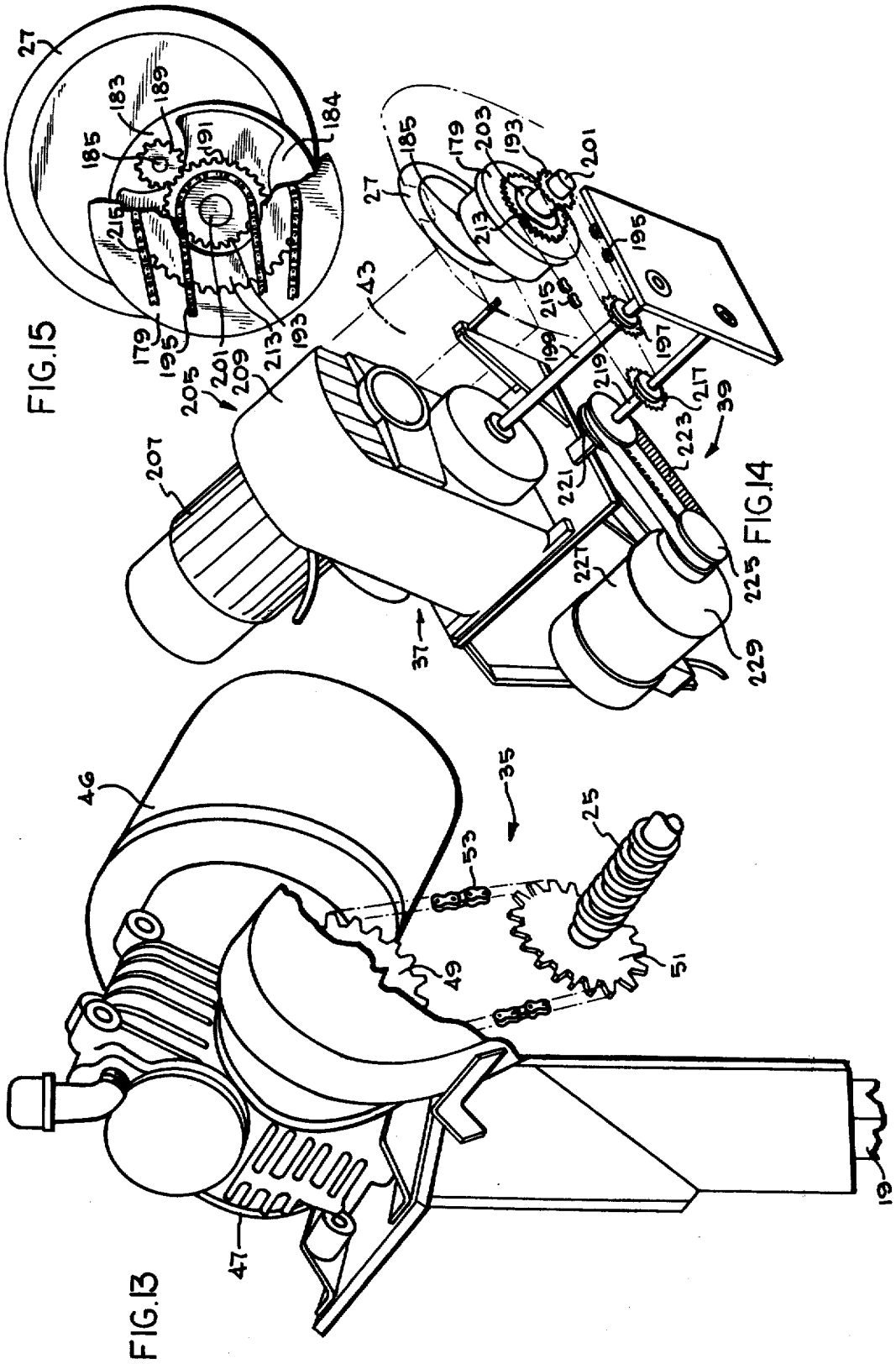


FIG.9

FIG.12


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FIG.15
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FIG.14
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FIG.13

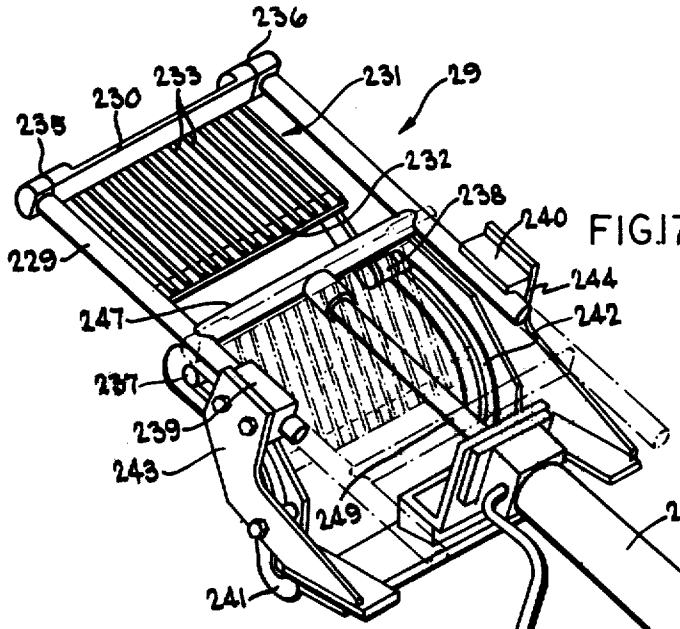

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FIG.17

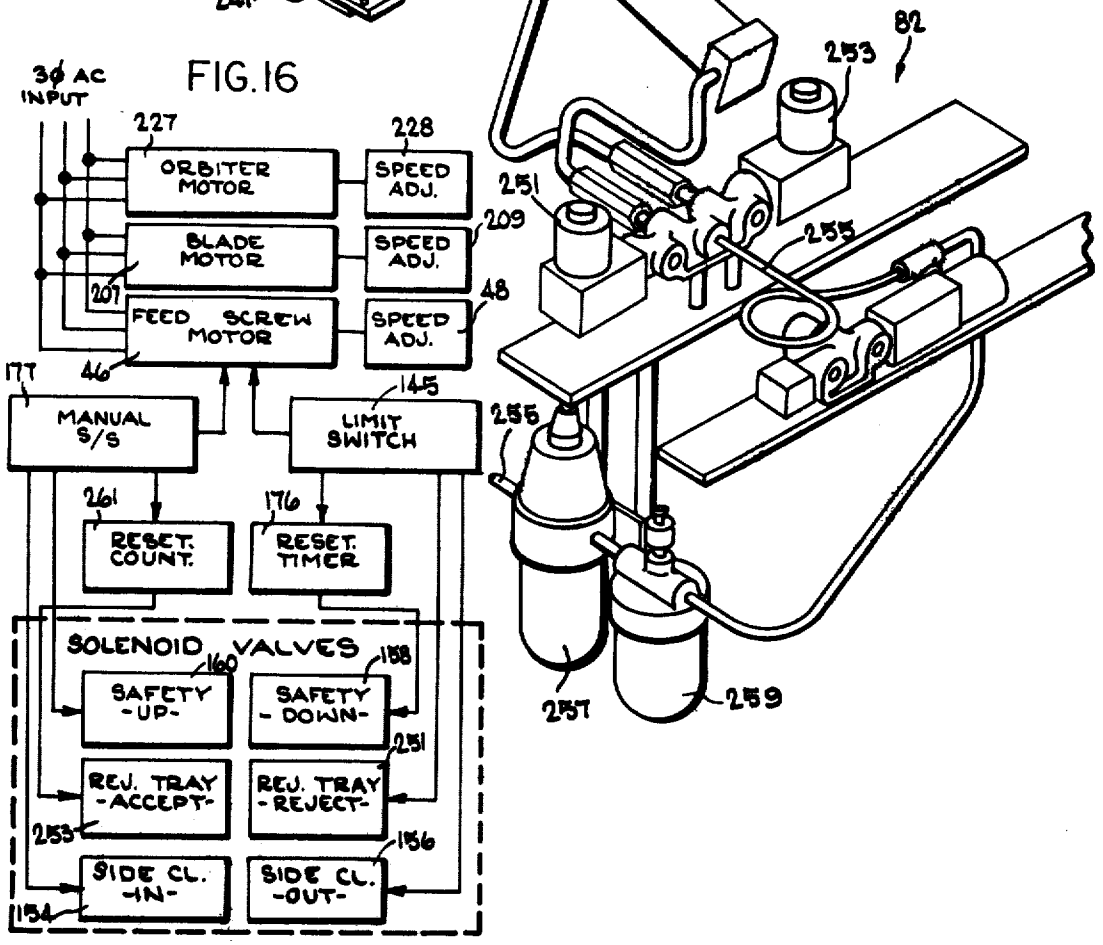

3φ AC INPUT
227
228
ORBITER MOTOR
SPEED ADJ.
BLADE MOTOR
SPEED ADJ.
209
207
FEED SCREW MOTOR
SPEED ADJ.
48
177
46
145
MANUAL S/S
LIMIT SWITCH
261
176
RESET COUNT.
RESET TIMER
SOLENOID VALVES
160
158
SAFETY -UP-
SAFETY - DOWN-
251
REJ. TRAY -ACCEPT-
REJ. TRAY -REJECT-
253
156
SIDE CL. -IN-
SIDE CL. -OUT-
154
82
253
251
255
255
257
259

FIG.16

FIG.18

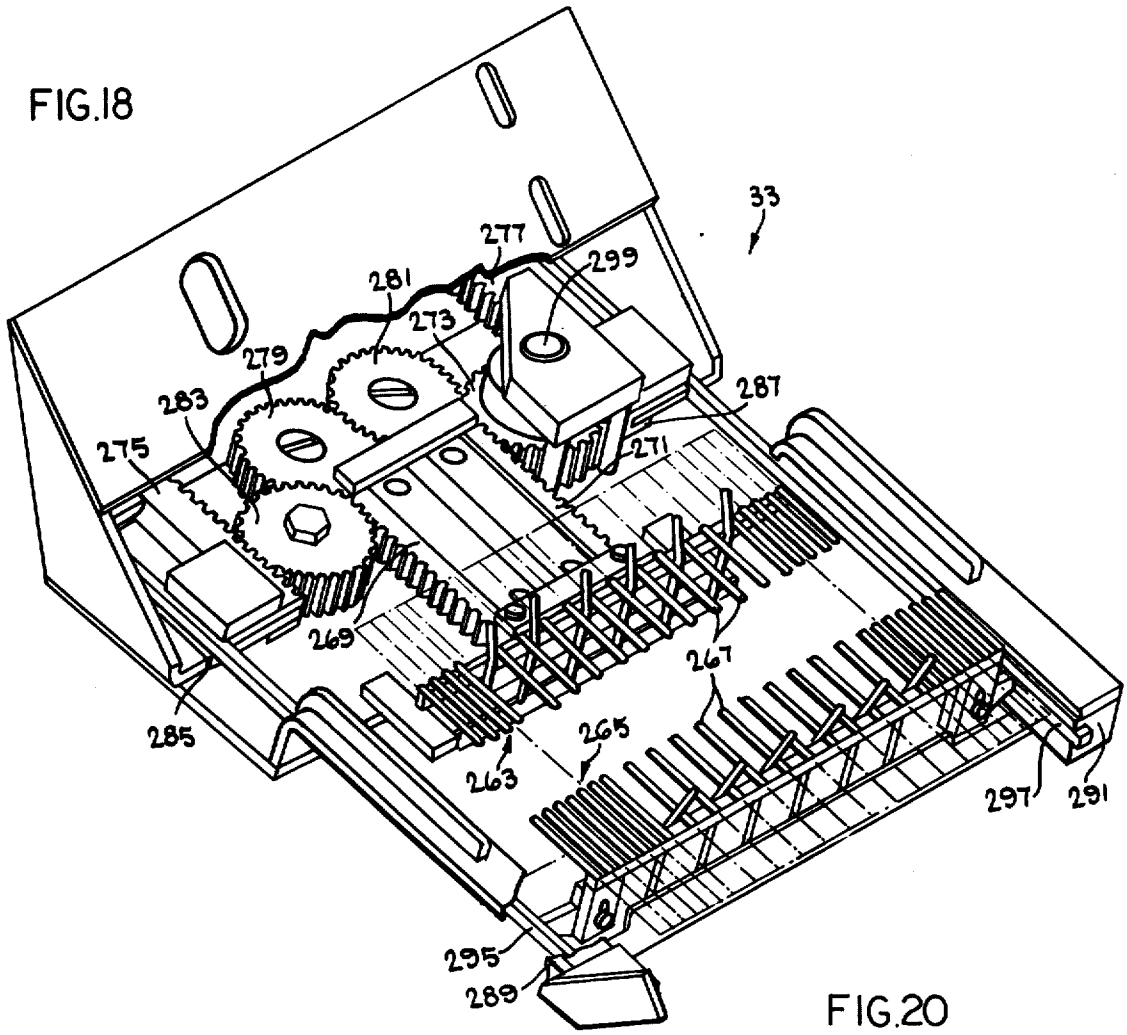


FIG.20

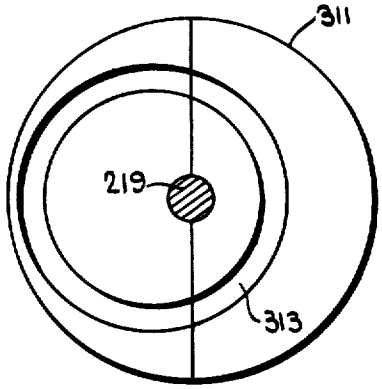
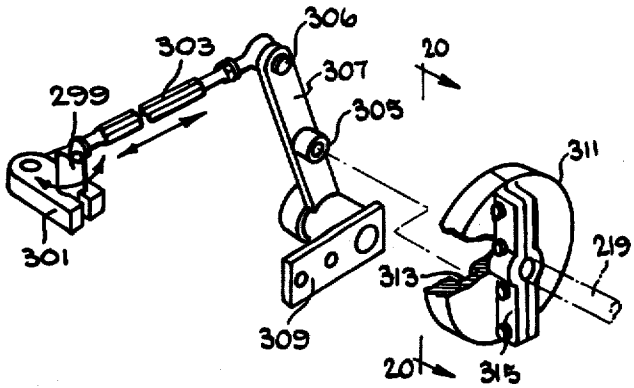


FIG.19



METHOD OF RAPID SLICING

The present invention is a division of co-pending application Ser. No. **146,286,** filed May **24, 1971,** now U.S. Pat. No. **3,797,343,** issued Mar. **19, 1974.**

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. 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 accummulator, 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 by 16 by 20'' 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 3⅜ 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 19 inches and to a height falling within a range of 8 inches maximum and 6¾ inches minimum. Bars having a height less than the minimum of 6¾ 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 shaft 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 **10.** Correlating inversely with these indicia are weights ranging from approximately **14** pounds to approximately **20** pounds. Dial setting **10** corresponds to a bar weighing approximately **14** pounds, whereas dial setting **2 8/10** corresponds to a bar weighing approximately twenty 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 coarse, 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 orbitary 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 **6** 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 **59** 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 **102** 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 **112***a* and **112***b* 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 **114***a* and **114***b* retained on their respective extensions by pull rod extension collars **116***a* and **116***b*. 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 **119***a* and **119***b* 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 **119***a* and **119***b* 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 **119***a* and **119***b* 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 **119***a* and **119***b* 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 down-

wardly. As this occurs, the surface **129**, with which the finger **127** is slidably in contact, moves downwardly, permitting the counterclockwise rotation of the support **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 **112***a*, 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 **112***a* is operatively associated with one pair of half nuts. In like manner, the other pull rod extension **112***b* 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 **112***a* and **112***b* 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 **105** 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 in 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 journalled 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 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 adjusts 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 journalled 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 two hundred 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 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 a separate receptacle the first three slices of a new product bar. The means com-

prises 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 extend 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 the 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 end of its end 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 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 operation. 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 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 sliding 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 **306** 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 ad-

justed 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 resetable 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 resetable 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 slides 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. A method of producing slices of a substantially uniform weight from a plurality of bars of materials having varying densities between bars, comprising the steps of:

trimming each of said bars to a substantially uniform size,

weighing each bar before slicing to determine the density thereof,

feeding each bar forwardly at a constant speed,

slicing each bar as it is fed forwardly at a predetermined slicing speed, and varying one of said speeds for each bar in accordance with the density thereof to provide substantially uniform thickness slices for

each bar and to provide substantially uniform weight slices from the varying density bars.

2. A method of producing slices of a substantially uniform weight from a plurality of blocks of material having varying density between blocks, comprising the steps of:

subdividing each block of material into a plurality of bars of a roughly equivalent size,

trimming each of said bars to a substantially uniform size,

weighing each bar before slicing to determine the density thereof,

feeding each bar forwardly for slicing at a constant speed for each bar,

slicing each bar at a predetermined slicing speed,

and varying one of said speeds for each of said bars in accordance with the density thereof to form slices having substantially uniform weight but different thicknesses.

3. A method of producing slices of controlled weight from a plurality of bars of material wherein the comparative density among the bars is non-uniform, comprising trimming the bars to a substantially uniform size, weighing each bar to determine the density thereof, marking indicia on each bar corresponding to its density, and controlling the slicing of each of the bars in accordance with the density indicia to provide substantially uniform thickness slices for each bar and to provide substantially uniform weight slices from the varying density bars.

4. A method of producing slices of controlled weight in accordance with claim 1 further comprising the steps of accumulating a predetermined number of slices cut at the beginning of each bar and them removing said predetermined number of slices, thereby rejecting certain initial slices from each bar.

5. A method of producing slices of controlled weight in accordance with claim 4 wherein said accumulating of a predetermined number of slices includes discharging all slices individually in a path, counting the initial slices from each bar, intercepting the counted slices, and providing a signal when the count of said slices reaches said predetermined number; and wherein said removing includes retracting the intercepted slices from said path in response to said signal.

6. A method of producing slices of controlled weight in accordance with claim 1 wherein the slices are subsequently individually wrapped, said method further comprising the steps of discharging all slices individually in a path onto a conveyor and controlling the fall of each slice in the path so as to cause the slices to be aligned and uniformly spaced on the conveyor.

7. A method of producing slices of controlled weight in accordance with claim 6 wherein said controlling of the fall includes momentarily arresting the movement of each slice in the path during its fall toward the conveyor and then releasing each arrested slice in timed relationship with preceding slices on the conveyor.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,894,457

DATED : July 15, 1975

INVENTOR(S) : Roland E. Miller et al.

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

Col. 6, line 12, "coarse" should be --course--.

Col. 14, line 63, "relative" should be inserted after "uniform".

Col. 15, line 27, "accept" should be in quotes.

Col. 15, line 33, "one end of its end" should read --one of its ends--.

Col. 15, line 47, "reject" should be in quotes.

Col. 15, line 49, "accept" should be in quotes.

Col. 15, line 63, "accept" should be in quotes.

Col. 16, lines 25 and 26, "accepted" should be in quotes.

Col. 16, line 38, "accept" should be in quotes.

Col. 16, line 42, "reject" should be in quotes (both occurrences).

Col. 16, line 44, "accept" should be in quotes.

Col. 18, line 7, "sliding" should be --slicing--.

Col. 19, line 15, "accept" should be in quotes.

Col. 19, line 17, "accept" should be in quotes.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,894,457

DATED : July 15, 1975

INVENTOR(S) : Roland E. Miller et al.

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

Col. 19, line 17, "up" should be in quotes.

Col. 19, line 20, "in" should be in quotes.

Col. 19, line 35, "down" should be in quotes.

Col. 19, line 37, "reject" should be in quotes (first occurrence).

Col. 19, line 38, "reject" should be in quotes (second occurrence).

Col. 19, line 39, "out" should be in quotes.

Signed and Sealed this

seventeenth Day of *February 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks