United States Patent [19]

Schlueter et al.

[11] **3,729,085**

[45] **Apr. 24, 1973**

[54] **CASING MACHINE**

[75] Inventors: **David F. Schlueter**, Hoopeston, Vermilion, Ill.; **Myron C. Noble**, St. Joseph, Ind.

[73] Assignee: **FMC Corporation**, San Jose, Calif.

[22] Filed: **Oct. 19, 1970**

[21] Appl. No.: **82,044**

Related U.S. Application Data

[62] Division of Ser. No. 757,876, Sept. 6, 1968, abandoned.

[52] **U.S. Cl.** ....**198/25,** 198/33 AD

[51] **Int. Cl.** **B65g 47/24**

[58] **Field of Search** ....198/25, 33 AD, 209, 198/211; 53/159

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Primary Examiner—Edward A. Sroka

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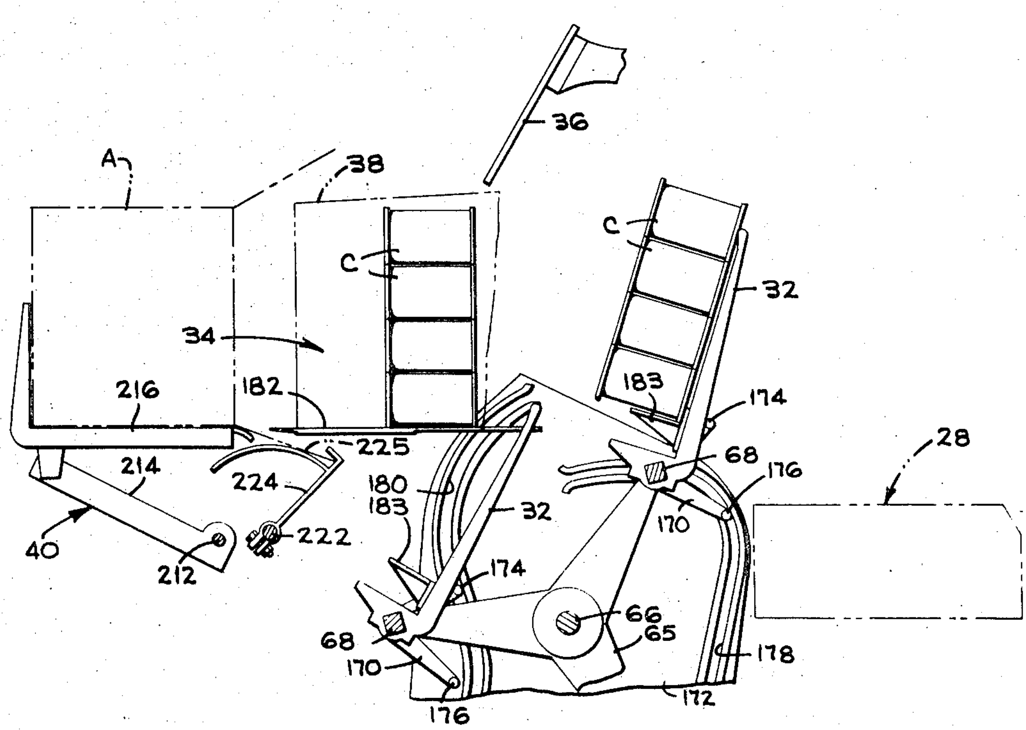
[57] **ABSTRACT**

Upright containers are fed into the casing machine from a multiple lane supply line, assembled into one tier, and the tier is transferred and reoriented by tiering fingers which deposit the containers in a tiering chamber. The open end of an empty case is manually positioned adjacent the tiering chamber, and pusher feet insert the tier in the case. A feature of the casing machine is a rocking differential which smoothly accelerates and decelerates the tiering fingers to prevent damage to the containers. Other features include a timing pin and chain mechanism which can be manually adjusted to control the number of tiers loaded into a case, rapid change structure in the zone where the tiers are assembled so that the machine is readily adaptable to handle a range of container sizes, and a lowerator mechanism under positive mechanical control for gently lowering the loaded cases to a discharge position.

4 Claims, 33 Drawing Figures



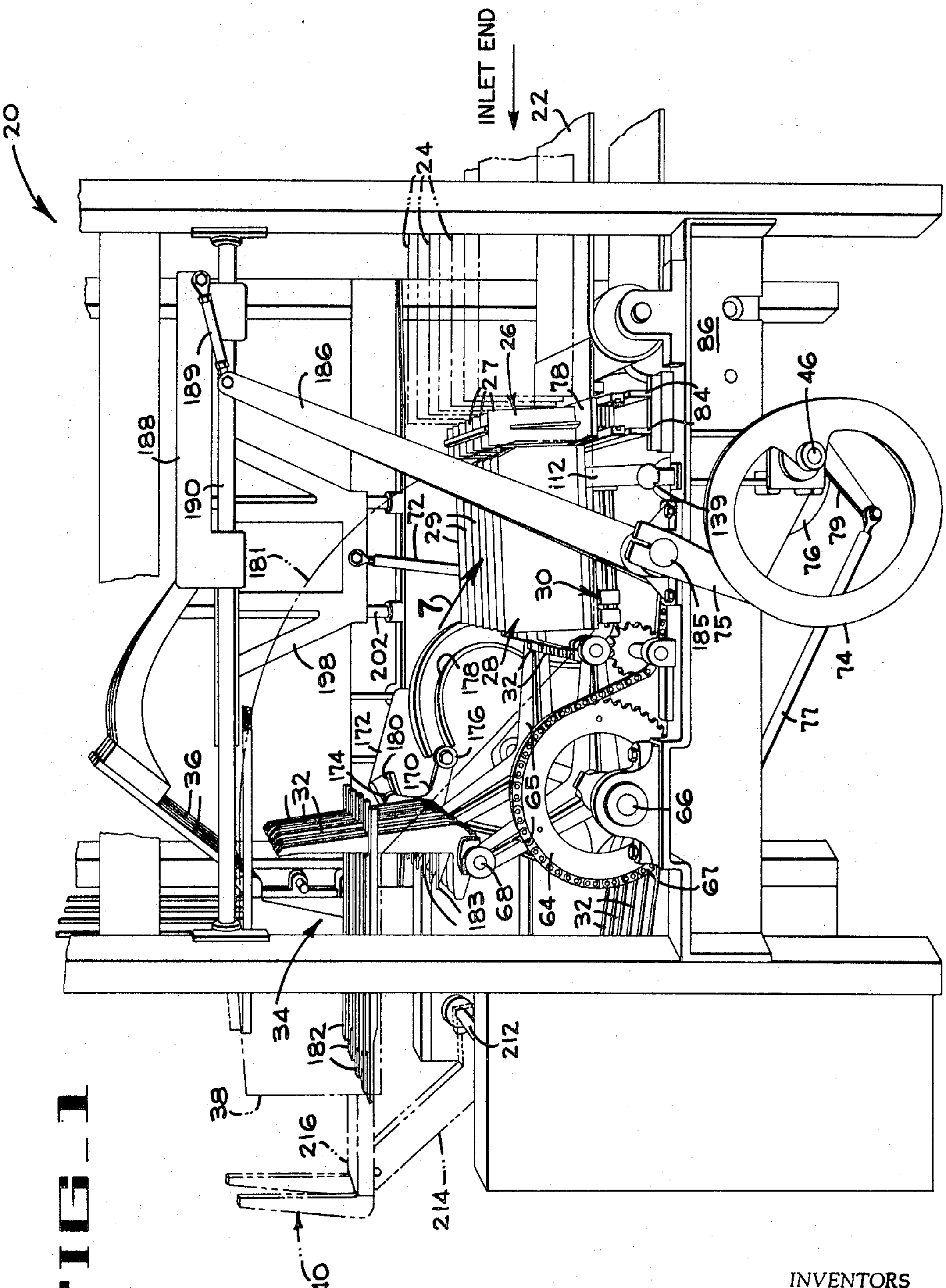


FIG_1

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Patented April 24, 1973

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15 Sheets-Sheet 2

FIG_2

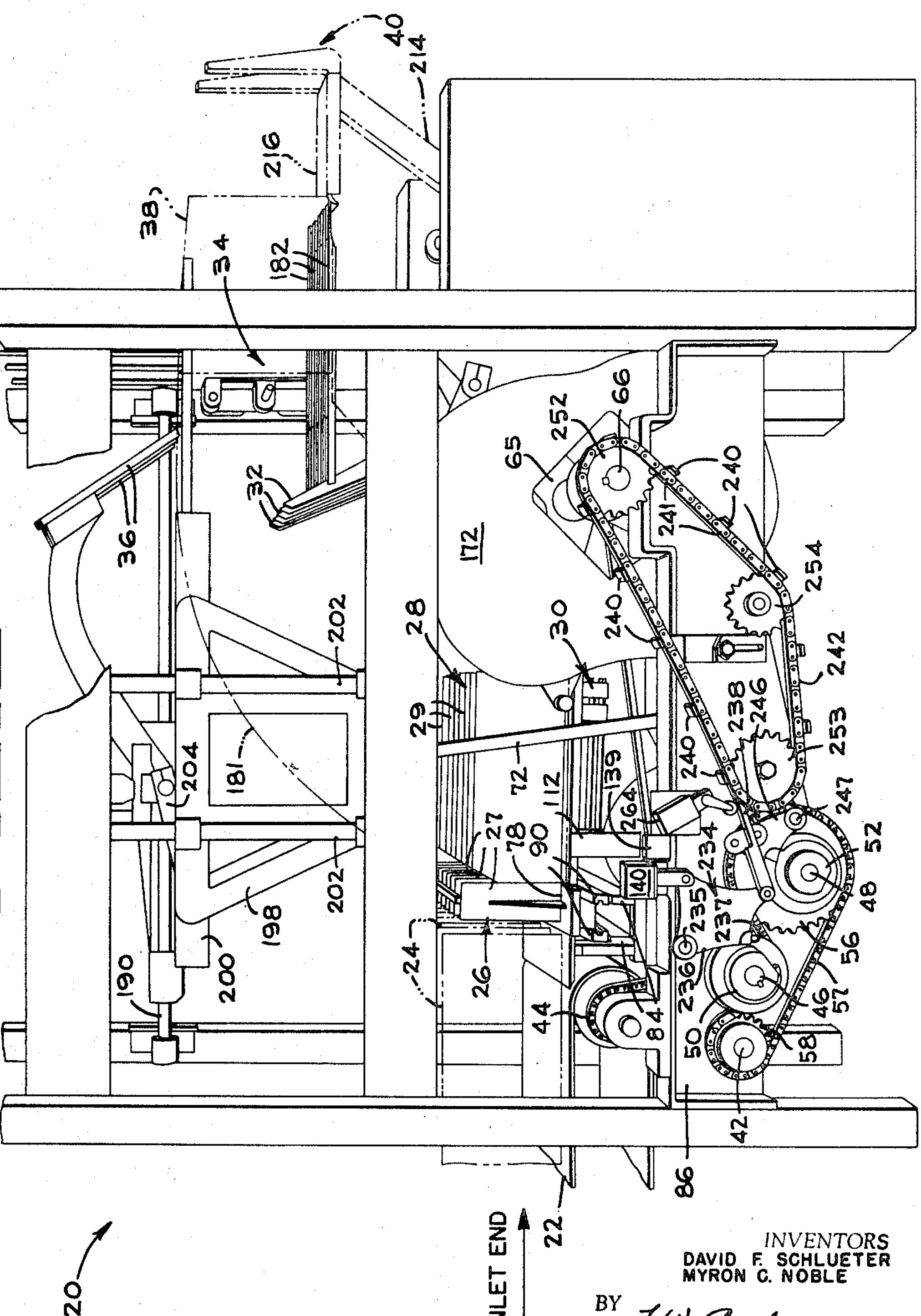

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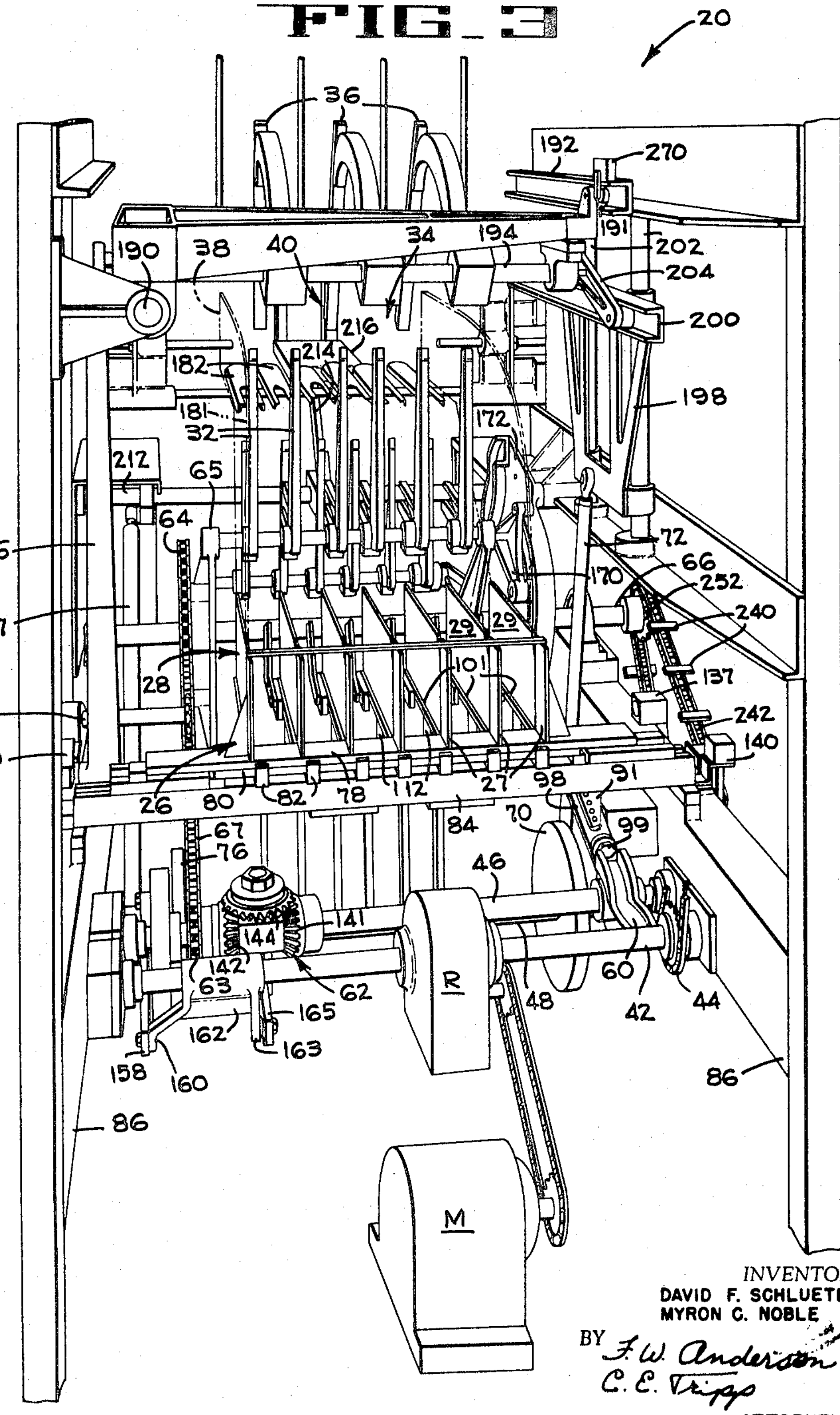
FIG_3



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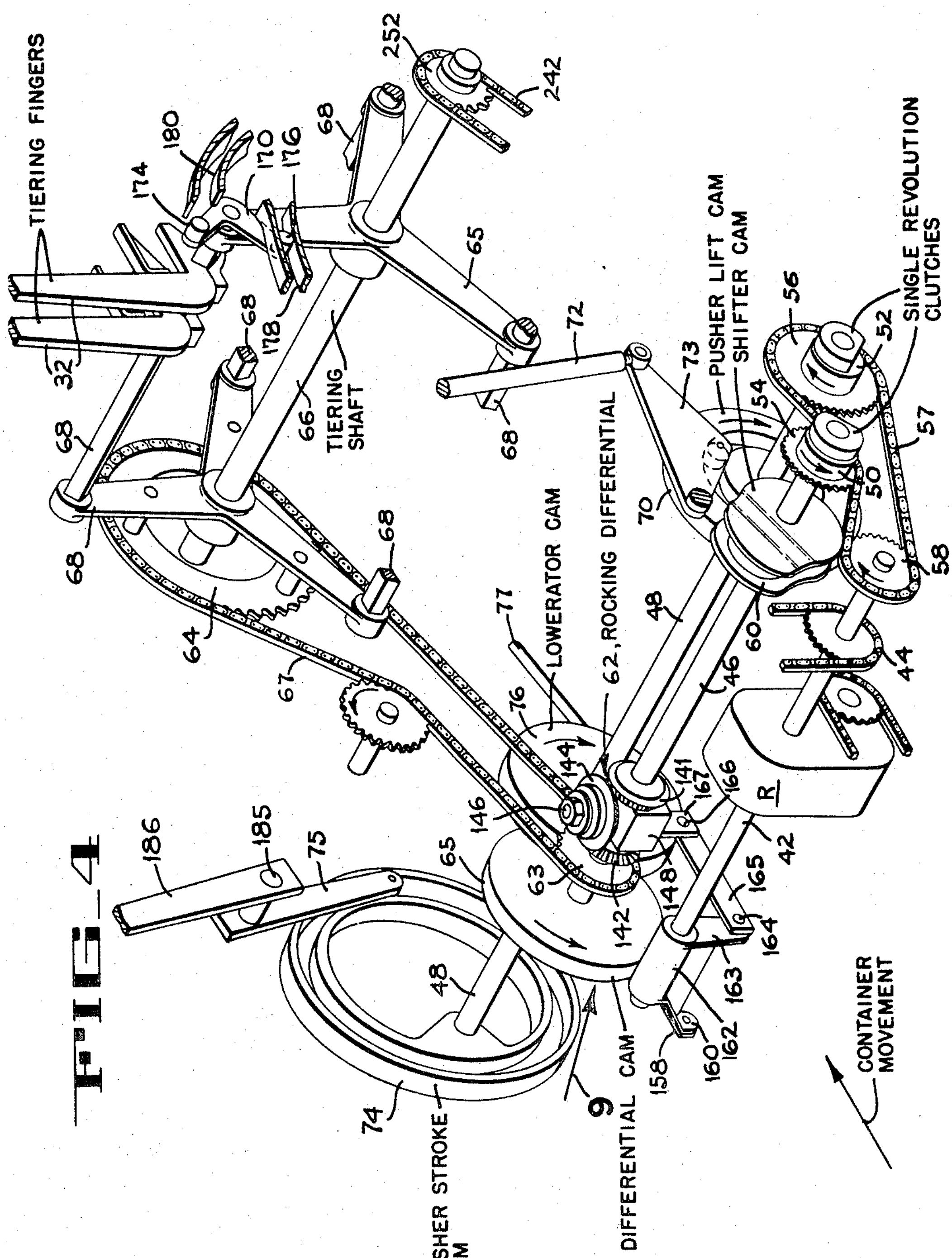

FIG_4

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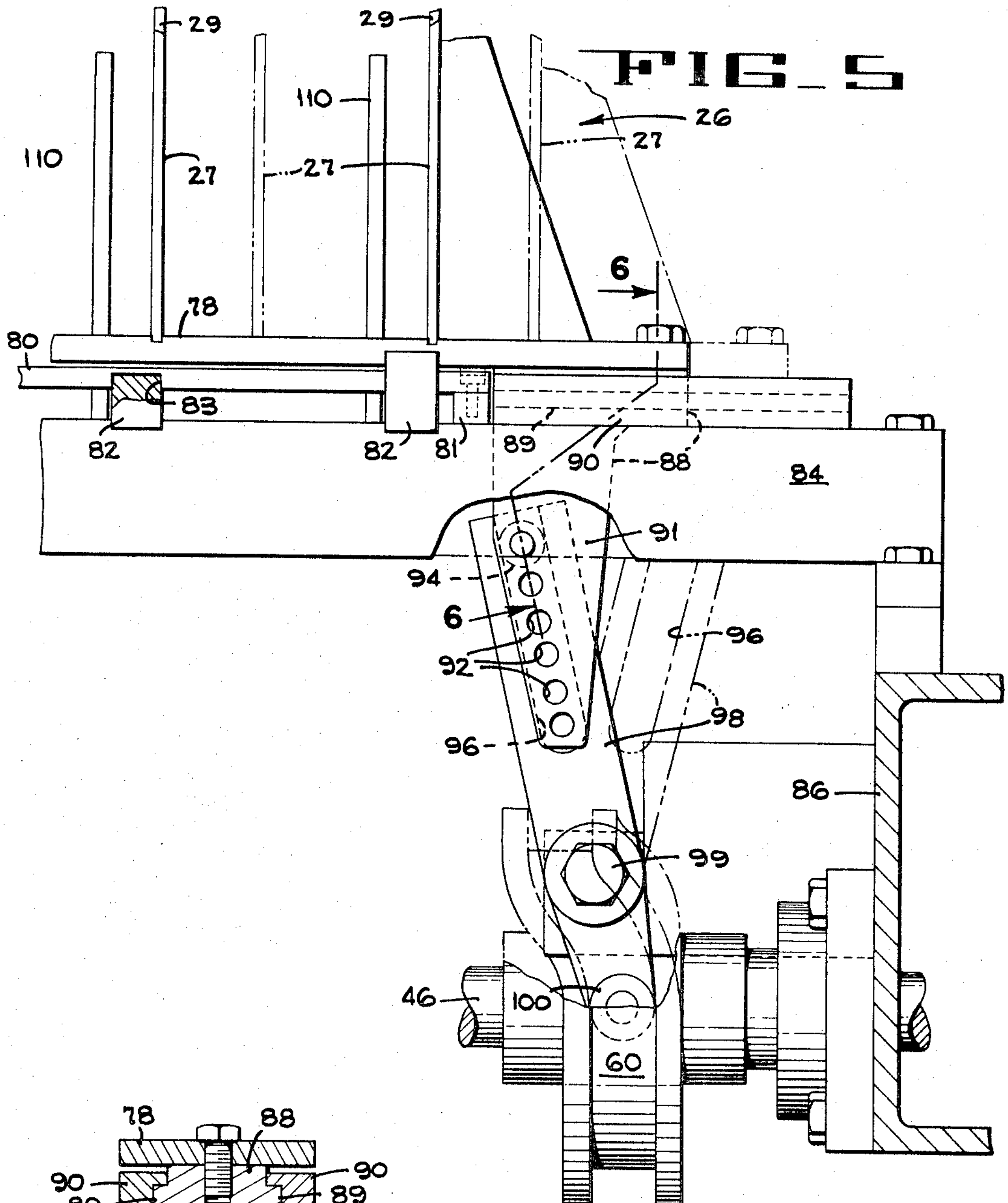
FIG_5



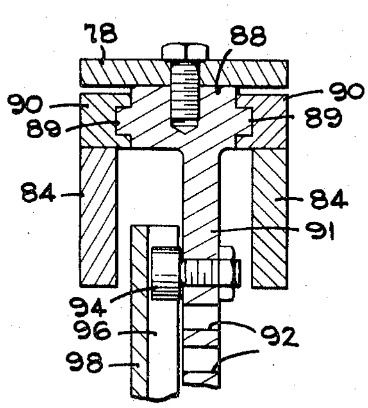


FIG_6

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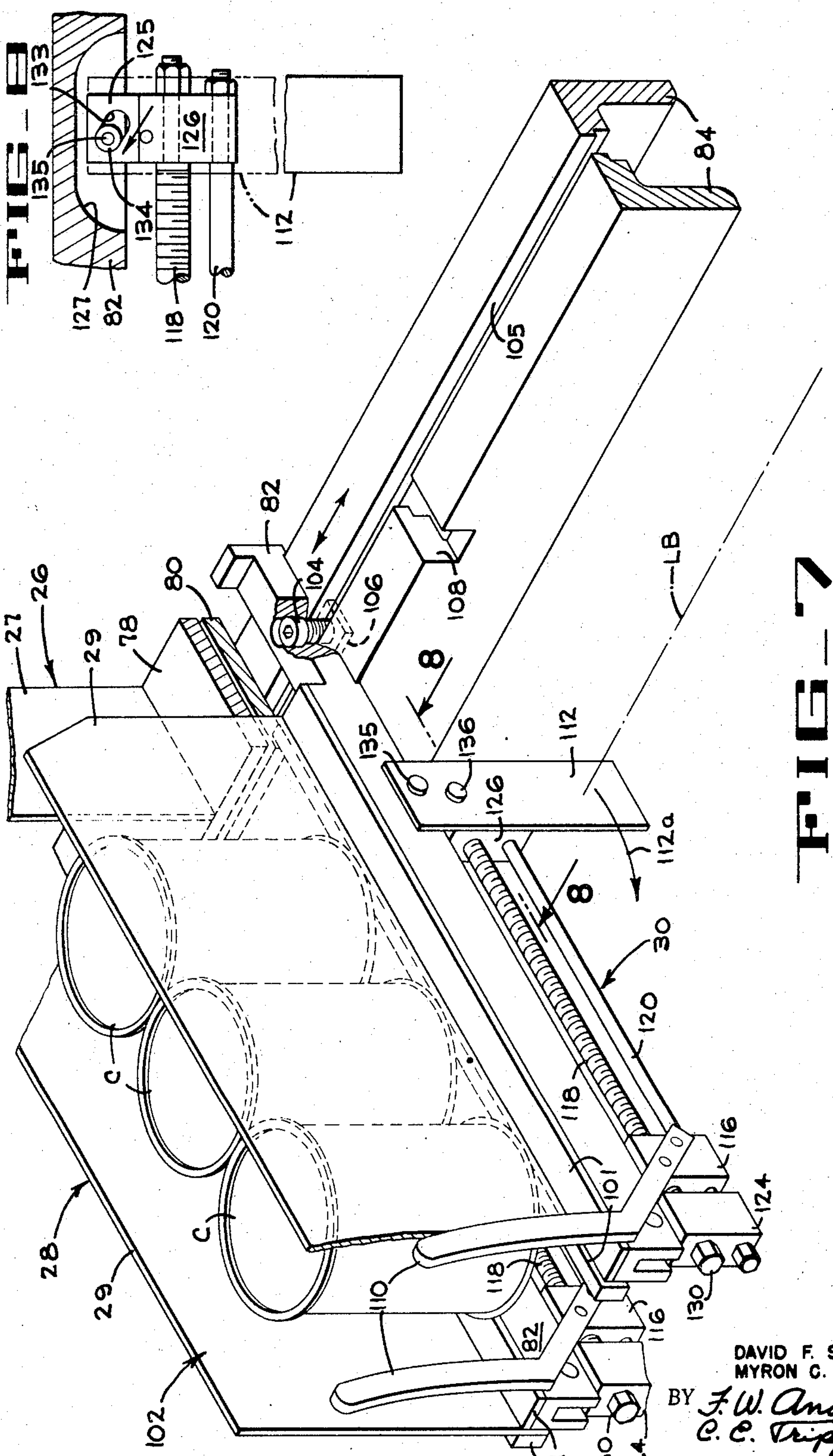

FIG_8

FIG_7

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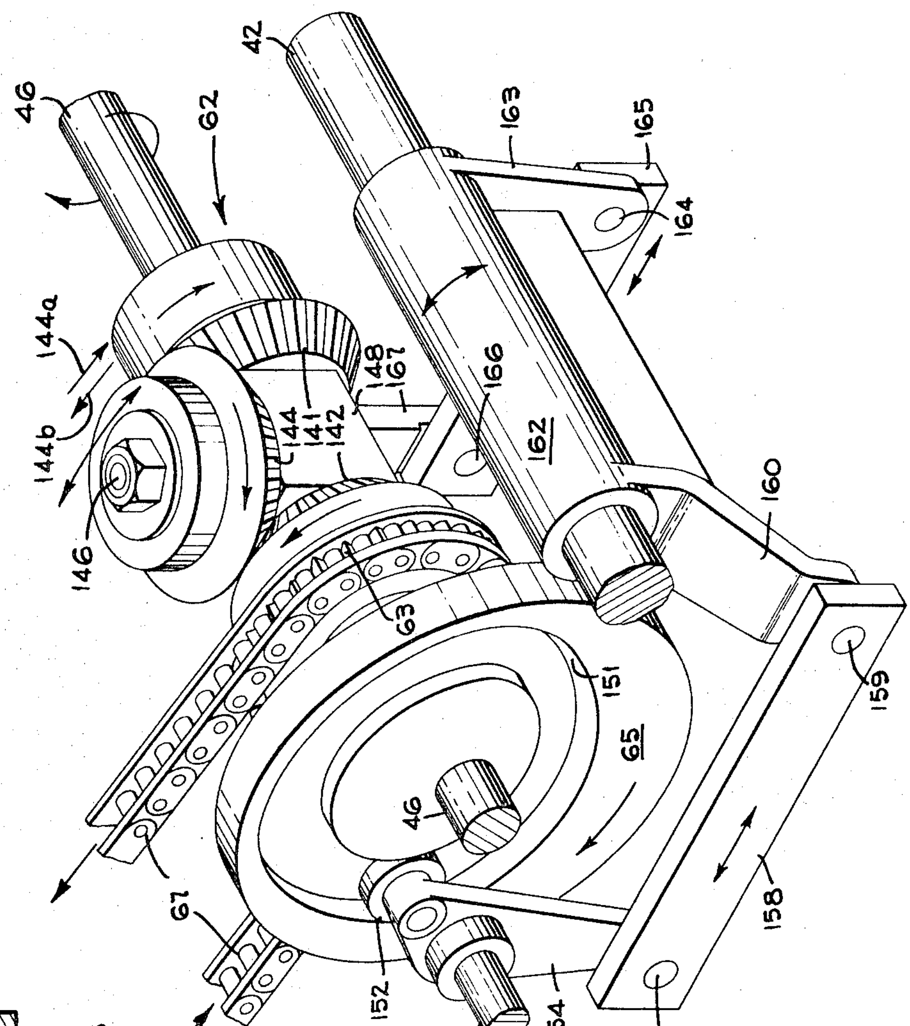

FIG_9

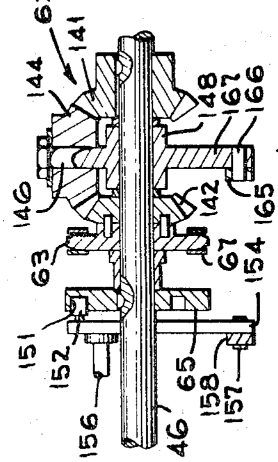

FIG_9A

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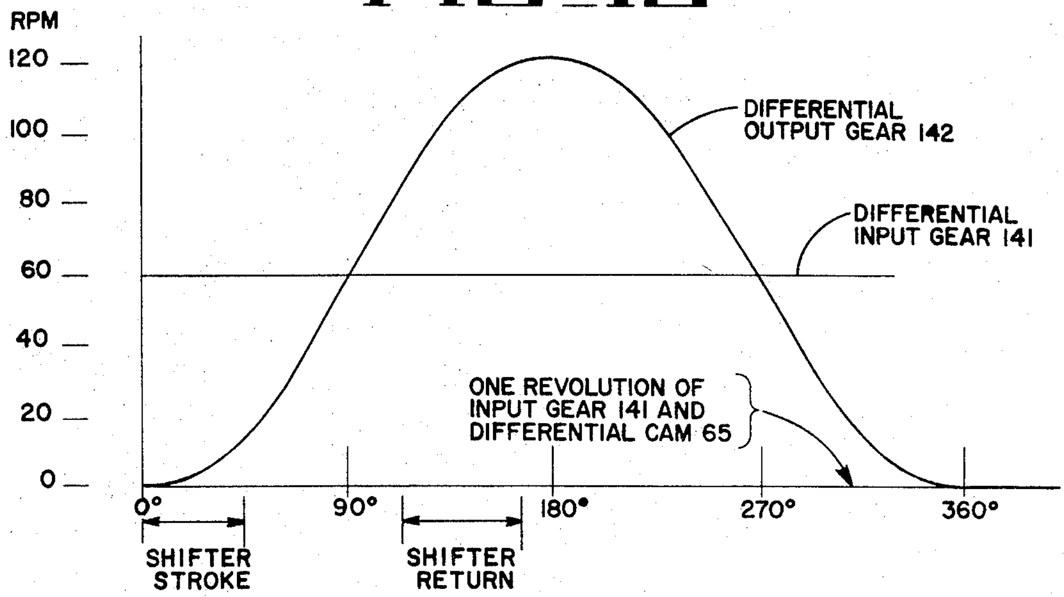
FIG_10



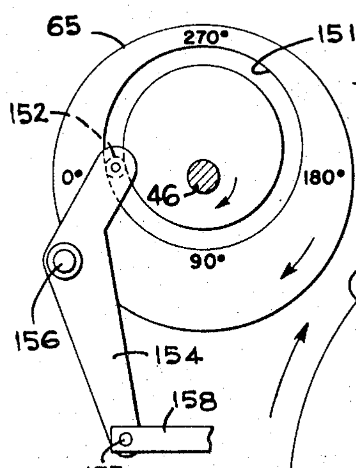


FIG_10A

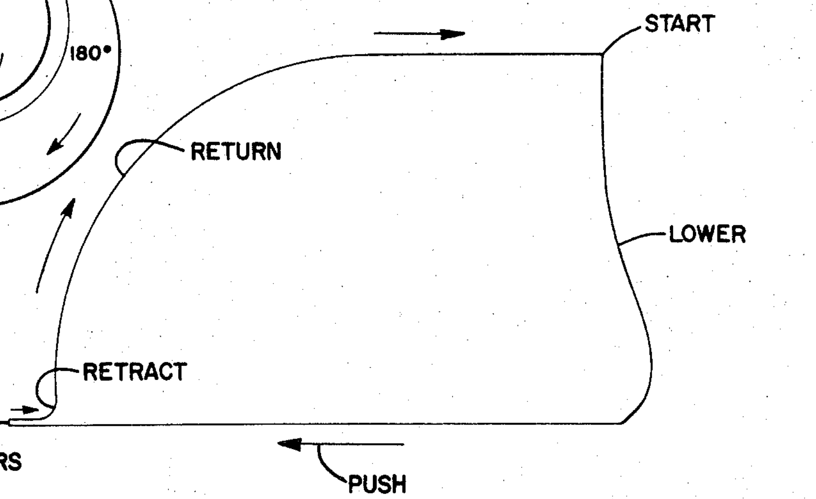


FIG_12

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FIG_11A

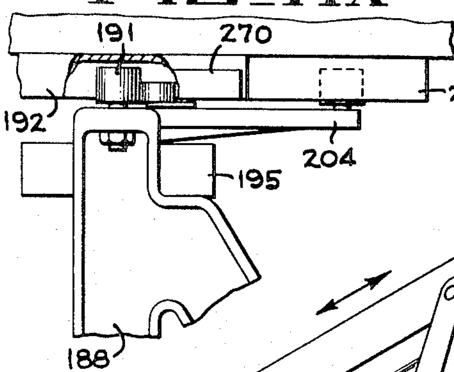
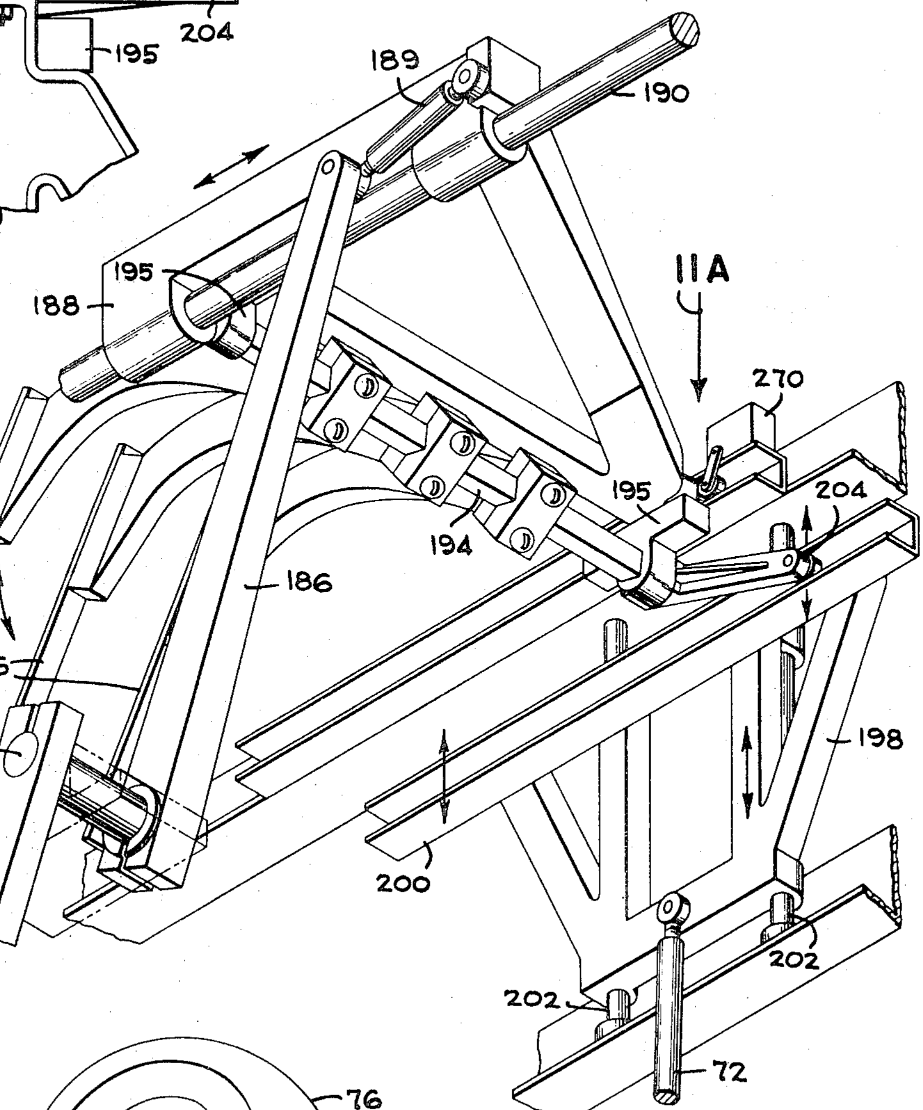


FIG_11



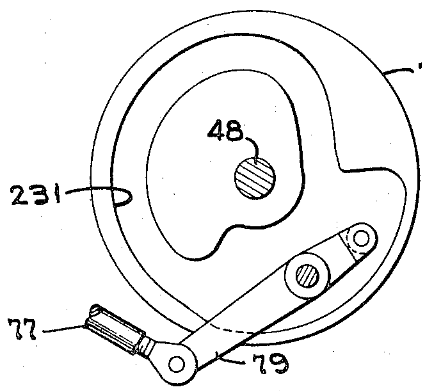


FIG_18A

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FIG_14

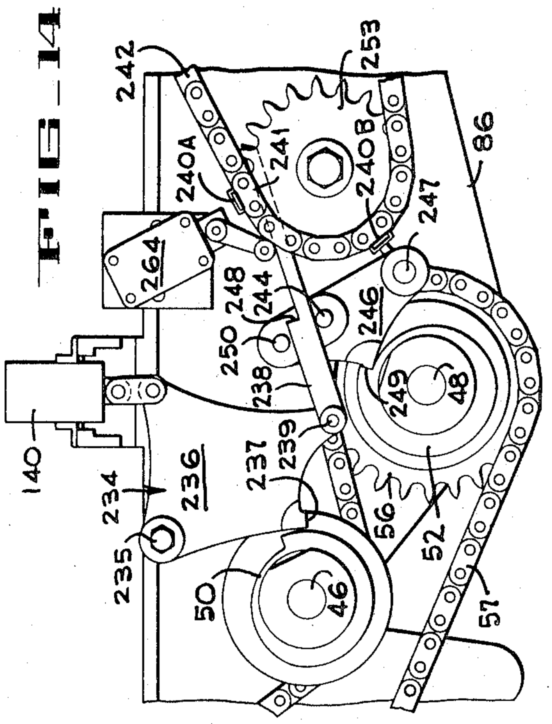


FIG_16

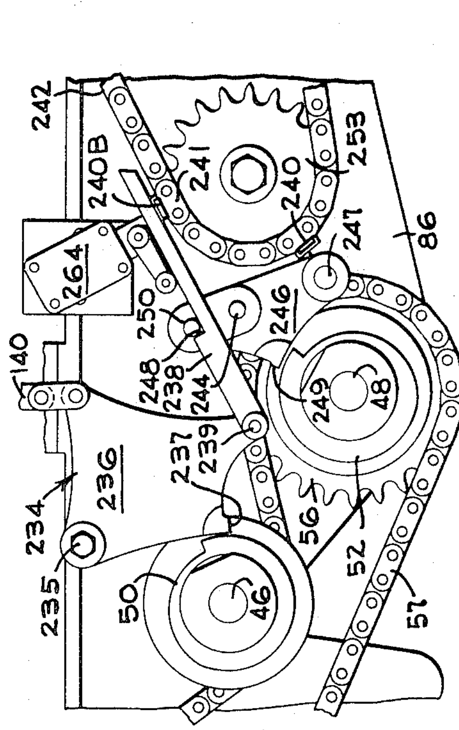


FIG_13

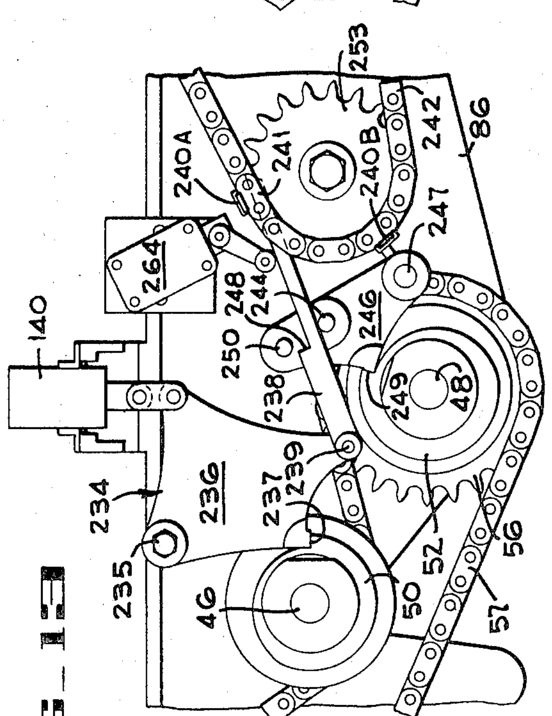
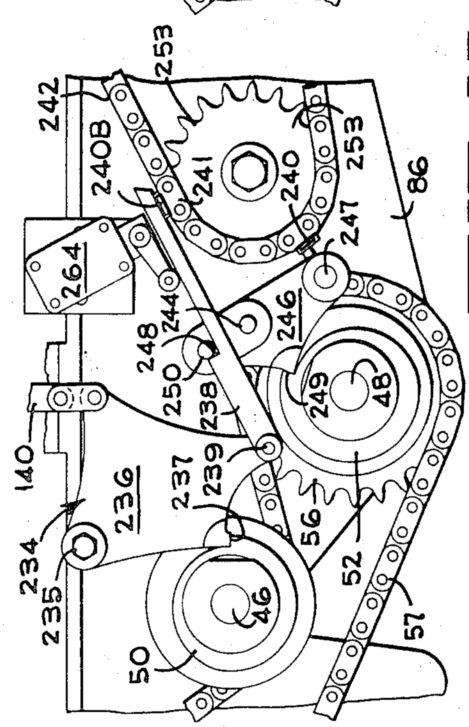


FIG_15



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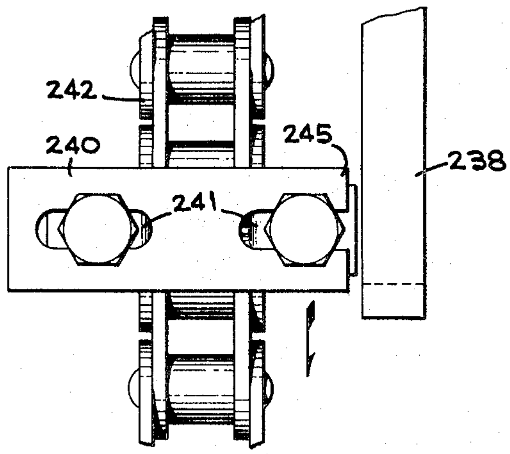

FIG_17

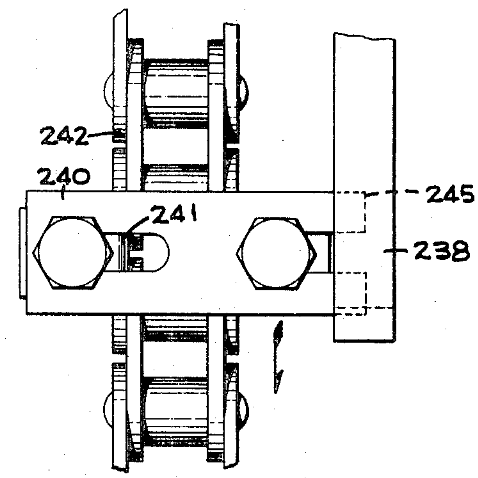

FIG_17A

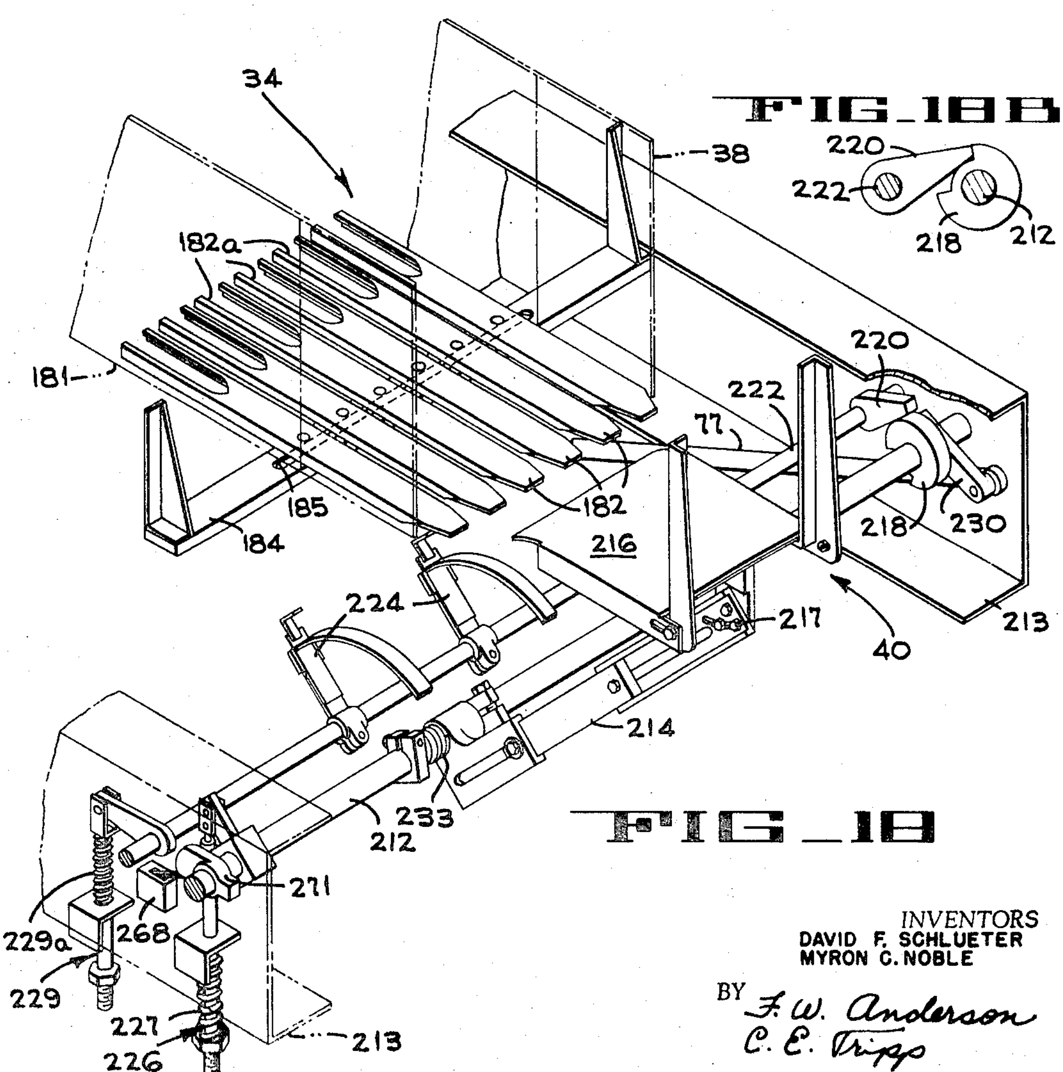

FIG_18B

FIG_18

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FIG_19

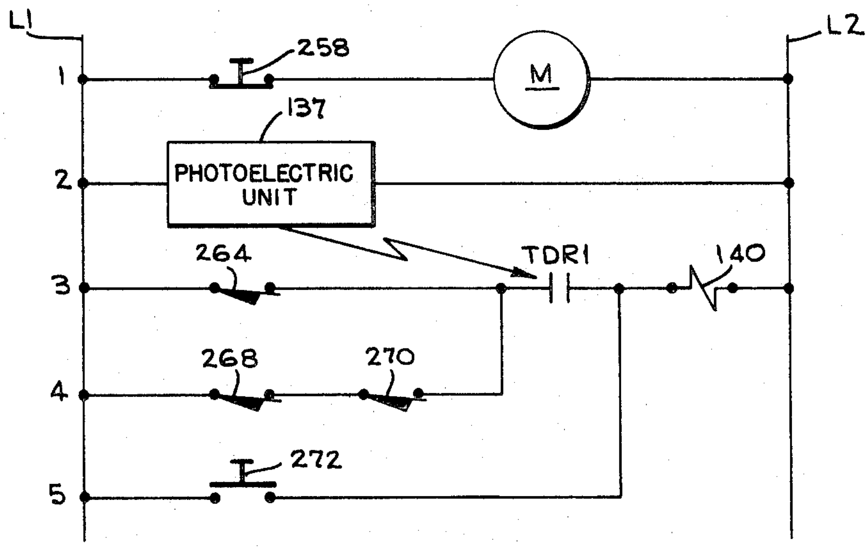
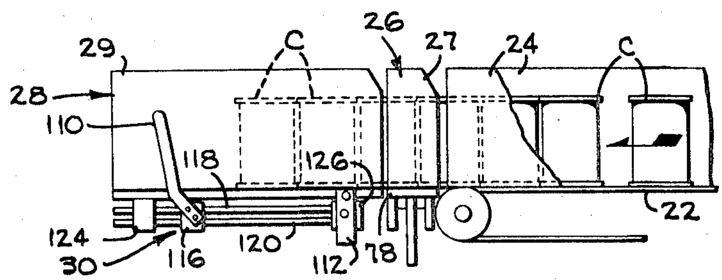


FIG_20



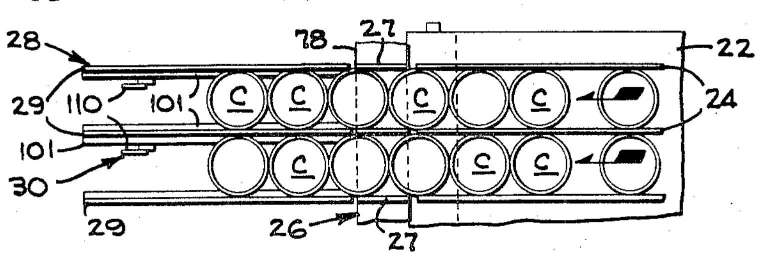


FIG_20A

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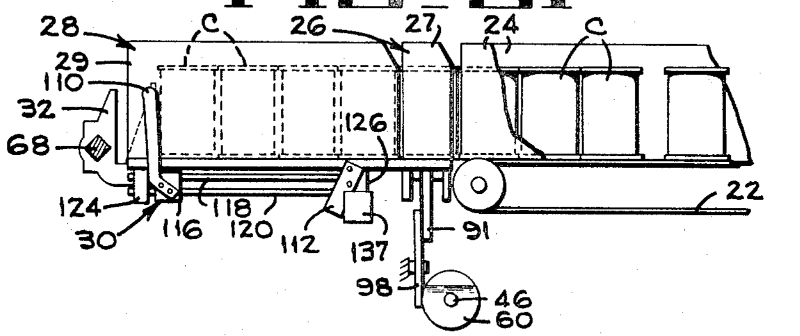
FIG_21



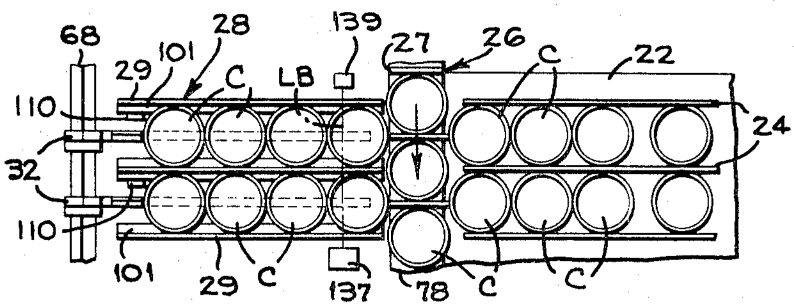


FIG_21A

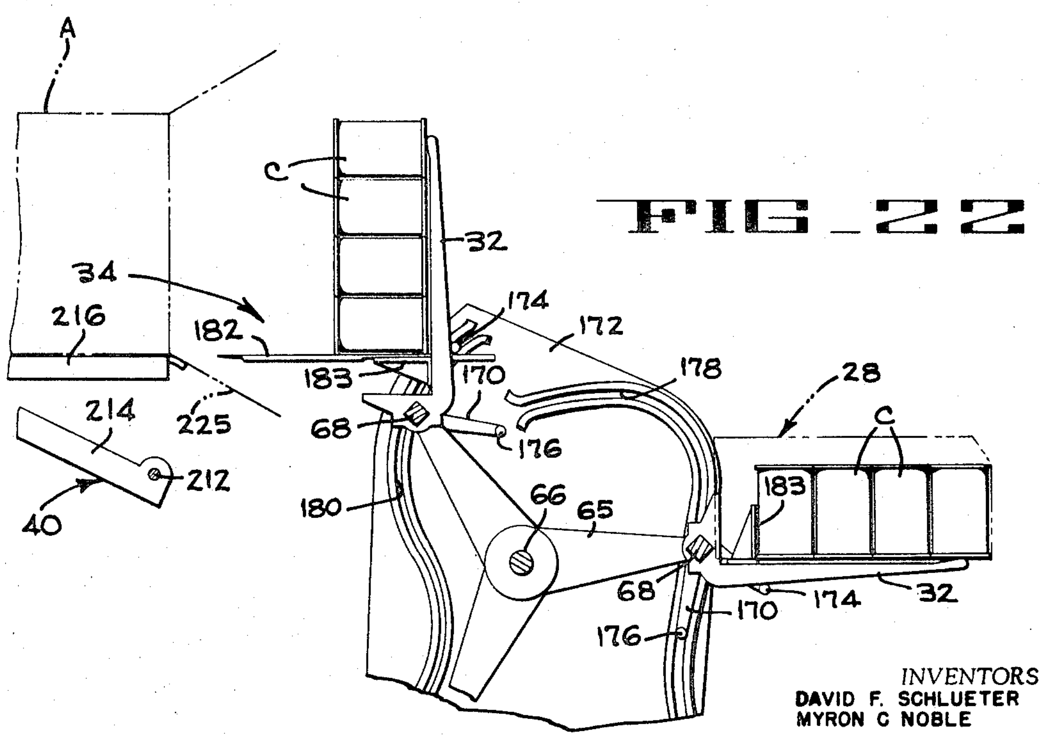


FIG_22

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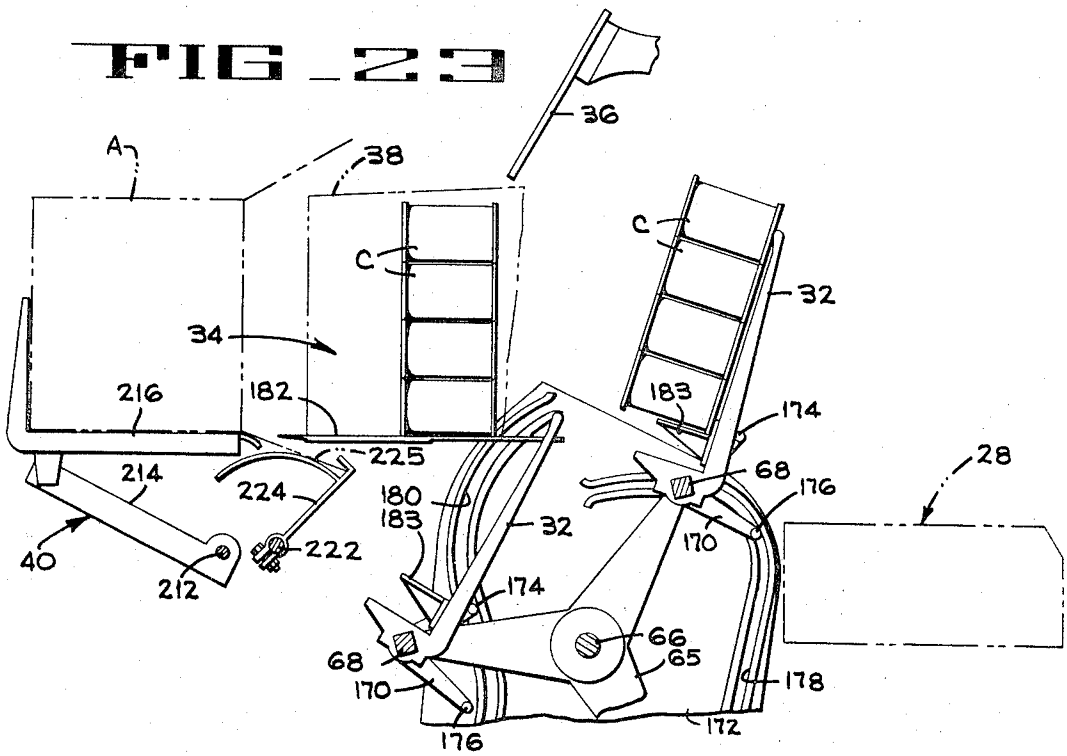
FIG_23



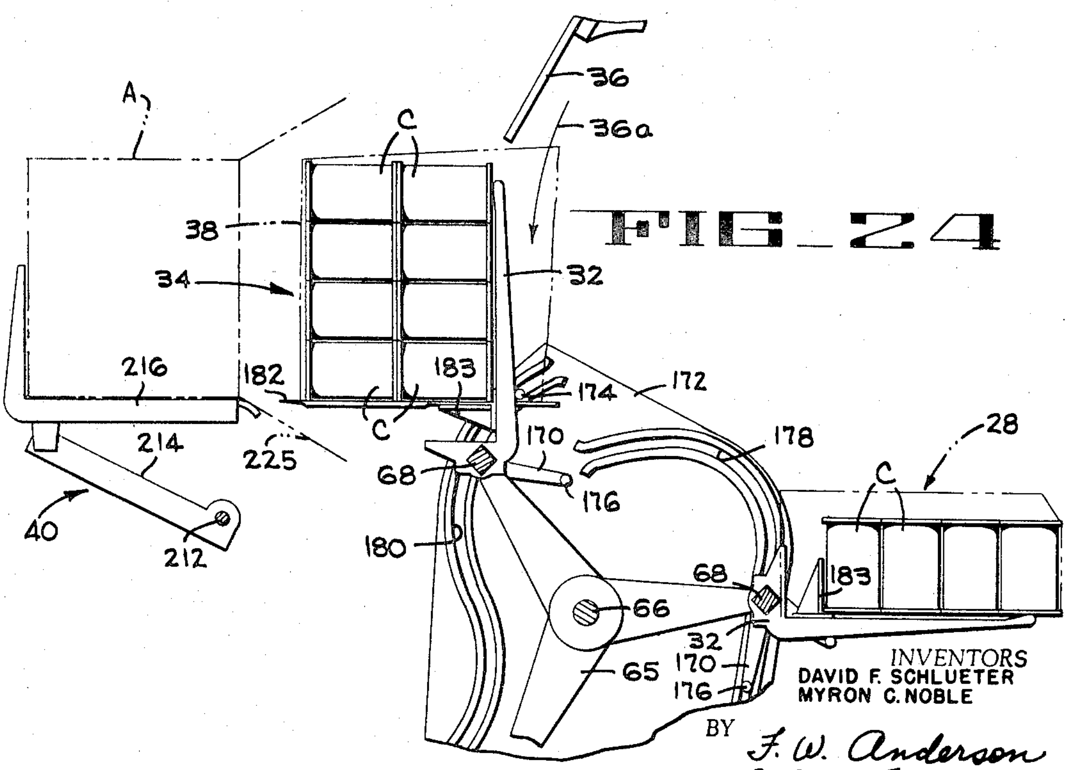


FIG_24

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FIG_25

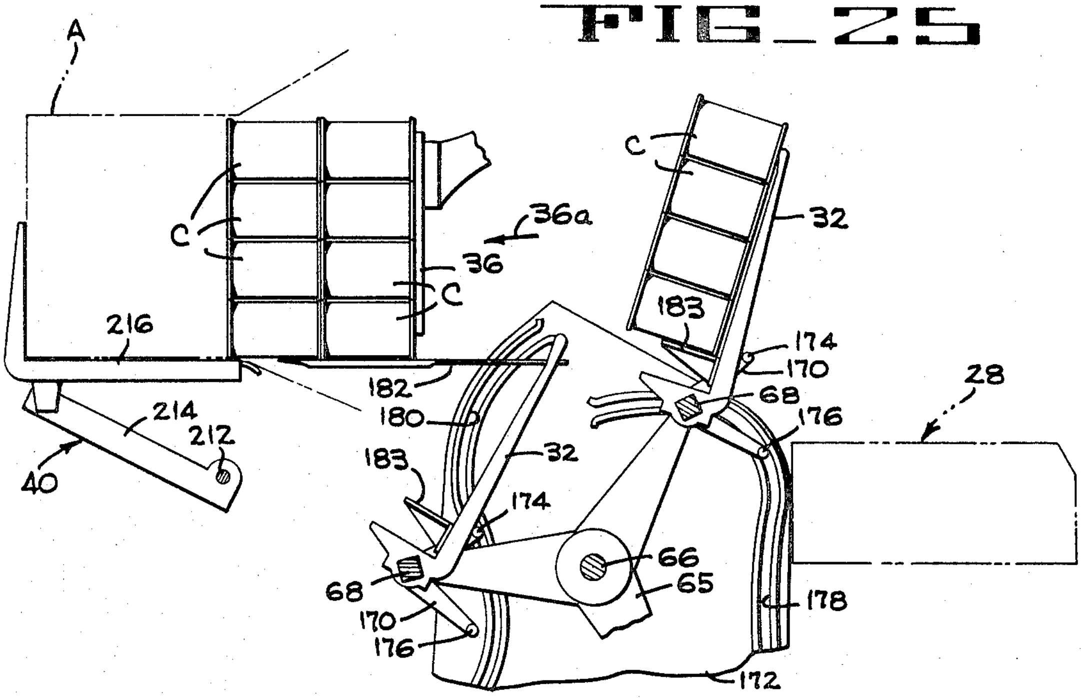
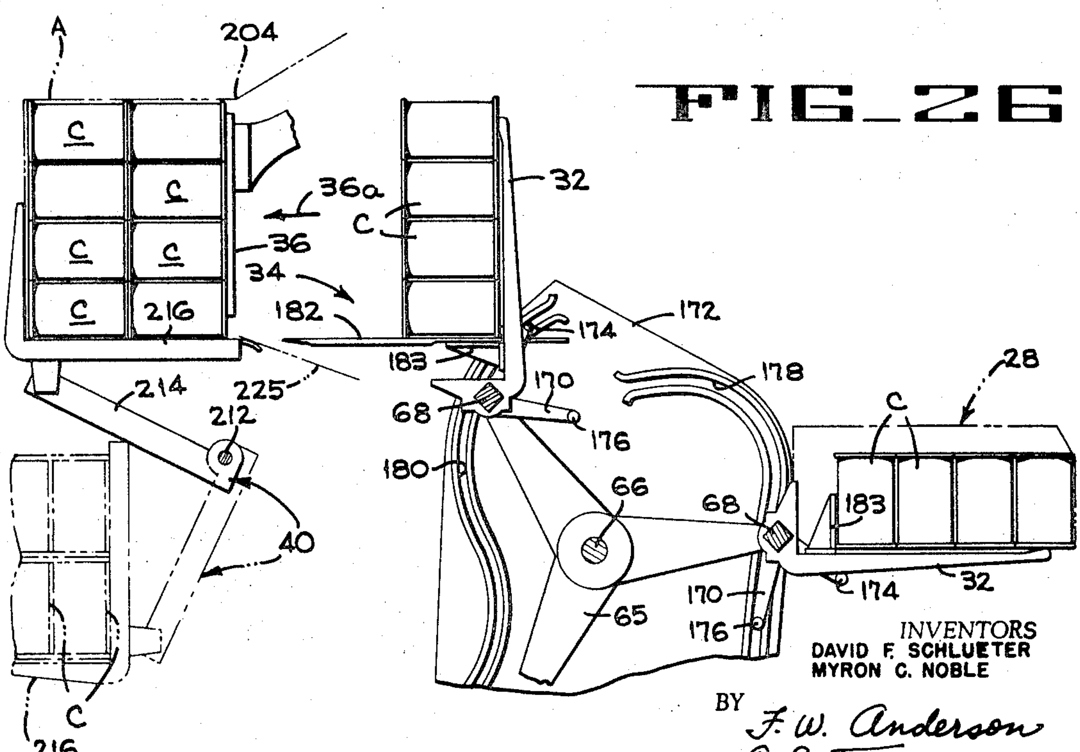


FIG_26



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CASING MACHINE

This is a division of application Ser. No. 757,876 filed Sept. 6, 1968, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to container handling machines, and particularly to machines which insert a tier or tiers of containers into a case. More specifically, the invention concerns casing machines of the type including sets of aligned tiering fingers which lift multiple row tiers of upright containers from a centrally apertured separator adjoining the end of a container supply line, and which reorient and transfer the tier of containers to a tiering chamber from which they are inserted endwise into a case.

2. Description of the Prior Art

The present invention concerns a casing machine of the type disclosed in U.S. Pat. No. 2,650,009 to Kerr, and assigned to the assignee of the present invention. One disadvantage of the Kerr apparatus is that undesirable shock loads are sometimes imparted to the containers and to the driving mechanism of the machine because of the sudden engagement of a single revolution clutch which drives the tiering fingers that transfer the containers, and due to the inertia of the fingers and their almost instantaneous acceleration to maximum speed.

Also, the tiering fingers must travel upward approximately three inches before contacting the bottoms of each assembled tier of containers to allow time for a shifter mechanism to block the incoming containers that must be isolated from the tier. As a result, the containers are subjected to shock and/or denting because the tiering fingers are moving near maximum velocity at the time they engage the containers. Additional shock and jarring is experienced by the containers as they are transferred onto the floor of a tiering chamber because the tiering fingers which effect the transfer, travel at a constant velocity. Also, containers whose height is approximately equal to or less than their diameter tend to become disoriented when entering the tiering chamber at a high velocity and the top rows of containers tend to tip forwardly.

Pusher feet in the patented structure transfer the tiers of containers into a case. The pusher feet trace a path similar to a parallelogram in a vertical plane, and the forward and rearward cycles are identical. The resulting motion is quite rapid, tending to upset tiers of short cans, and the case flaps are sometimes torn by the pusher feet due to their immediate lifting in the rearward stroke.

SUMMARY OF THE INVENTION

An important feature of the present invention is a rocking differential drive mechanism, by means of which the cans are smoothly accelerated from rest to maximum velocity, and are then decelerated as they are deposited on the floor of the tiering chamber where they are assembled into case loads. This eliminates undue shock which might otherwise damage the containers or their product.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective of the casing machine of the present invention, with the inlet end of the machine at the right.

FIG. 2 is a perspective of the casing machine viewed from the side opposite to the side shown in FIG. 1.

FIG. 3 is a perspective of the casing machine viewed from its inlet end.

FIG. 4 is a perspective of the drive train of the casing machine.

FIG. 5 is an enlarged, fragmentary elevation of a shifter mechanism which controls the flow of containers into the casing machine and is viewed in a downstream direction.

FIG. 6 is a section taken on lines **6—6** of FIG. **5**.

FIG. 7 is a fragmentary perspective of two divider units which cooperatively define a lane for a row of cans in the area indicated by the arrow **7** on FIG. **1**.

FIG. **8** is an enlarged section taken along lines **8—8** on FIG. **7**.

FIG. **9** is a perspective of a rocking differential indicated by the arrow **9** on FIG. **4**.

FIG. **9A** is a section, at reduced scale, taken through the center of the rocking differential shown in FIG. **9**.

FIG. **10** is a diagram showing the input and output speeds of the rocking differential.

FIG. **10A** is an elevation of a cam and follower arm, shown in the FIG. **4** drive train, for rocking the differential.

FIG. **11** is a perspective of pushers, and their mounting and actuating members, viewed from below, that push a tier of containers into a case.

FIG. **11A** is a fragmentary plan indicated by the arrow **11A** on FIG. **11**.

FIG. **12** is a trace of the motion of the pushers shown in FIG. **11**.

FIGS. **13–16** are fragmentary elevations of a synchronization control shown in FIG. **2**, and illustrate successive operational positions of the control elements.

FIGS. **17** and **17A** are enlarged fragmentary plans of an inactive and an active timing pin, respectively, which are part of the synchronization control.

FIG. **18** is a perspective primarily illustrating a lowerator which supports an empty case in filling position, and lowers the filled case to a discharge position.

FIG. **18A** is an elevation of a lowerator cam which actuates the lowerator shown in FIG. **18**.

FIG. **18B** is a fragmentary elevation of a trip lever mechanism partially shown in FIG. **18**.

FIG. **19** is a schematic electrical control diagram.

FIGS. **20** and **20A** are fragmentary, diagrammatic elevation and plan views, respectively, which illustrate the inlet end portion of the casing machine and an associated supply conveyor.

FIGS. **21** and **21A** are diagrammatic elevation and plan views, respectively, illustrating a mechanism for sensing when each of a plurality of longitudinal rows of can in one assembled tier is complete.

FIGS. **22–26** are fragmentary diagrammatic elevations illustrating the operational sequence of assembling tiers of cans and loading the tiers in a case.

DESCRIPTION OF THE PREFERRED EMBODIMENT

General

With reference to FIGS. 1 and 21–26, upright containers, such as cans C, are supplied to the casing machine 20 by a multi-lane feed conveyor 22 which is driven from the casing machine. The cans are divided into multiple lanes on the conveyor by conventional means not shown and are separated by lane dividers 24 (FIG. 1). The cans pass through a transversely movable shifter 26 whose vertical partitions 27 are initially aligned with the lane dividers 24.

The cans advance into a separator 28 having vertical partitions 29 in alignment with the lane dividers 24. When all lanes in the separator 28 are completely filled to constitute one tier of a case, a can stop and sensing mechanism 30 in each lane is actuated to initiate a can transfer or tiering cycle.

Certain drive mechanism of the casing machine is now actuated, causing three sets of equally spaced tiering fingers 32 to rotate 120 degrees about a common support shaft. This moves shifter mechanism 26 laterally to temporarily interrupt the flow of incoming cans. The tier up upright cans are lifted from the separator 28 by one set of tiering fingers which reorients the tier 90° and deposits the tier on edge, with the cans in a lying down position, in a tiering chamber 34.

After the desired number of tiers of cans has been assembled in the tiering chamber 34, pusher feet 36 are actuated to move the tiers into a case A which has been manually positioned over a nozzle 38 and is supported by a lowerator 40. The filled case is then lowered to a discharge conveyor or the like by the lowerator.

After the removal of the filled case, placement of an empty case on the nozzle 38 swings the lowerator 40 to its raised position supporting the empty case.

Power Train

With more specific reference to the casing machine 20, power is supplied from a motor M (FIGS. 3 and 4) through a speed reducer R to a power shaft 42. Shaft 42 rotates continuously and supplied power through a sprocket and chain drive 44 to the feed conveyor 22.

A tiering input shaft 46 and a pusher-lowerator shaft 48 are respectively driven by single revolution clutches 50 and 52. On their driving sides, the clutches have sprockets 54 and 56 (FIG. 4) which are connected by a chain 57 to a sprocket 58 mounted on the power shaft 42. Shafts 46 and 48 are driven only when their respective clutches 50 and 52 are engaged, but the sprockets 54 and 56 rotate continuously in the directions indicated by the arrows in FIG. 4.

When the single revolution tiering clutch 50 is engaged, the tiering input shaft 46 rotates in the same direction as the sprocket 54. The shaft 46 rotates a shifter cam 60 and a differential cam 61 that drives one side of a rocking differential 62. The differential 62 which operates the tiering fingers 32. The output of the differential 62 drives a sprocket 63 freely mounted on shaft 46. Sprocket 63, by means of a chain 67, drives a tiering sprocket 64 which is attached to one of two spaced spiders 65 that are mounted on a tiering shaft 66.

One set of tiering fingers 32 is mounted on each of three cross-shafts 63 which are carried by the spiders 65. A three to one speed reduction from the differential output sprocket 63 to the tiering sprocket 64 causes the tiering fingers 32 to be rotated 120 degrees for each complete revolution of the tiering input shaft 46.

Upon engagement of the clutch 52, (FIG. 4) a constant rotation is imparted to the pusher-lowerator shaft 48. The vertical motion of the pusher feet 36 is controlled by a pusher lift cam 70 which is mounted on the shaft 48 and actuates a pusher lift arm 72 by means of a pivoted pusher lift lever 73 having a follower roller engaged with the cam. The horizontal motion of the pusher feet 36 is effected by a pusher stroke cam 74 which is mounted on the shaft 48 and actuates a pusher stroke follower arm 75.

As the result of mounting both the pusher lift and stroke cams on a common shaft 48, their resultant motions are coordinated with a lowerator cam 76 on the same shaft 48. The lowerator cam motion is transmitted to the lowerator 40 by a rod 77 (FIGS. 4 and 18A) which is actuated by a cam follower arm 79.

VARIABLE STROKE SHIFTER

The variable stroke shifter 26 (FIGS. 1 and 5) functions as a blocking device to interrupt the flow of containers from the feed conveyor 22. For this purpose, a shifter bar 78 is displaced one-half of a can diameter so that each of a plurality of the vertical partitions 27 is placed in blocking relation to an incoming row of cans between the lane dividers 24 of the feed conveyor 22.

The shifter bar 78 (FIGS. 5 and 7) carries a depending shifter bracket 88, and slides on a spacer plate 80. Each end of the spacer plate 80 is supported by and secured to a block 81, as shown in FIG. 5. Downwardly open recesses 83 in the spacer plate 80 locate and retain a plurality of support arms 82, one of which is provided for each of the separator plate partitions 29. The shifter bracket 88 has side ribs 89 (FIG. 6) that slide in grooved guide bars 90. The guide bars 90 are mounted on a pair of transverse tie bars 84 that interconnect longitudinal side frame members 86. The shifter bracket 88 (FIG. 5) includes a depending arm 91 having a series of holes 92 which provide for adjustment of the amount of lateral shifter stroke for various diameter cans.

Thus, a follower roller 94 is mounted in a selected hole 92 corresponding to the desired shifter bar displacement, and so mounted, rides in a slot 96 in a shifter cam follower lever 98. The lever 98 is pivotally mounted to the frame of the machine at 99 and is oscillated between the phantom and full line positions shown by a cam follower 100 which is engaged with the shifter cam 60.

Separator

After passing between the partitions 27 through the shifter 26 (FIG. 1) the cans C enter the lanes defined by the partitions 29 (FIG. 7) of the separator 28. Opposite site sides of the cans are supported by ramps 101, adjacent pairs of which are spaced apart so that the tiering fingers 32 can pass upward between the ramps to lift the containers. The separator 28 includes multiple divider units 102. Each divider unit is provided with a pair of the ramps 101, one of the partitions 29, and is removably mounted on the tie bars 84 by means of a bolt **104** recessed in the support arm **82**. The tie bars **84** cooperatively form a T-shaped slot **105**, and a square nut **106** which fastens the bolt **104** is captured in the slot **105**.

The divider units **102** are positioned to accept a particular diameter of can between adjacent partitions **29** by first removing the spacer plate **80**, and then loosening the bolts **104** and sliding the support arms **82** along the tie bars **84**. Thus, by substituting a different spacer plate **80**, the interspacing of the partitions **29** can be changed to accept a different can size. If a different number of lanes are required, as well as different lane sizes, the divider units **102** are readily removed by sliding the loosened unit along the slot **105** to a cross-slot **108** (FIG. 7). The divider unit is then removed by sliding it forwardly out of the cross-slot. Other units can be added in the obvious, reverse procedure. This mechanism forms the subject matter of our aforesaid parent application.

Can Stop and Sensing Mechanism

With continued reference to FIG. 7, one of the can stop and sensing mechanism **30** is mounted on each divider unit **102**. Its purposes are to control the number of cans allowed to accumulate in each lane of the separator **28**, to control the longitudinal position of the row of cans so that the cans do not partially extend into the shifter **26**, and to actuate a control circuit when this lane and the other lanes are full of cans. This mechanism also forms the subject matter of our aforesaid parent application.

The can stop and sensing mechanism **30** for each lane is actuated by the leading can in the row of cans pressing against an upstanding stop finger **110** which is mounted for limited displacement in a downstream direction. When so displaced, the mechanism **30** actuates a flag **112** that interrupts a light beam LB projected across the casing machine. When all lanes of the separator **28** are completely filled and all of the flags **112** have been actuated to clear the light beam, a later described photoelectric control unit is energized to initiate a loading of the assembled containers into the tiering chamber **34** (FIG. 1).

Referring to FIGS. **7** and **8**, the can stop fingers **110** is rigidly mounted on a support block **116**. The support block **116** is adjustable axially of a threaded rod **118** which is engaged with a threaded aperture in the block, and slides on a guide rod **120**. The ends of the threaded rod **118** are rotatably mounted in spaced carriage blocks **124** and **126**, and the guide rod **120** is rigidly secured in the carriage blocks. By turning a nut **130** fixed on one end of the threaded rod **118**, the support block **116** and the can stop finger **110** mounted thereon are moved along the guide rod **120** to longitudinally adjust the can stop finger **110** for the desired row-length of cans to be accumulated in the corresponding lane. It is believed apparent that because the partitions **29** of two adjacent divider units **102** form the lateral limits of one lane of cans, the outermost divider unit at the left side of the casing machine (viewed in a downstream direction) does not require a can stop finger **110** or a flag **112**.

Each carriage block **124** and **126** depends from the support arm **82** in the manner shown for the carriage block **126** in FIG. **8**. Thus, each carriage block is provided with a central upstanding tab portion **125** that extends upward into a downwardly open milled slot **127**. The tab **125** is provided with a diagonal slot **133** and is retained by a roller **134**, mounted on a pin **135**, which is disposed in the slot. With this construction, the assembly including the carriage blocks **124** and **126**, can stop finger **110**, and the support block **116** gravitate to the upstream position illustrated, but move downstream and diagonally upward when a lane of cans pushes against the can stop **110**. These movements control the flag **112** to mask or unmask the light beam LB.

The flag **112** is pivoted to the support arm **82** by the pivot pin **135**, and is pivoted to the carriage block **126** by a pivot stud **136**. Accordingly, when the lane of cans pushes against the can stop finger **110**, the pivot stud **136** is moved away from the pivot pin **135** and the flag **112** swings about the pin **135** out of the light beam LB, as indicated by the arrow **112*a***.

The light beam LB originates from a photoelectric unit **137** (FIG. 3) which includes an integral lamp and receiving element and is mounted on one of the frame members **86**. The projected light beam LB is received by a reflector **139** which returns the beam to the receiving element of the photoelectric unit **137**. Since the light beam is interrupted by any one of the flags **112** in rest position, thus indicating that one or more lanes of cans is not yet complete, the photoelectric unit generates a control signal only when the separator **28** accumulates a complete tier of cans. The signal from the photoelectric unit **137** energizes an adjacent solenoid **140** which in turn causes clutch **50** (FIG. 4) to engage and initiate the tiering cycle.

Rocking Differential

As previously indicated, and in accordance with the present invention, the set of tiering fingers underlying the cans in the separator are smoothly accelerated upward to pick up cans from the separator and are smoothly decelerated as the cans are deposited in the tiering chamber by the tiering fingers. In the illustrated embodiment of the invention this smooth acceleration and deceleration is performed by the rocking differential **62** (FIGS. 4, 9 and 9A).

The rocking differential **62** provides a variable speed drive connection from the tiering input shaft **46** to the tiering shaft **66**, via rotation of a pair of bevel gears **141** and **142** which are meshed with a spider gear **144**. When the solenoid **140** (FIG. 3) actuates the tiering clutch **50** (FIG. 4) to transfer one tier of cans from the separator **28** (FIG. 1) to the tiering chamber **34**, the tiering shaft **66** is turned 120° by the rocking differential **62** and the drive train including sprockets **63** and **64**, and the chain **67**. During each tier transfer cycle, the spider gear **144** (FIG. 9) of the rocking differential is first translated about the axis of the shaft **46** in the direction of the arrow **144*a*** to subtract motion from the drive chain **67** while the tiering fingers **36** lift the cans from the separator **28**. While the lifting movement continues, the spider gear **144** is then moved bodily in the opposite direction, indicated by the arrow **144*b***, to add motion to the drive chain **67** and accelerate the tiering fingers. During the tiering cycle, the rate of motion of the spider gear in the direction of the arrow **144*b*** is reduced to decelerate the tiering fingers and then reversed to bring the fingers to a smooth stop.

Referring to FIGS. **9** and 9A, both the gear **141** at the input side of the differential and the differential cam **61** are keyed to the tiering input shaft **46**. The gear **142** at the output side is pinned to the sprocket **63**. The gear **142** and the sprocket **63** rotate together freely on the shaft **46**, so that their motion can be modified by fore and aft motion of the spider gear **144**.

The spider gear **144** rotates on a stub shaft **146** that projects from a spider gear hub **148**, and the hub rotates freely on the shaft **46**. Thus, oscillation of the spider gear hub **148** will add to and subtract from the drive motion transmitted from the shaft **46**, by means of the gears **141**, **144** and **142**, in accordance with known principles of differential gearing.

The oscillation of the spider gear hub **148** is provided by the differential cam **61** and associated linkage, as will now be described. The cam has a track **151** which is eccentric to the shaft **46**. A cam follower **152** rides in the cam track and hence oscillates a cam follower lever **154** which is pivoted to the frame of the machine by a pivot shaft **156**.

The lower end of the cam lever **154** is pivoted at **157** to one end of a cam link **158**. The other end of the cam link is pivoted at **159** to a cam crank **160**. The crank **160** depends from one end of a sleeve **162** that turns freely on the power shaft **42**.

Depending from the other end of the sleeve **162** is a companion crank **163** which is pivoted at **164** to one end of a spider link **165**. The other end of the spider link is pivoted at **166** to a spider crank **167** that depends from the spider gear hub **148**.

Rotation of the tiering shaft **46** one revolution, by actuation of the tiering clutch **50** (FIG. **4**) turns the differential cam **61** one revolution, the eccentric thus driving the cam lever **154** between its two limits of swinging movement. This movement of the cam lever oscillates the spider gear hub **148** and the spider gear **144** fore and aft via the cam link **158**, cam crank **160**, sleeve **162**, companion crank **163**, spider link **165** and spider crank **167**.

The oscillation of the spider gear **144** is superimposed on the motion transmitted by the spider gear **144** to the chain **67** so that the tiering shaft **66** (FIG. **4**) rotates with non-uniform motion to accelerate and decelerate the tiering fingers **32** in the manner previously described.

FIG. **10** is a diagram showing the speed change in revolutions per minute of the differential output gear **142**, and hence the rotation of the shaft **66** which carries the tiering fingers **32**, during one rotation of the differential input gear **141**. FIG. **10A** illustrates the relation of the differential cam **61** to the FIG. **10** diagram; the degree markings on the cam are the same degree markings of the base line of the FIG. **10** diagram. Reference should also be made to the later described FIG. **22** which illustrates the can transfer operation of the tiering fingers **32**. The abscissa of FIG. **10** is marked in 90° increments for one complete revolution of the input gear **141** and the differential cam **61**. The speed of the input gear **141** is seen to be **60** RPM from the scale along the left margin of the diagram. Starting at 0°, the differential cam **61** rotates at **60** RPM upon energization of the tiering clutch **50** to drive the shaft **46**. From the 0° reference point (FIG. **10A**) the cam follower **152** moves toward the shaft **46**, whereby the spider gear hub **148** (FIG. **9**) is driven rearward in the direction of the arrow **144*a***. This subtracts from the linear speed of the chain **67** which powers the tiering fingers so that the tiering fingers start slowly from their rest positions. It will be seen that the **0°–90°** quadrant of the cam track **151** will decelerate the movement of the differential hub **148** in the direction of the arrow 144a. Accordingly, the output gear **142** gradually accelerates from 0° to 90°.

The lowest point of the cam track **151** is at **90** degrees, and the cam follower **152** is at its extreme of movement inwardly toward the shaft **46**. Accordingly, at **90** degrees the spider hub **148** is briefly motionless and the differential **62** transmits the full 60 RPM rotation of the input shaft **46** to the output gear **142**. Translated into movement of the tiering fingers **32** (FIG. **1**), this means that the tiering fingers underlying the charge of cans in the separator **28** rapidly accelerate after contacting the cans at the beginning portion of the can transfer movement.

Between 90° and 180°, the cam follower **152** moves outward from the shaft **46** and drives the spider hub **148** (FIG. **9**) forward in the direction of the arrow 144b. This adds to the linear speed of the chain **67** which powers the tiering fingers. It will be noted that the 90°–180° portion of the cam track **151** is symmetrical with the 0°–90° portion. Consequently, the 90°–180 ° rotation of the output gear **142** smoothly acclerates the tiering fingers from 60 RPM to their maximum speed of 120 RPM as the cam **61** rotates to its 180° position. It should be noted that the hub **148** at this time has not attained its forward limit of movement in the direction of the arrow **144*b***.

From 180° to 270°, the cam follower **152** continues to move outward, and the hub **148** forward, although at a reduced rate. Therefore, the speed of the output gear **142** is reduced from its maximum at 180° of cam rotation due to the reduced rate of forward rotation of spider hub **148**. At 270° the cam follower **152** has reached its maximum outward excursion and the spider hub **148** is again stationary, as at 90°, transmitting the 60 RPM input gear rotation to the output gear **142**.

As the cam follower moves from 270° back to 0°, the spider hub **148** is moved rearward in the direction of the arrow **144*a*** and reduces the speed of the output gear **142** from 60 RPM to 0 RPM. The tiering fingers during this latter movement thus decelerate the can charge as it is deposited in the tiering chamber **34**.

With regard to the magnitude and rate of translation of the hub **148** about the shaft **46**, it is pointed out that in any differential it is inherent that the spider gear will translate at one half the rotational speed of one side gear when the other side gear is held. In the present case, it is to be noted that the cam follower lever **154** provides motion amplification such that the cam track **151** translates the spider gear hub **148** at half the velocity of the shaft **46** at 0° and at 180° in the cycle. Because the direction of movement of the hub is opposite at these points in the cycle, the output speed varies from 0 RPM to 120 RPM, or twice the input speed of the shaft **46**, and is readily provided for by means of the motion amplifying linkage and cam arrangement shown.

The shifter **26** (FIGS. **1** and **4**) and the rocking differential **62** are both driven from the shaft **46** in timed relation to each other. As shown in FIG. 10, the shifter stroke is initiated during the initial 40 degrees of rotation of the input shaft 46. During this period, the tiering fingers 32 rotate only about one degree about the tiering shaft 66. Thus, the initial slow acceleration of the tiering fingers 32 allows sufficient time for the shifter 26 to block incoming cans so that the cans in the separator 28 are isolated before they are picked up by the tiering fingers.

Tiering

The tiering steps (FIG. 1) comprise lifting the assembled tier of upright cans from the separator 28 and depositing the tier on edge in the tiering chamber 34 so that the cans are in a substantially horizontal position.

As best shown in FIG. 4, each of the three sets of tiering fingers 32 are mounted on a cross shaft 68. One tiering finger is provided for each lane of cans, and the cross shafts 68 are rotatably mounted in two spaced spiders 65 that are secured to the tiering shaft 66. A bell crank 170 is attached to each cross shaft and is provided with follower rollers 174 and 176 which engage a fixed tiering cam 172. As the tiering shaft 66 rotates the spiders 65, the bell cranks 170 pivot the cross shafts 68 and the attached tiering fingers 32 in the manner illustrated in FIGS. 22–26. For this purpose, the cam rollers 174 and 175 successively engage a cam track 178 and a cam track 180 of the tiering cam 172.

Referring to FIG. 22 and the same can transfer movement mentioned in conjunction with FIG. 10, the lower cam follower 176 engages the track 178 and pivots the cross shaft 68 and the tiering fingers 32 into position to pick up the tier of cans C from the separator 28 for transfer to the tiering chamber 34. The cam follower 174 of this same set of tiering fingers 32 later engages the track 180 and serves to pivot the tiering fingers (as illustrated for the leading set of fingers 32) rearwardly away from the cans. Thus, the tier of cans is deposited on a plurality of slats 182 that form the floor of the tiering chamber 34, and the fingers retract while lowering to prevent disturbing the delivered cans. The can transfer cycle is sequentially illustrated in FIGS. 22 through 24.

An adjustable thumb 183 (FIG. 22) is secured in a selected position along each tiering finger 32 to support the cans C as they are rotated through 90° from the upright position at the right of FIG. 22, to the lying down position at the top of FIG. 22.

The tiering chamber 34 has side retaining plates 181 (shown in phantom in FIGS. 1, 2 and 3) which extend upward and downstream from the outside partitions 29 of the separator. The retaining plates 181 serve to retain and guide the containers as they are lifted from the separator 28 and deposited on the floor of the tiering chamber.

The rearward portion of each slat 182 (FIG. 18) of the tiering chamber floor has a slot 182*a* which provides clearance for the tiering fingers 32. The slats 182 are bolted to a cross member 184 having a longitudinal slot 185 to allow lateral adjustment of the slats when the machine is readjusted to accommodate various container sizes.

Pusher Feet

FIG. 11 is a perspective of the pusher mechanism, looking from below, which inserts the tiers of cans into a case.

When the desired number of tiers have been assembled in the tiering chamber 34, the single revolution clutch 52 (FIG. 4) is activated by a later described control circuit. The pusher feet 36 are moved through the path shown by the arrow 36*a* in FIGS. 24–26. This path is determined by the pusher stroke and the pusher lift cams 74 and 70 (FIG. 4) that are mounted on the pusher-lowerator shaft 48.

The pusher stroke follower arm 75 (FIGS. 1 and 4) pivots about a shaft 185 and oscillates a pusher stroke arm 186 that is connected to a pusher stroke carriage 188 by a lengthwise adjustable link 189. One side of the carriage 188 (FIGS. 11 and 11A) is slidably mounted on a horizontal guide rod 190 and the other side of the carriage is supported by means of a roller 191 seated in a fixed horizontal guideway 192. The stroke carriage 188 is thus mounted for fore and aft movement, but is adequately restrained in all other directions. A square section pusher foot shaft 194 has end portions rotatably mounted in pillow blocks 195 on the carriage 188.

The lower end of the pusher lift rod 72 (FIGS. 4 and 11) is pivotally connected to the pusher lift lever 73, and the upper end of the lift rod 72 is pivotally attached to a pusher lift carriage 198.

The pusher lift carriage 198 (FIG. 11) includes a horizontal guideway 200, and is vertically slidable on a pair of vertical guide rods 202. The carriage 198 oscillates the pusher foot shaft 194 to raise and lower the pusher feet 36. For this purpose, the shaft 194 is provided with a crank arm 204 having a roller mounted in the vertically reciprocable guideway 200. The horizontal guideway 200 allows the pusher feet 36 to be moved horizontally without affecting their vertical motion. Therefore, the vertical motion of the pusher feet can be varied independent of their horizontal movement.

FIG. 12 graphically illustrates the path of the pusher feet 36. Following the linear pushing stroke, the pusher feet retract slightly before following the arcuate return stroke. The significance of this retraction, as shown in FIG. 26, is that the pusher feet are withdrawn rearwardly beyond the fold line at 204 between the upper flap and body of the case A. This prevents tearing of the case, since the flap hinges at the fold line, when the pusher feet follow their return path to the start position. It is to be noted that the pusher stroke cam 74 provides a relatively slow pushing stroke so that the cans delivered to the tiering chamber 34 have little tendency to become misaligned or fall from the tier.

Lowerator

One function of the lowerator 40 (FIG. 1) is to support an empty case mounted over the nozzle 38 of the tiering chamber 34. The nozzle is of conventional construction as shown in the Kerr U.S. Pat. No. 2,649,946 and funnels a charge of containers into an empty case. At the completion of the loading stroke of the pusher feet 36 (FIG. 26), the lowerator deposits the filled case on a subposed conveyor or the like for removal from the casing machine.

A lowerator shaft 212 (FIG. 18) is rotatably mounted between two caser side frame members 213 for oscillating a lowerator arm 214, that is carried by the shaft 212, between the phantom and full line positions shown in FIG. 26. The lowerator arm 214 is mounted to the lowerator shaft 212 by means including a torsion safety spring 233 so that if the lowerator is accidentally obstructed during a lowering cycle, the spring allows the lowerator arm to pivot upward about the shaft **212**. A lowerator seat **216** for supporting a case A is mounted on the free end of the lowerator arm **214**, and the arm **214** is telescopically adjustable to vary the height of seat **216**. Further, the angular relation of the seat **216** with the arm **214** can be adjusted by means of a bolt and slot connection at **217**. When properly positioned, the seat **216** in raised position is coplanar with the floor of the tiering chamber **34**.

Also mounted on the shaft **212** is a notched disc **218** which engages a trip lever **220** mounted on a trip shaft **222**. The trip shaft **222** is rotatably mounted in the frame members **213**. A pair of adjustable trip arms **224** are attached to the trip shaft **222** and release the lowerator **40** for movement to a case-supporting position when an empty case is positioned on the nozzle **38**. As shown in FIG. **23**, the trip arms **224** are arranged to be pivoted rearwardly by the lower flap **225** of an empty case A positioned on the nozzle **38**. It will be recalled that the case is manually positioned on the nozzle when the lowerator is in a down position.

When the trip arms **224** (FIG. **18**) are pivoted rearwardly, the trip lever **220** disengages the notched disc **218** and releases the lowerator shaft **212** for upward movement of the lowerator **40** into the illustrated case-supporting position. The lowerator shaft is rotated to raise the seat **216** and retain the empty case in filling position, by a spring actuated rod mechanism **226** which is coupled to the shaft **212** and includes a compression spring **227**. As will be presently described, the lowerator cam **76** (FIG. **4**) provides a mechanical lock for supporting the lowerator in its raised, case loading position. The same cam also positively lowers and controls the rate of descent of the lowerator.

After the last tier of cans has been inserted into a case, the lowerator cam **76** (FIG. **4**) on the pusher-lowerator shaft **48** actuates the rod **77**. A crank arm **230** (FIG. **18**) that is coupled to the rod **77** and the lowerator shaft **212** rotates the shaft **212** in a direction pulling the lowerator seat **216** to its lowered phantom line position shown in FIG. **26**. This lowerator movement is timed to the pusher foot cycle since the lowerator cam **76** is mounted to the same shaft as the pusher stroke and lift cams.

When the lowerator reaches its lowermost position and the filled case is removed, the trip shaft **222** (FIG. **18**) is returned to its original position by an actuating mechanism **229** powered by a compression spring **229a**, and the trip lever **220** re-engages the notched disc **218** preventing the lowerator from returning to the raised position until another empty case is inserted over nozzle **38**. FIG. **18B** illustrates the manner in which the trip lever **220** locks the shaft **212** when the lowerator **40** is in its lowered, case discharge position. The placing of an empty case will then rotate the shaft **222** via the trip arms **224**, and the trip lever **220** releases the lowerator shaft **212** so that the lowerator again rises into case supporting position.

As seen in FIG. **18A**, the lowerator cam **76** has a discontinuous cam track **231** which is engaged by a cam follower on the arm **79**. The cam is effective to control movement of the lowerator **40** to the case discharge position, and also locks the actuating rod **77** at the time a charge of containers is pushed into an empty case so that the lowerator is positively supported during the case loading operation. After the lowerator is locked in case discharge position by the lever **220** and the disc **218**, the cam follower on the arm **79** (FIG. **18A**) disengages upon reaching the end of the cam track **231**. When an empty case is placed over the nozzle **38** and releases the lowerator in the manner already described, the spring **227** (FIG. **18**) raises the lowerator and pivots the arm **79** so that its cam follower is in position to engage the beginning of the cam track **231** (FIG. **18A**) for the next lowerator cycle.

Synchronization Control

The proper phasing of the tiering motion to the operation of the pusher feet **36** and lowerator **40** is provided by a synchronization control **234** (FIG. **2**). The synchronization control **234** governs the action of clutches **50** and **52**, and therefore phases the operation of the shafts **46** and **48**. It will be recalled that the movements of the pusher feet and lowerator are predetermined by their cams which are mounted on the common pusher-lowerator shaft **48**, and that the tiering motion is controlled by the rocking differential **62** which is driven by the shaft **46**. The control **234** also includes a simple and rapidly adjustable counting control for changing the number of tiers loaded into a case.

The engagement of the clutch **50** (FIGS. **13–16**), which drives the rocking differential **62**, is controlled through the action of the solenoid **140** as previously mentioned. When the solenoid **140** is energized to retract its armature (FIG. **14**), a tiering clutch latch **236** is pivoted about a pivot stud **235** to withdraw a ledge **237** from the clutch **50**, thus engaging the clutch to rotate the shaft **46** and transfer one tier of containers to the tiering chamber.

When the tiering clutch latch **236** is pivoted to its FIG. **14** position, a pusher latch control arm **238** carried by the latch is moved rearwardly. The arm **238** is pivoted to the latch **236** by a pivot stud **239** and extends between a pair of vertically spaced studs **244** and **250**, and alongside a timing chain **242**. The timing chain is driven by an 18-tooth sprocket **252** mounted on the tiering shaft **66** and is trained over idler sprockets **253** and **254**. The timing chain **242** is provided with **72** links, and a timing pin **240** (FIGS. **17** and **17A**) is mounted on every sixth link. Each timing pin is secured to a conventional chain attachment link **241** by bolts **243**, and is longitudinally slotted for lengthwise positioning on the timing chain.

By presetting the positions of the timing pins so that the outer ends **245** of certain pins lie in a vertical plane including the pusher latch control arm **238**, these pins are in an active position and will engage the arm **238** to control the number of tiers of cans transferred into a case. FIG. **17A** illustrates an active timing pin **240** which will contact the control arm **238**, and FIG. **17** illustrates an inactive timing pin **240** which in its path of travel will clear the control arm.

Returning to FIG. **13**, the pusher latch control arm **238** is supported by the stud **244**, and both studs **244** and **250** are mounted on a clutch latch **246** which is pivotally mounted on a pivot **247**. The timing pin **240A** which has progressed upwardly alongside the arm **238** is an inactive pin. Consequently, the arm **238** is free of the timing pin **240A** and rests on the stud **244**. The next approaching timing pin **240B** (FIG. **14**) is an active pin, and in attaining its FIG. **15** position will lift the latch control arm **238**. It is important to note that the latch **236** will have first returned to its FIG. **13** position because the solenoid **140** is only briefly energized when a full tier of cans in the separator **28** actuates the photoelectric unit **137** to energize the solenoid. The next actuation of the solenoid **140**, FIG. **16**, pivots the tiering clutch latch **236** and moves the control arm **238** rearwardly, as previously mentioned, to a position which may be termed an armed position. Since the control arm **238** is now lifted by the timing pin **240B**, a notch **248** in the armed control arm **238** engages the stud **250** of the pusher clutch latch **246** and pivots the latch about its pivot **247**. In this manner a ledge **249** of the pusher clutch latch **246** disengages the clutch **52**, which thus effects rotation of the shaft **48** to load the tier of cans into a case.

The number of tiers assembled in the tiering chamber **34** to be inserted in a case may be varied by presetting selected timing pins **240** to active positions. With the combination of a 72 pitch timing chain **242**, an **18** tooth drive sprocket **252**, and an active timing pin **240** every sixth pitch, single tiers of containers are cased. For a two tier case only every other timing pin **240** is adjusted to an active position. For three tiers or four tiers, respectively, every third or every fourth timing pin is made active. For a five tier case a timing chain with a different number of pitches must be used since 72 pitches are not evenly divisible by five.

Electrical System

The electrical system of the casing machine (FIG. **19**) includes power input lines **L1** and **L2** which energize the motor M, line **1**, upon closure of a stop-start switch **258**, and line 2 energizes the photoelectric unit **137**. The photoelectric unit **137** incorporates a time delay relay having normally open contacts **TDR1**, line 3, which momentarily close a brief time after the light beam LB (FIGS. **7** and **21A**) is reflected back to the photoelectric unit **137** by the reflector **139**. When the containers are lifted from the separator **28** (FIG. **1**), the flags **112** (FIG. **7**) of the can stop and sensing mechanism **30** pivot back to their beam blocking position. If the flags **112** rebound from that position the light beam LB cannot cause an undesirable actuation of the photocell unit because the delay contacts **TDR1** close only after the flags **112** are at rest.

A tier limit switch **264**, line 3, controls the tiering cycle and is operated by the pusher latch control arm **238** as seen in FIGS. **13–16**. In the position shown in FIGS. **13** and **14**, the actuator of the switch **264** holds its contacts closed. The contacts are in series with the contacts **TDR1** and the solenoid **140**. Therefore, it is only when all of the light beam interrupting flags **112** of the sensing mechanism **30** have been pivoted forwardly, and the contacts **TDR1** are closed, that the solenoid **140** is energized to engage clutch **50** and effect one tiering cycle.

When the actuator of the tier limit switch **264** is moved to the FIGS. **15** and **16** position, it contacts are open, but the solenoid **140** can remain energized by a lowerator switch **268** (FIG. **18**) and a pusher foot switch **270** (FIG. **11**) which are in series (line **4**) with the contacts **TDR1**. The lowerator switch **268** indirectly prevents the initiation of the pusher stroke until an empty case, placed over nozzle **38**, allows the lowerator **50** to swing up to the raised position. Thus, the lowerator shaft **212** is provided with a switch lever **271** which actuates the switch **268** when the case support seat **216** is fully raised.

The pusher switch **270** only affects the loading operation when single tiers are cased. Since the pusher cycle operates at one-half the speed of the tiering cycle, each tiering cycle must be delayed until the pusher cycle is completed. This is accomplished by the pusher switch **270** which has contacts that are closed by the pusher carriage **188** when it has been completely retracted to its FIG. **11** position.

A cycle switch **272**, line **5**, directly energizes the solenoid **140** when its contacts are closed. The cycle switch is used to empty the machine and index it to the initial tiering cycle, and is convenient to operate the caser during maintenance.

Operation

The following description briefly reviews the steps in an operating cycle wherein two tiers of cans are assembled in the tiering chamber for insertion into a case.

The operational sequence is initiated when the switch **258** (FIG. **19**) is closed. Power is supplied to the casing machine from the motor M (FIG. **3**) through the speed reducer R (FIG. **4**) to the shaft **42**. The shaft **42** rotates continuously and drives the feed conveyor **22** (FIG. **1**) via the drive train **44**. The feed conveyor advances multiple lanes of cans through the shifter **26** (FIGS. **20** and **20A**) and into the separator **28**.

As each lane in the separator **28** becomes filled, the leading container presses against the can stop **110** and actuates the sensing mechanism **30** to pivot the flags **112** forwardly. When all lanes of the separator **28** are filled, all of the flags **112** are free of the light beam LB and the photoelectric unit **137** (FIG. **19**) is activated by the light beam. The signal generated by the photoelectric unit closes the contacts **TDR1** and actuates the solenoid **140**, which by withdrawing the tiering clutch latch **236**, (FIG. **14**) engages the clutch **50** (FIG. **4**) to drive the shaft **46**.

Shaft **46** drives both the shifter cam **60** and the rocking differential **62**, which in turn drives the tiering shaft **66** which powers the tiering fingers **32**. During the first **40** degrees of rotation of the shaft **46**, the shifter bar **78** (FIG. **21A**) moves approximately half of a can diameter. The vertical shifter bar partitions **29** thus block the incoming containers from the feed conveyor **22** to isolate the charge of containers in the separator **28**.

Simultaneously, the rocking differential **62** drives the tiering fingers **32**. However, due to the initial retarding effect of the differential, the tiering fingers **32** rotate about the shaft **66** approximately 1.1° while the shifter **26** shuts off the flow of incoming containers. This allows time for the shifter to be fully actuated before the tier of cans is lifted by the tiering fingers. The tiering fingers **32** (FIG. **22**) which underlie the separator **28** are spaced within one-half inch of the container bottoms. This further insures that the fingers will be moving at a low velocity when the containers are lifted from the separator, thus preventing shock damage or denting of the containers. Between 120°–160° of rotation of the shaft **46** (FIG. **10**) the shifter returns into alignment with the separator to allow containers to fill the separator again.

FIG. 23 shows an intermediate position of the tiering fingers **32** as a tier of containers C is raised from the separator **28**. In this position (at 180° in the FIG. **10** graph) the velocity of the tiering fingers **32** is at a maximum. The fingers **32** are then smoothly decelerated until they come to rest as the tier is deposited in the tiering chamber **34**.

For a second actuation of the tiering clutch **50** (FIGS. **13** and **14**) the timing pin **240A** is inactive and the pusher latch control arm **238** does not engage the pusher clutch latch stud **250**.

As clutch **50** is engaged for the third time, an active timing pin **240B** (FIG. **15**) lifts the control arm **238** which actuates the tiering limit switch **264** and pivots the latch **246** so that the tiering clutch **52** drives the shaft **48** as previously described. As the third tier of containers for another case is transferred to the tiering chamber **34** (FIG. **25**), the pusher feet **36** lower and insert the first two assembled tiers forward into the case A which is positioned over the nozzle **38**. If a case has not yet been placed on the nozzle, the lowerator **40** is in its lowered position and the switch **268** (FIGS. **18** and **19**) remains open. This prevents the actuation of the solenoid **140** so that a third tiering cycle will not occur. Accordingly, the loading cycle is interrupted until an empty case has been placed over the nozzle **38**.

FIG. **26** shows the completion of a third tiering cycle with the pusher feet **36** in the extreme forward position. The pusher feet retract while the next tier is transferred from the separator **28** to the tiering chamber **34**.

From the preceding description it will be seen that among the improved results provided by the disclosed structural arrangements are the following:

Shock to the containers and to the drive train is minimized by employing the rocking differential **62** to drive the tiering fingers **32**, so that the fingers are smoothly accelerated from rest when picking up the containers from the separator **28**, and are smoothly decelerated to their rest positions in the tiering chamber **34**. Spilling and misalignment of the containers delivered to the tiering chamber **34** is also successfully overcome by smoothly decelerating the containers delivered to the tiering chamber. The slow initial acceleration of the tiering fingers allows actuation of the shifter **26** to shut off incoming cans before any significant motion and acceleration of the tiering fingers **32**. This, in turn, allows the tiering fingers adjacent the separator **28** to be positioned closer to the containers than has previously been possible, thus minimizing shock to the containers as they are picked up.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention as set forth in the appended claims.

Having completed a detailed description of the invention so that those skilled in the art could practice the same, we claim:

1. In a case loading apparatus including separator means for retaining one tier of containers for subsequent transfer into a case, and tiering fingers rotatable about a tiering shaft for transferring one tier per cycle, said cycle initiating with said tiering fingers at a tier pickup position adjacent said separator means and terminating at a tier discharge position in a tiering chamber where groups of tiers are assembled into a case load; the improvement comprising a constant speed power input shaft, a power transmission driven by said input shaft and having a cyclically variable output speed, and a power train interconnecting said transmission and said tiering shaft, said tiering shaft rotating at inconstant speed during one tiering cycle, between said tier pickup and said tier discharge positions, such that the tiering fingers accelerate after picking up the tier of containers and decelerate before discharging the containers to minimize shock damage to the containers and the product therein.

2. Apparatus according to claim **1** wherein said transmission comprises a differential including an input gear and an output gear on a common axis, a hub mounted for oscillatory translation about the axis of said gears, a spider gear carried by said hub in meshed relation with said input and output gears, and power means interconnecting said hub and said power input shaft for oscillating said hub, translation of the hub in one direction adding to the rotational speed of the output gear and translation in the other direction subtracting from said rotational speed so that the input speed for said power train varies and said tiering shaft accelerates and decelerates.

3. Apparatus according to claim **2** wherein said hub angularly oscillates said spider gear at a varying rate in one tiering cycle such that subtractive rotation of said output gear progressively decreases from initiation of said tiering cycle to accelerate said output gear until it attains the speed of said input gear, said hub then reversing its direction of translation so that additive rotation of said output gear progressively increases until said output gear attains twice the speed of said input gear at midpoint of the tiering cycle, said translatory movements then repeating for the other half of the tiering cycle so that said output gear decelerates in approaching the termination of said tiering cycle.

4. Apparatus for loading cases, the containers of the type having a multi-lane feed conveyor with lane dividers that supply the containers in a predetermined number of lanes to a tier former, the tier former having separator partitions aligned with said lane dividers; a drive including a rotatable shaft for raising tiering fingers up between said separator partitions for lifting a tier of cans out of the separator; a shifter between said lane dividers and said separator partitions and having a plurality of shifter partitions of the same spacing as that of said separator partitions and said lane dividers; and means for laterally shifting said shifter back and forth over a predetermined stroke sufficient to cause said shifter partitions to block the further passage of containers from the supply lane dividers into the lanes between said separator partitions; the improvement wherein said tiering finger drive has means for initially slowly turning said shaft for gently raising the tiering fingers from a stationary position just below the bottoms of containers in said separator to a position against the containers for allowing time for said shifter to block the feed before the tiering fingers pick up the containers as well as for causing the tiering fingers to pick up the containers gently, said tiering finger drive comprising means for thereafter accelerating said shaft and hence the tiering fingers to complete the tier raising operation.

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