United States Patent [19]

Stroobants

[11] **3,916,746**

[45] **Nov. 4, 1975**

[54] **CAN TRIMMING APPARATUS**

[76] Inventor: **Alphonse Stroobants,** Rte. 1, Forest, Va. 24502

[22] Filed: **Feb. 28, 1975**

[21] Appl. No.: **554,330**

Related U.S. Application Data

[62] Division of Ser. No. 492,860, July 29, 1974, abandoned.

[52] **U.S. Cl.** **83/666;** 82/54

[51] **Int. Cl.²** **B26D 1/28**

[58] **Field of Search** 83/666; 82/54–58, 46–48

[56] **References Cited**

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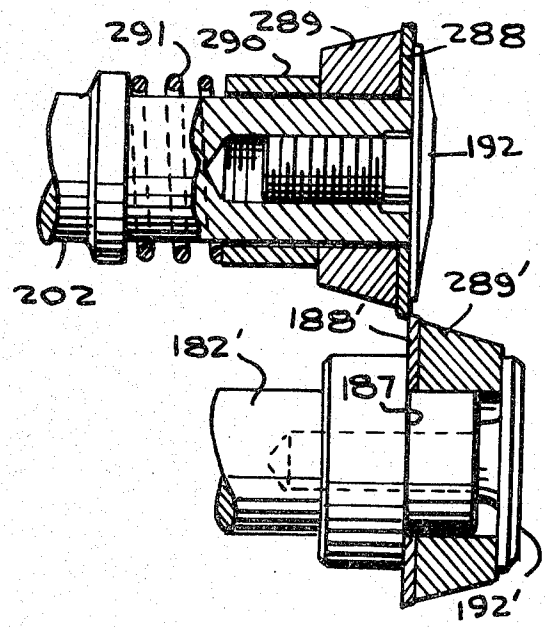
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Primary Examiner—Leonidas Vlachos
Attorney, Agent, or Firm—Mason, Fenwick & Lawrence

[57] **ABSTRACT**

A can end trimmer is disclosed including a main frame, a main rotary shaft mounted for rotation on the main frame and a plurality of self-contained cutter unit assemblies detachably connectable to the main shaft. Each cutter unit assembly includes first and second rotary cutter knives having circular cutting edges with one knife being mounted for movement between a first position having its cutting edge spaced from the cutting edge of the other knife and a second position having its cutting edge overlying the cutting edge of the other knife. A rotary vacuum chuck is mounted for cam controlled reciprocation toward and away from the cutter members for positioning a can end over the movable rotary knife when the knife is in its first or open position, subsequent closure of the knife trims the can end and subsequent opening of the knife permits the holder to retract the finished can from the cutting position; a unique stripper ring discharges the scrap ring to a separate receiving area. Finger discs mounted on the main shaft provide unique work handling functions for removing unfinished cans from an infeed means and positioning the cans for engagement by the vacuum chuck and for aiding in discharge of finished cans to an outfeed means. Control means for the cutter unit is supported by the main shaft or frame and the entire cutter unit can be removed for maintenance or placement with minimum difficulty. Another embodiment of the invention employs a central cutter knife and planetary cutter knives movable to overlying relation with respect to a cutting edge of the central knife for effecting the trimming of can ends positioned over the planetary knife members by automatic handling means similar to that of the first embodiment.

1 Claim, 19 Drawing Figures



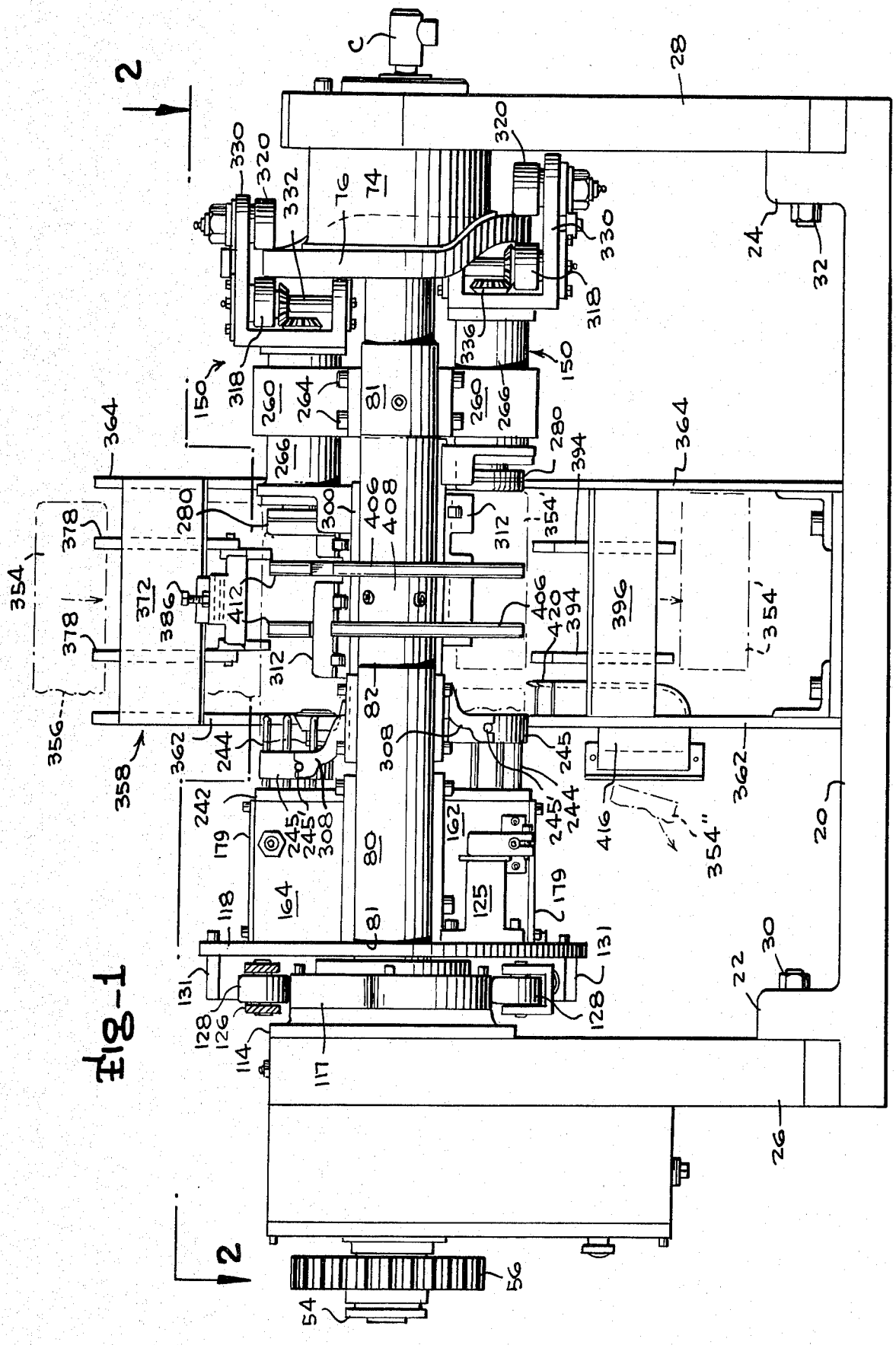

2
2
C
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332
76
74
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32
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364
300
406
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312
354'
354
378
372
386
412
420
396
82
308
362
244
245
242
179
162
164
80
125
118
131
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117
22
30
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26
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56
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356
416
354"

Fig-1

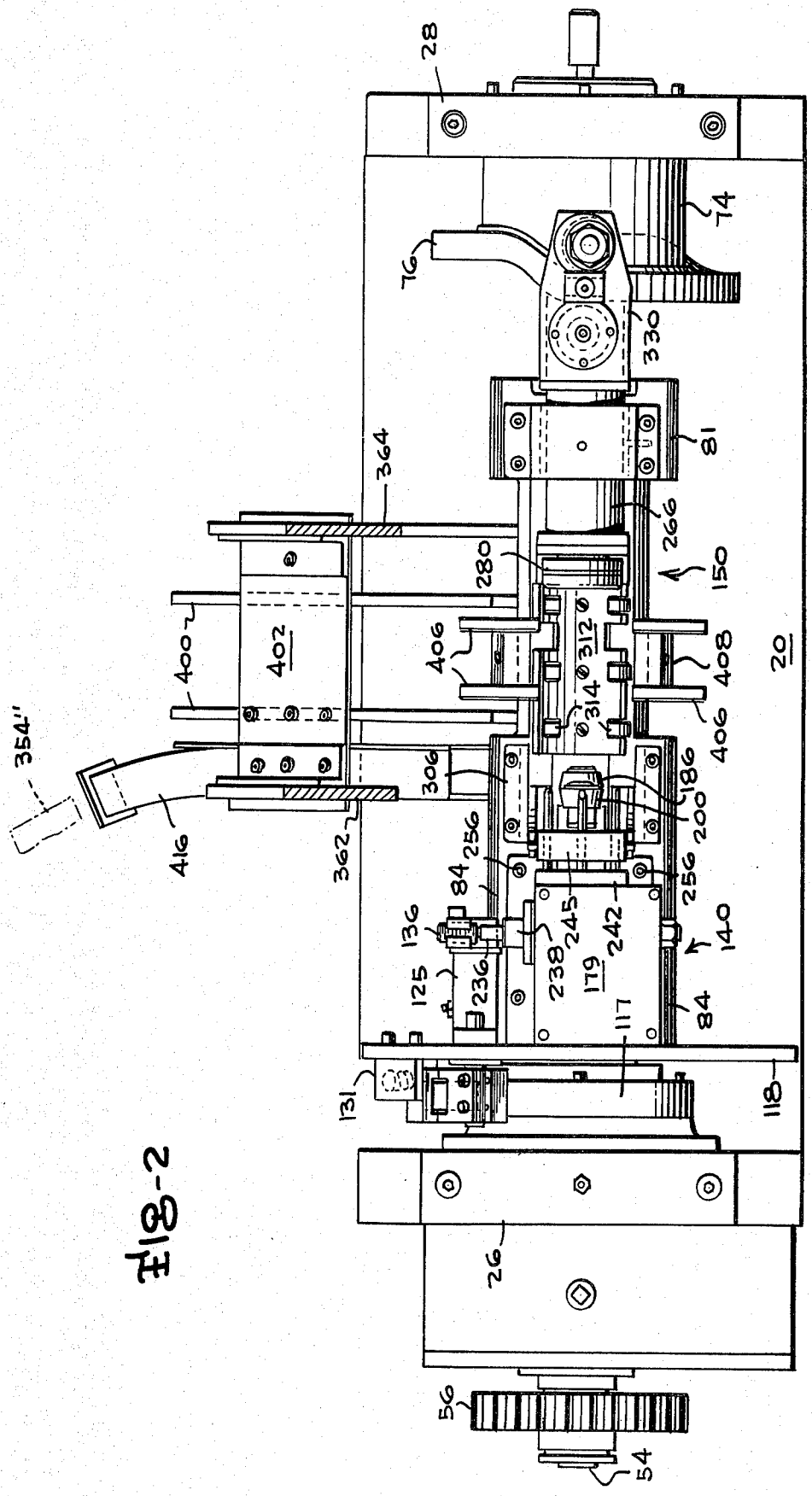

28
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76
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416
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FIG-2

FIG-3

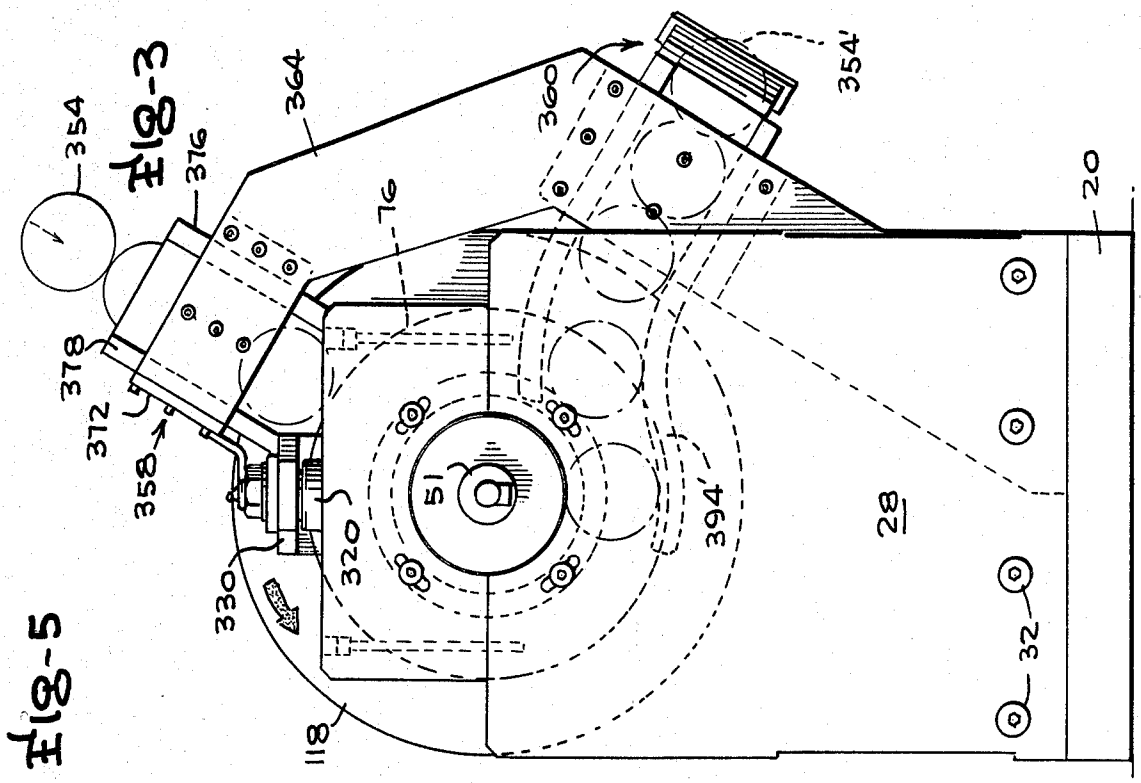
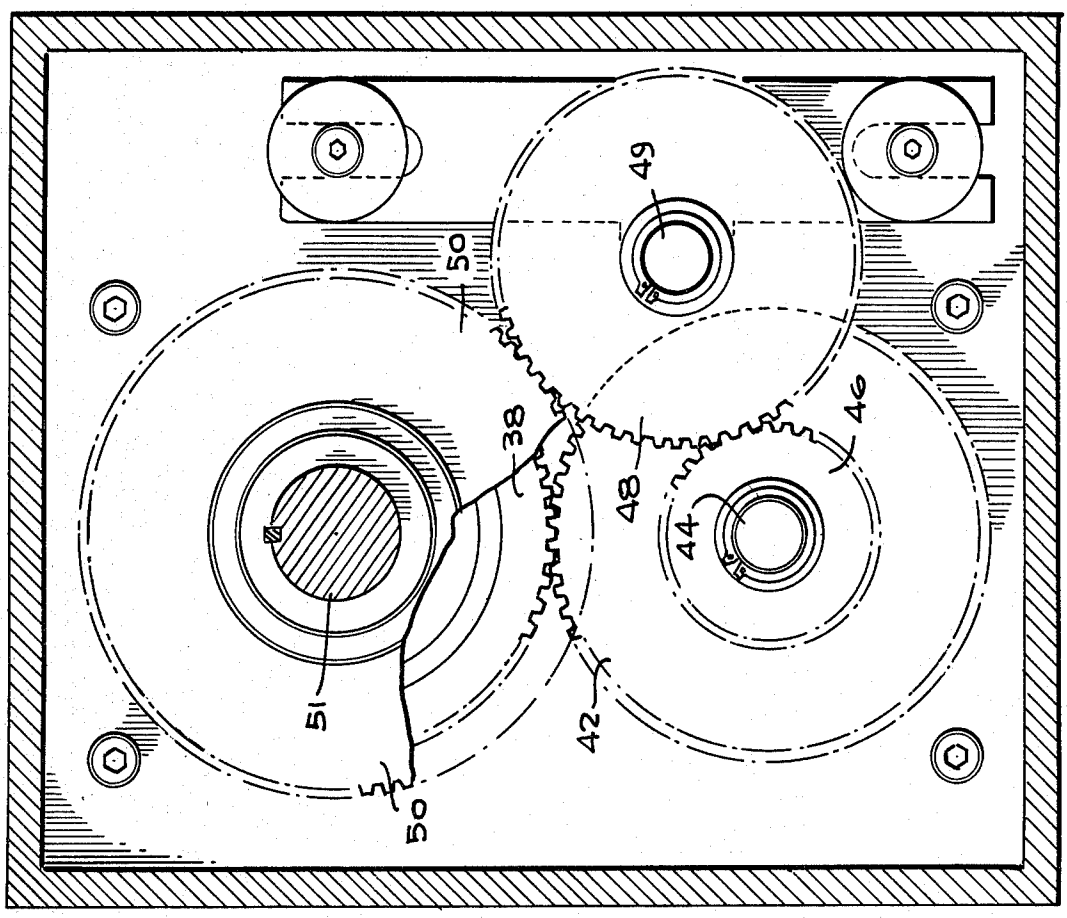

354
376
364
360
354'
20
76
378
372
358
51
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394'
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118

FIG-5


49
50
38
46
48
44
51
42
50

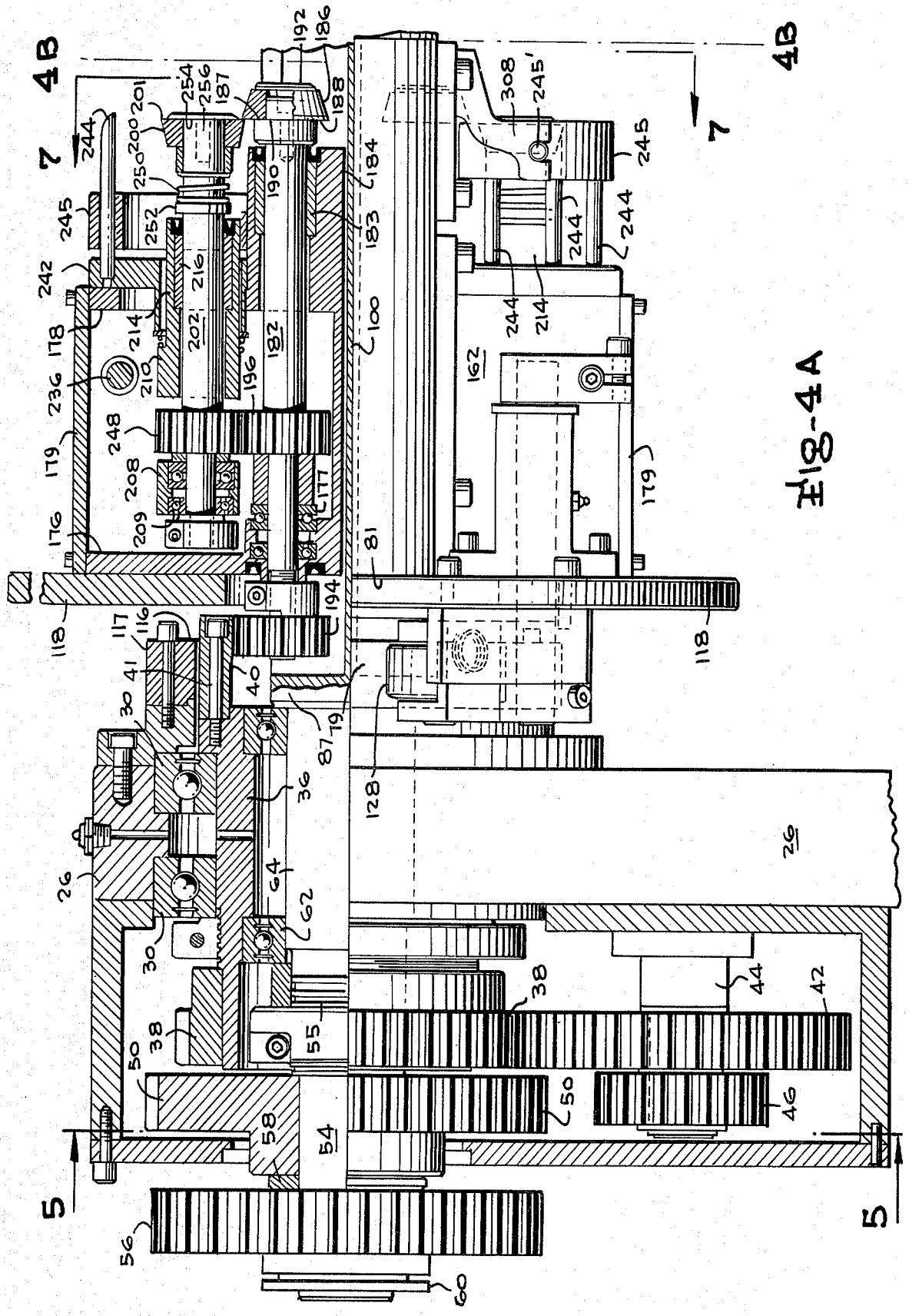

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4B
7
4B
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186
188
187
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256
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200
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244
245
252
242
178
236
179
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208
209
176
118
117
116
41
30
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194
177
182
196
202
216
214
210
184
183
100
162
81
87
79
128
36
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62
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56
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44
42
46
308
245'
214
179

FIG-4A

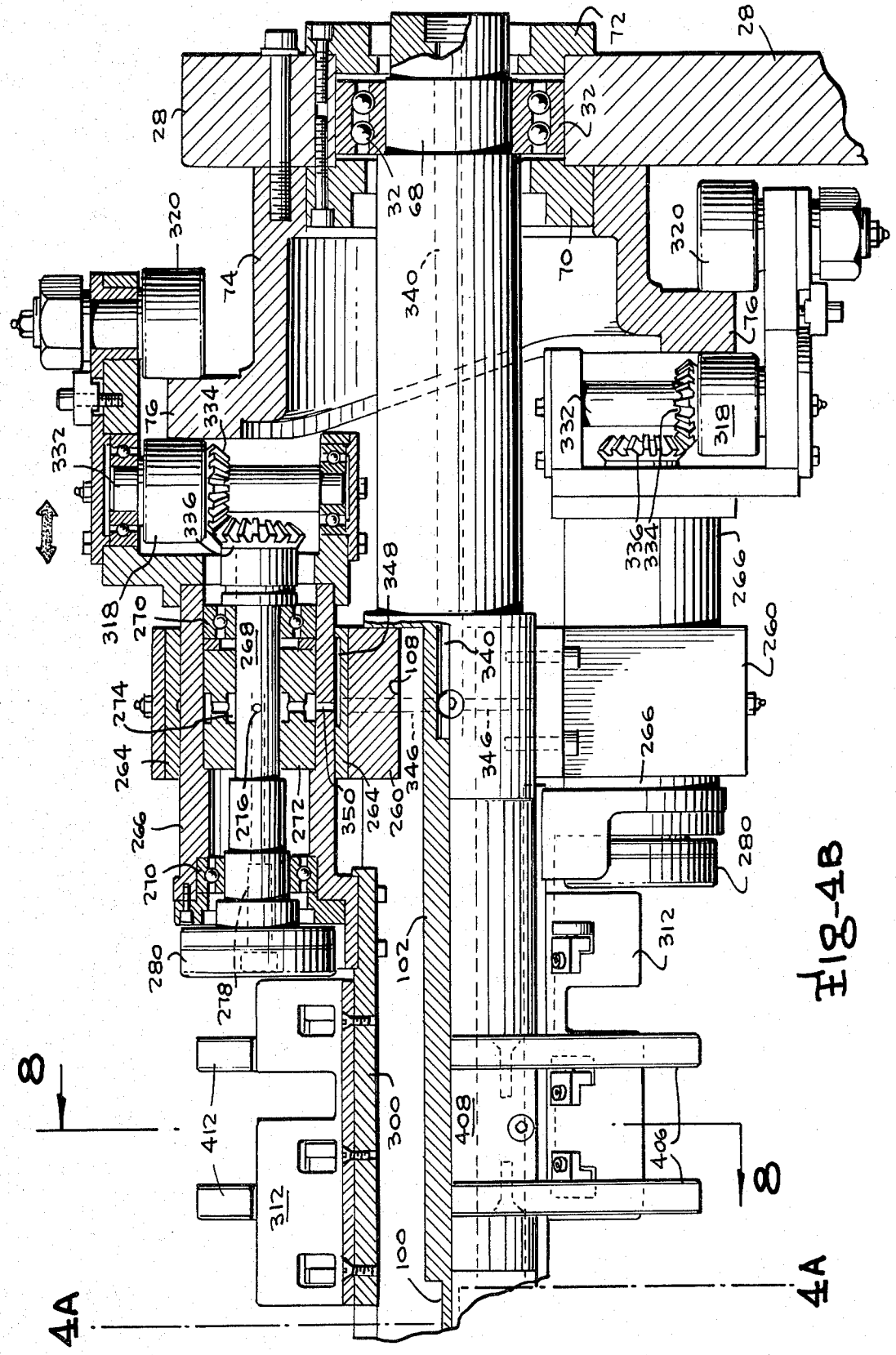

28
72
32
68
320
74
340
70
76
334
332
336
318
348
270
268
108
274
264
346
272
350
260
266
280
102
278
412
300
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408
406
100
8
8
4A
4A

FIG-4B

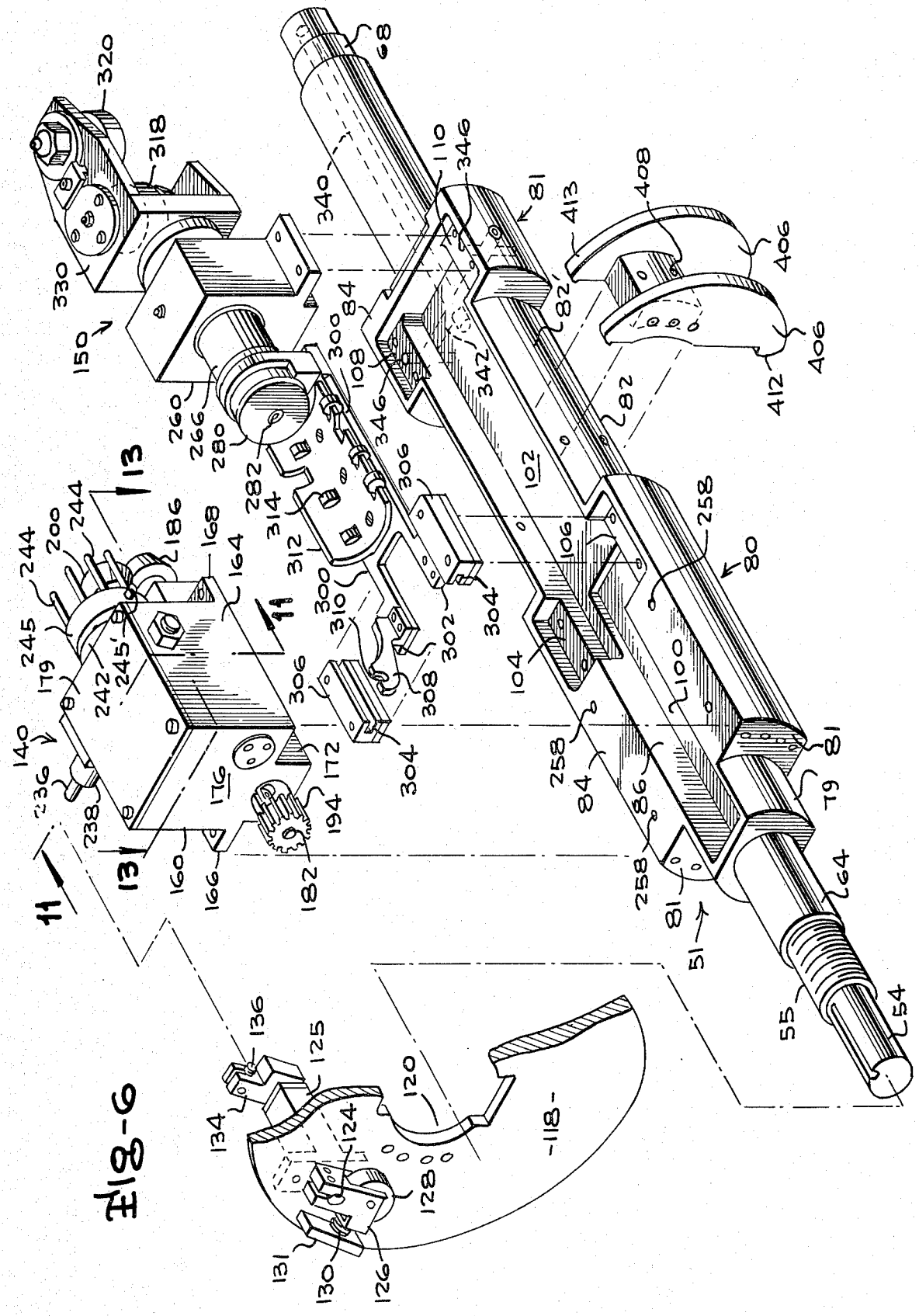

FIG-6
68
320
318
330
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340
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346
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413
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412
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84
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266
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308
106
104
258
80
100
79
64
55
54
51
86
172
176
194
182
160
166
140
236
238
179
242
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245'
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126

FIG-7

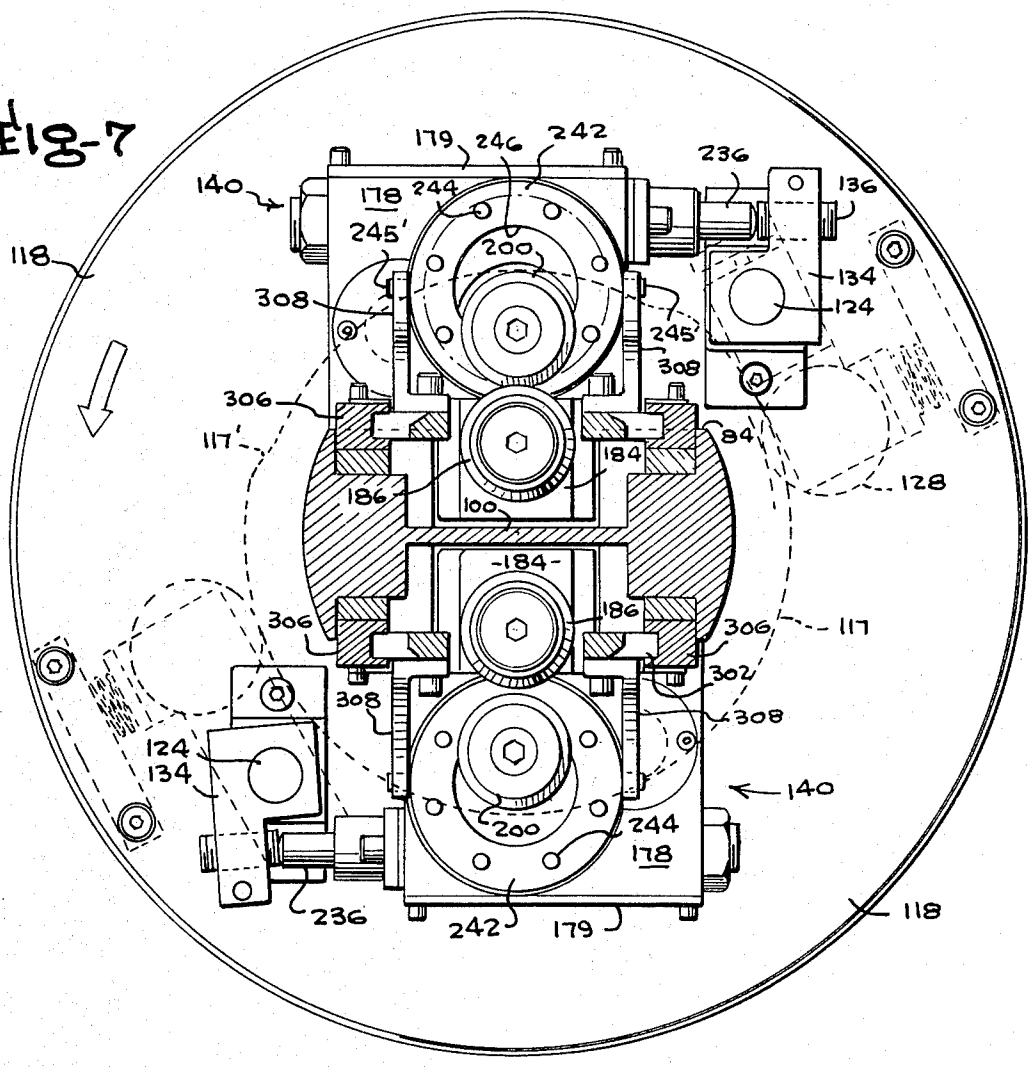
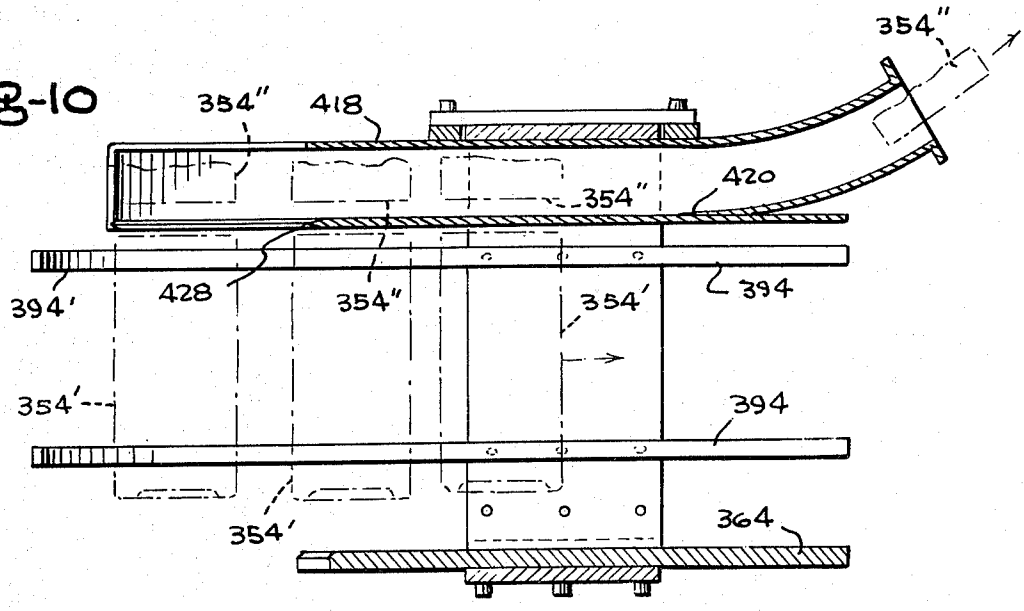

179
246
242
236
140
178
244
136
245'
200
118
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308
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245'
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84
117'
184
128
186
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-184-
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186
306
117
302
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308
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134
140
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242
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FIG-10


354"
354"
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428
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394'
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354'
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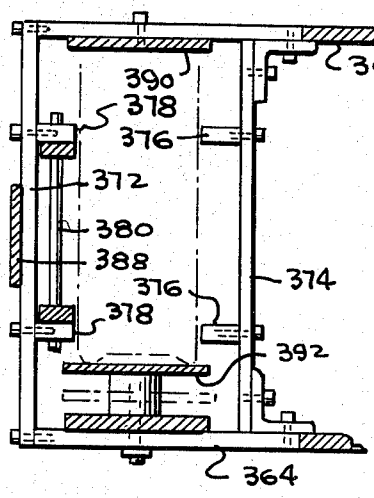

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Fig-9

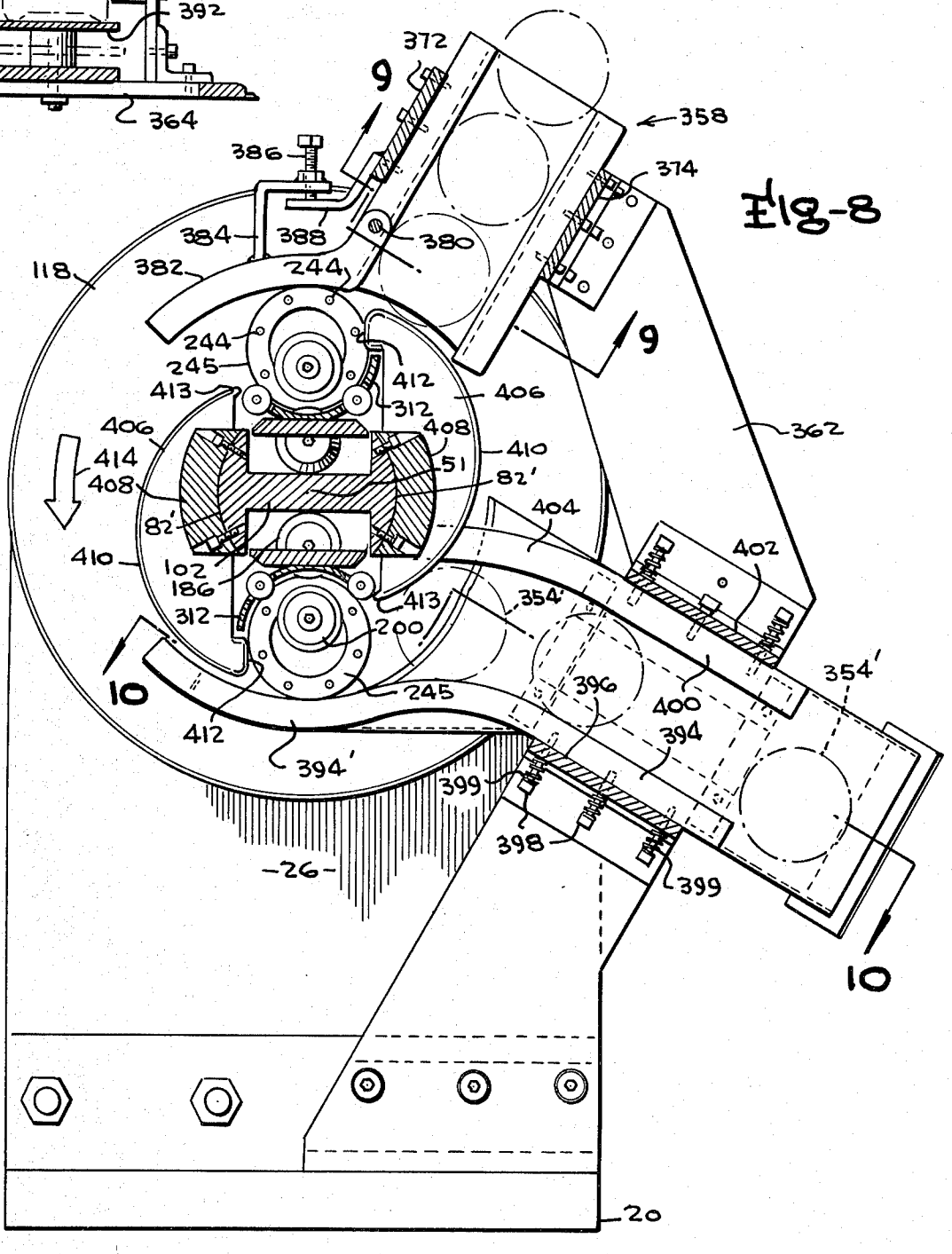

372
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358
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374
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388
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82'
404
82'
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186
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413
354'
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398
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Fig-8

Fig-13

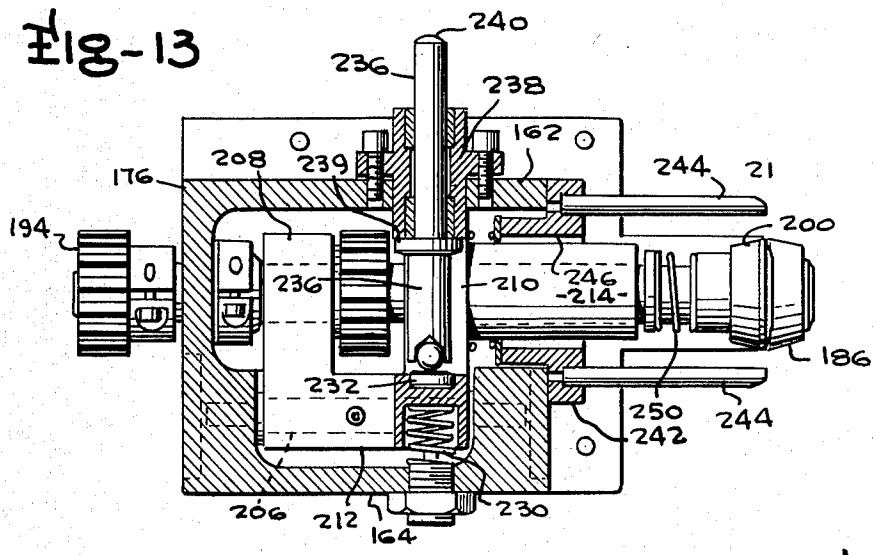


Fig-12

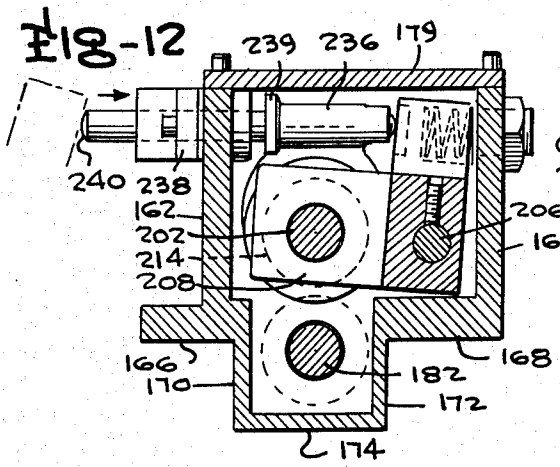


Fig-11

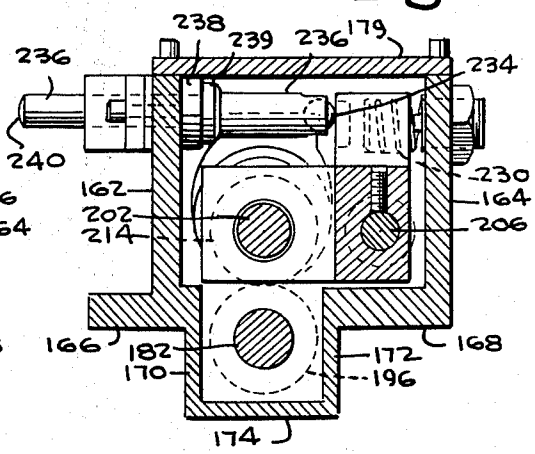


Fig-14

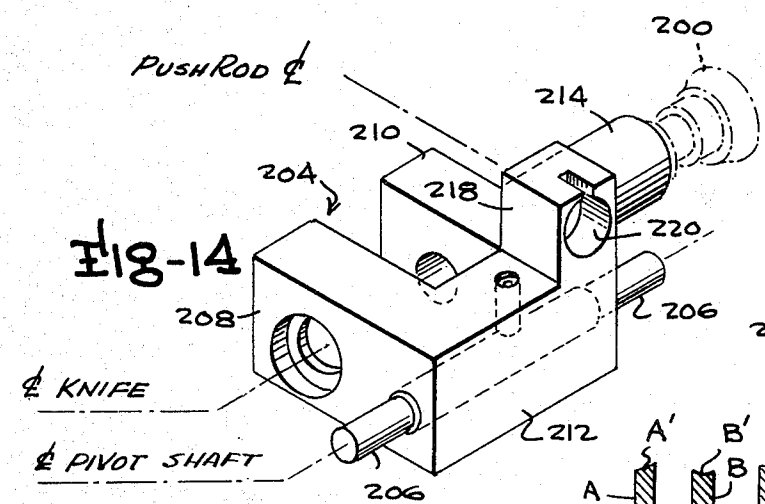


Fig-15

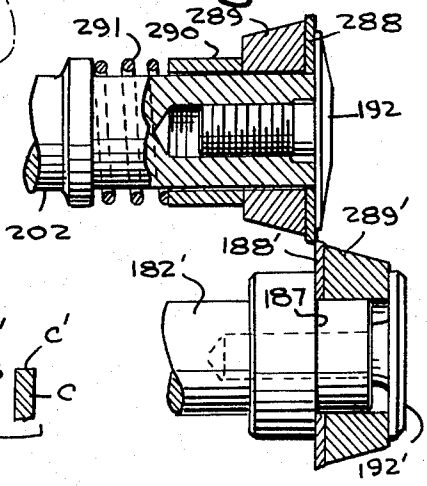
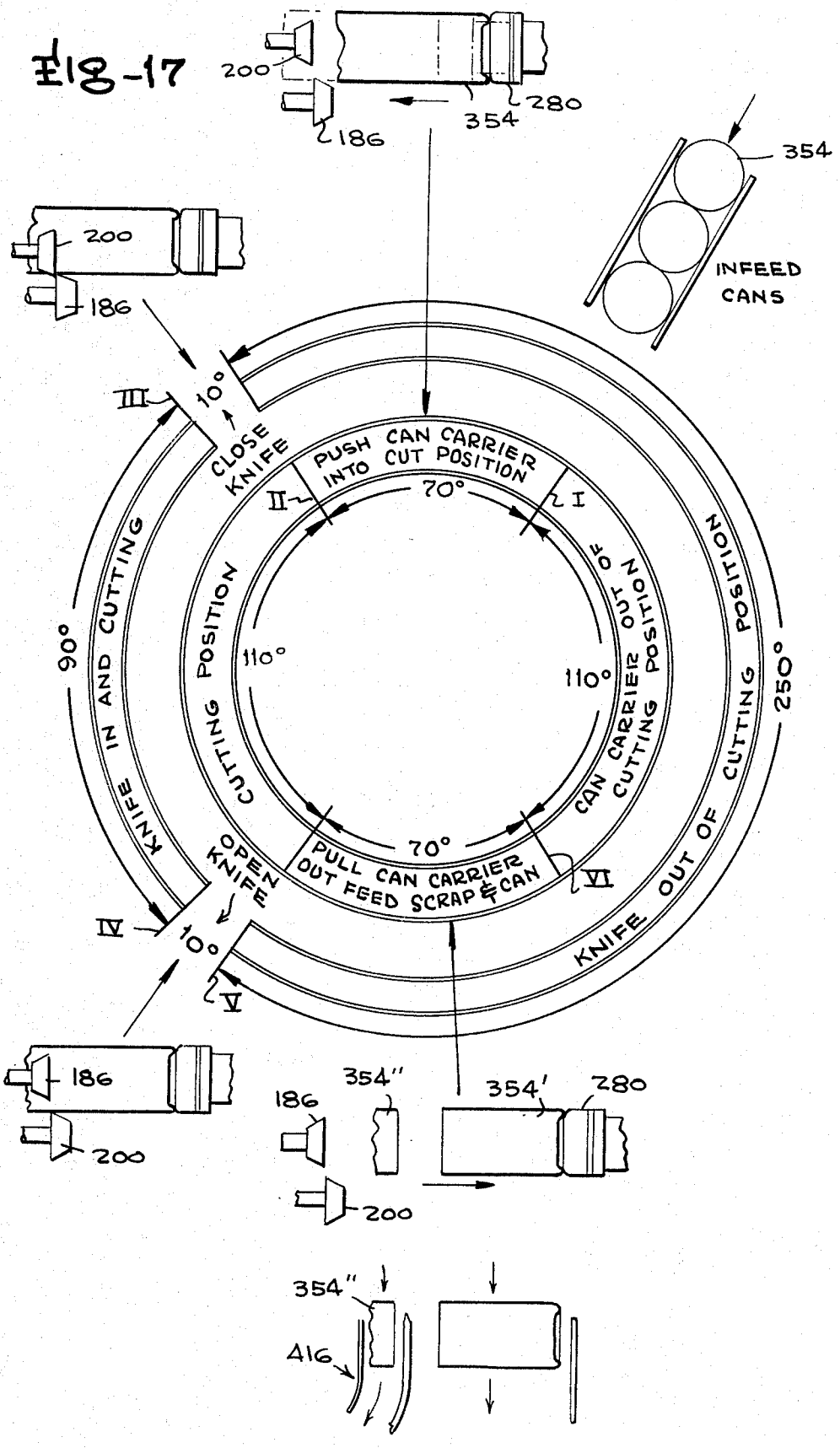


Fig-16

FIG-17


200
186
280
354
354
INFEED CANS
200
186
III
10°
CLOSE KNIFE
II
PUSH CAN CARRIER INTO CUT POSITION
70°
I
90°
KNIFE IN AND CUTTING
CUTTING POSITION
110°
110°
CAN CARRIER OUT OF CUTTING POSITION
250°
KNIFE OUT OF CUTTING POSITION
OPEN KNIFE
70°
PULL CAN CARRIER OUT FEED SCRAP & CAN
VI
IV
10°
V
186
200
186
354''
354'
280
200
354''
416

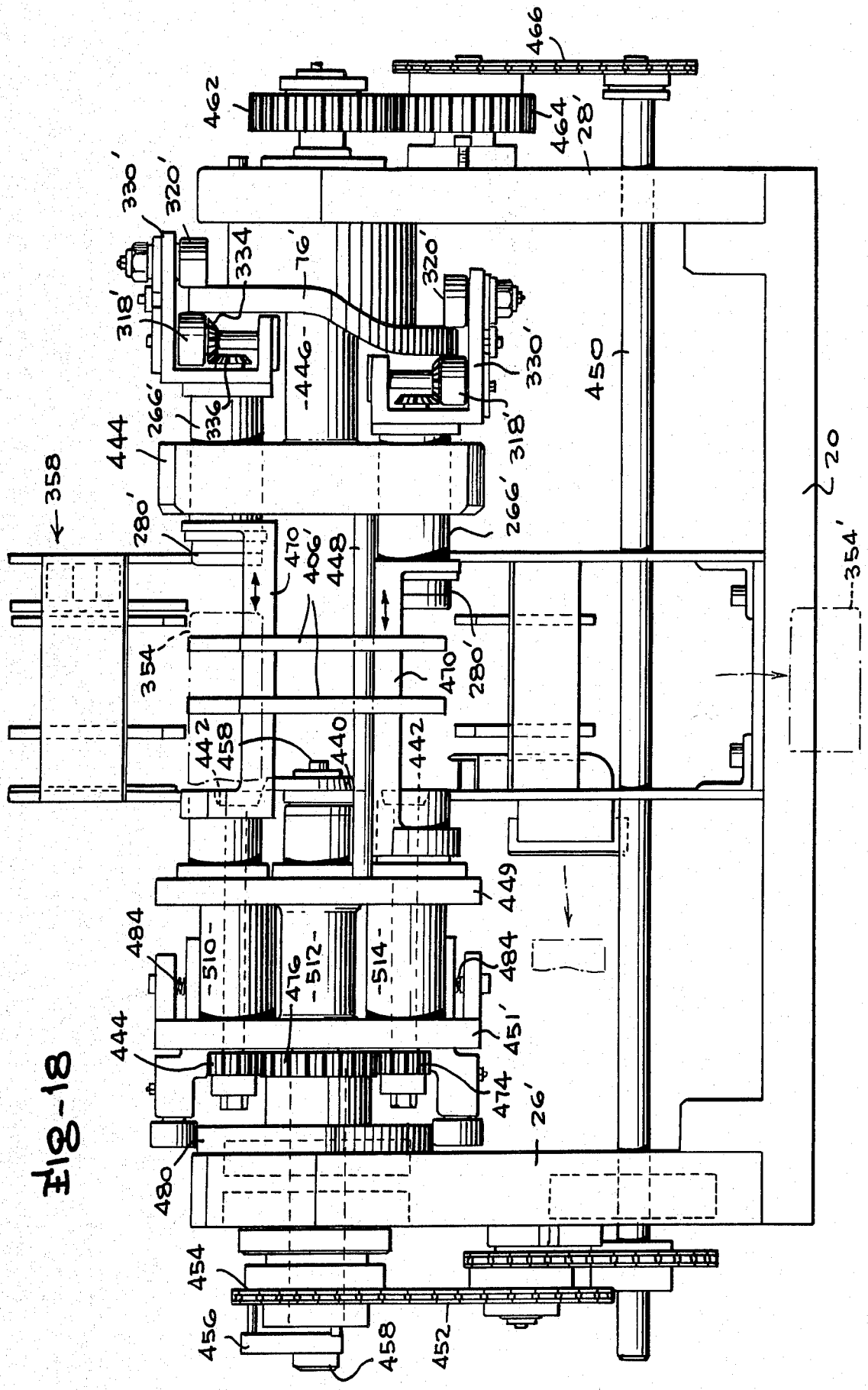

466
462
464
28'
330'
320'
334
76'
320'
318'
446
330'
450
266'
336
444
318'
266'
358
280'
470
406'
448
20
354'
354
470
280'
442
458
440
442
449
484
510
476
512
514
484
444
451'
474
26'
480
454
456
458
452

FIG-18

CAN TRIMMING APPARATUS

This is a division, of application Ser. No. **492,860,** filed July **29, 1974.**

BACKGROUND OF THE INVENTION

The present invention is in the field of cutting and trimming apparatus and is particularly directed to an improved apparatus for trimming the ends of cylindrical work pieces such as cans.

In the manufacture of metal cans, it is conventional practice to form an unfinished can or container of cylindrical configuration consisting of a bottom and a cylindrical side wall which is open on the top end. Such unfinished can members can be formed by a variety of processes such as drawing and ironing to provide the unfinished container. Subsequent to the formation of the unfinished container, it is necessary to trim the upper end of the container to achieve a container of a fixed desired height and having a smooth upper edge termination. It is essential that the upper edge termination of such containers be essentially flawless since the upper edge is subsequently subjected to an outward flanging process for enabling the connection of a top to the container. Any burrs, cracks or the like can prevent obtainment of a good seal between the top and the can in the flange area.

Numerous devices have evolved for the purpose of trimming the ends of unfinished containers. However, all of the presently known devices employed in trimming can ends suffer from a number of deficiencies for which adequate solutions have never been previously advanced. For example, some prior art devices have initially positioned the unfinished can on a mandril for cutting by an external cutter moved inwardly into engagement with the outer surface of the can and traversed about the periphery of the can for effecting the cutting of the can end. Substantial problems are encountered with devices of this type due to the fact that the cutting operation frequently results in burrs, cracks or other imperfections in the upper edge portion of the container wall which are enlarged during the subsequent flanging of the can ends prior to application of a top to the can body.

Various other devices have evolved in an effort to achieve a more perfect can trimming operation such as devices employing a circular knife member having an inner cutting edge with the can being positioned inside the knife member followed by the subsequent positioning of an internal knife inside the can which is then moved outwardly to effect a cutting operation with the external periphery of the knife member. Devices of this type are frequently complicated and the exact positioning of the knife members is of critical importance if a satisfactory cut is to be achieved.

A primary problem with many of the prior art devices resides in the fact that the cutter members, which are the heart of every cutting machine, are integrally built into the machine and any failure of any part of the cutter means requires a time consuming disassembly of substantial portions of the machine resulting in undesirably long periods of down time for such machines.

Probably the greatest drawback of the prior known devices is that the cutting members or knives require time consuming adjustment and alignment procedures and the knives are frequently damaged due to misalignment or misadjustment.

Another deficiency shared by the prior art machines is that they are frequently extremely complicated due to the complex plural-stepped positioning of the can members prior to, during and after a cutting operation. Not only does such complexity increase the initial cost of the machine, it also increases maintenance expense and down time to the detriment of the owner.

The subject invention provides a reliable and trouble-free can trimmer device which is relatively simple in construction, operation and maintenance. All parts of the mounting, driving and actuation functions for the cutter units are part of a removable unit that can be easily removed from the machine for maintenance and adjustment. While one cutter unit is being worked upon, another unit can be positioned on the machine in less than a minute so that there is no substantial down time for the particular machine.

Another extremely significant achievement of the present invention resides in the fact that the unique removable cutter units enable a sharpening of the rotary cutter members and replacement in an exact position with respect to each other without any necessity for time consuming adjustment in the machine. The accurate positioning of the cutter members enables the cutter members to be operating for much longer periods of time without making imperfect cuts.

SUMMARY OF THE INVENTION

Therefore, it is the primary object of this invention to provide a new and improved apparatus for trimming can ends.

Achievement of the foregoing object is enabled in the preferred embodiment by the provision of a main rotary shaft extending horizontally between bearing supports with first and second cutter units being positioned on the shaft in a manner which enables an easy removal and replacement of the cutter units in the event of any malfunction. Each cutter unit includes a pair of shafts geared together and each supporting a rotary cutter knife on an outer end externally of the frame of the cutter unit. One of the knife shafts is mounted for movement with respect to the other on a limited arcuate path so that the cutter knives can be moved between one position in which their peripheries overlie each other and an open position in which their peripheries are spaced apart to enable the insertion or removal of a can member. When a can is inserted over the cutter members, one cutter knife is received inside the can and the other is received externally of the can.

Each cutter unit includes a cutter knife actuator positioned adjacent an actuator pin timingly reciprocated by a cam follower during rotation of the main shaft. Oscillation of the cutter actuator arm serves to move one of the cutter knives into the cutting position overlying the other knife at desired time intervals during a cycle of operation. In one embodiment, the knife members are removable, relatively thin discs having either single or double cutting edges. Additionally, each cutter unit includes a power input gear engageable with the internal teeth of a ring gear encircling the main shaft and rotating with respect to the main shaft so that the cutter members are drivingly rotated. However, the cutter units can be removed from the main shaft by simply removing three threaded bolt or pin members and a lifting of the unit from the main shaft. A new cutter unit can then be repositioned on the main shaft in a very short time and operation of the device resumed while

the initially removed cutter unit is repaired or adjusted as required by the particular circumstance of its removal.

Another feature of each cutter unit resides in the provision of a plurality of can positioning pins positioned about one of the cutter knives and extending forwardly axially parallel to the shaft on which that knife is mounted. Unfinished cans are moved forwardly by a vacuum chuck over the positioning pins all of which are received on the interior surface of the open end of the can. A stripper ring is mounted for reciprocation on the positioning pins and the ring is moved toward the outer end of the positioning pins following a cutting operation to remove the scrap rings from the pin to be discharged into a scrap receiving chute.

Inward and outward movement of a vacuum chuck receiving unfinished cans from an infeed conveyor is provided by a radial flange type cam by first and second cam followers on the sides of the radial flange with one of the cam followers having a surface with a substantial coefficient of friction so that the cam follower is driven by frictional engagement with the side of the cam. Rotational drive from the cam follower is provided to the vacuum chuck so that the chuck is continuously rotated. It is of some importance that the same cam that provides for reciprocation of the chuck toward and away from the cutting knives also provides the rotational drive of the chuck.

Reciprocation of the vacuum chuck results in connection of the chuck to a source of vacuum at desired portions of each rotation of the main shaft and subsequent disconnection to permit discharge of a completed or finished can member into an outfeed conveyor.

In a second embodiment of the invention, the cutting operation is effected by a main central rotary cutter knife and orbiting planetary cutter members simultaneously cooperating with the main cutter member. The orbiting cutters are reciprocated radially with respect to the main cutter and can ends are positioned between the main cutter knife and the orbiting knife surrounding the orbiting knife by handling means similar to that discussed previously with respect to the first embodiment. The orbiting knife is then moved inwardly so that its cutting edge overlies the cutting edge of the main knife as the entire assembly is rotated through a substantial arcuate path. Rotation of the cutting knives serves to trim the scrap ring from the end of the containers which are then removed from the cutting position subsequent to opening of the knife members and are discharged into an outfeed conveyor. In the second embodiment, only three cutter members are employed for providing two cutting stations due to the cooperation of the main cutter with both of the planetary cutter knife members.

A better understanding of the subject invention will be enabled when the following written description is read in conjunction with the appended drawings which will now be described.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation view of the preferred embodiment of the invention;

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1;

FIG. 3 is an end elevation view of the preferred embodiment;

FIG. 4A is a longitudinal section with parts broken away for clarity of one end portion of the preferred embodiment which joins FIG. 4B at line 4A;

FIG. 4B is a longitudinal section with parts removed of the remaining portions of the preferred embodiment extending from line 4B of FIG. 4A;

FIG. 5 is a sectional view taken along lines 5—5 of FIG. 4A;

FIG. 6 is an exploded perspective view of the primary operative components of the preferred embodiment;

FIG. 7 is a sectional view taken along lines 7—7 of FIG. 4A;

FIG. 8 is a sectional view taken along lines 8—8 of FIG. 4B;

FIG. 9 is a sectional view taken along lines 9—9 of FIG. 8;

FIG. 10 is a sectional view taken along lines 10—10 of FIG. 8;

FIG. 11 is a sectional view taken along lines 11—11 of FIG. 6 illustrating the can end rotary cutter knives in a closed condition;

FIG. 12 is a sectional view similar to FIG. 11 but illustrating the can end rotary cutter knives in an open non-cutting position;

FIG. 13 is a sectional view taken along lines 13—13 of FIG. 6;

FIG. 14 is a perspective view of a knife support rocker block cutter support of the cutter unit;

FIG. 15 is a partial section of an alternate cutter construction;

FIG. 16 is a bisecting section of alternate forms of removable cutter blades usable in the cutter of FIG. 15;

FIG. 17 is a pictorial timing chart illustrating various steps in a cycle of operation of the preferred embodiment; and

FIG. 18 is a front elevation view of a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is initially invited to FIG. 1 which illustrates a preferred embodiment of the invention which comprises a main support frame formed of a base or pillar plate 20 having vertically extending connector flanges 22 and 24 extending upwardly from its upper surface. A first vertical support pillar plate 26 is connected to the vertical connector flange 22 and a second vertical support pillar plate 28 is fixedly connected to the second vertical connector flange 24 by nut and bolt members 30 and 32 respectively. All of the operative components of the preferred embodiment are supported between the first and second vertical support pillar plates 26 and 28 by rotary bearing means 30 (FIG. 4A) mounted in first vertical support pillar plate 26 and rotary bearing means 32 mounted in the second vertical support pillar plate 28 (FIG. 4B).

A main rotary generally cylindrical sleeve 36 is supported by rotary bearing members 30 for rotation and a sleeve drive gear 38 is fixedly connected to the end of the main rotary sleeve 36 for providing input drive to the sleeve in a manner and for purposes that will become apparent hereinafter. Additionally, the other or opposite end of sleeve 36 is provided with a ring gear 40 fixed to sleeve 36 by threaded pin bolts 41. Ring gear 40 has a continuous circular array of inwardly facing teeth which provide an output drive for a cutter unit to be described hereinafter.

Rotation of the main rotary sleeve **36** is effected through gear means best illustrated in FIG. **4A** and FIG. **5** including an idler gear **42** meshing with gear **38** and coaxially mounted for unitary rotation on support means **44** with a smaller coaxial gear **46.** Gear **46** meshes with an idler gear **48** (FIG. **5**) which also meshes with a primary shaft drive gear **50** keyed to the end of a main shaft **51** (FIG. **6**) on a cylindrical end portion **54** of the main shaft with a threaded shaft portion **55** being immediately inward of end portion **54.** Additionally, a main power input gear **56** is also keyed to the main shaft **51** on the cylindrical end portion **54** with a separator ring **58** providing proper spacing between the two gear members **50** and **56** and with a conventional retainer means **60** maintaining the gear **56** on the end of the shaft in an obvious manner.

It should be noted that rotation of the main input gear **56** in a clockwise direction will result in rotation of the main shaft **51** in a clockwise direction; however, the main rotary sleeve **36** will rotate in a counterclockwise direction. The relative rotation between the main sleeve **36** and the main shaft **51** is enabled by virtue of the fact that the only connection between the main sleeve and the main shaft is by rotary bearing means **62** (FIG. **4A**) externally engaging the interior of the sleeve **36** and internally engaging the cylindrical portion **64** of the main shaft **51.**

Support for the end of main shaft **51** opposite the end to which the main power input gear **56** is connected is provided by the rotary bearing means **32** mounted in the second vertical support pillar plate **28** and engaging a cylindrical bearing section **66** of the main shaft as best shown in FIG. **4B.** Bearing retainer rings **70** and **72** are provided on opposite sides of the second vertical support pillar plate **28** for retaining bearing **32** in position as best illustrated in FIG. **4B.** Additionally, a fixed cylindrical work piece positioning control cam **74** having a radial cam flange **76** is bolted to the vertical pillar plate **28.**

Main shaft **51** includes a gear and cam mounting oblate portion **79,** relatively large diameter cutter unit mounting portion **80** and a similar large diameter work piece feed holder mounting portion **81** with a central smaller diameter section **82** being provided between the portions **80** and **81.** The upper extent of the shaft as viewed in FIG. **6** is defined by planar surface **84** and a longitudinally extending recess, generally designated **86,** extends downwardly from the planar surface **84** and enables the mounting of various components on the main shaft for purposes to be discussed.

It should be understood that the main shaft **51** is symmetrical about a horizontal plane passing through its axis so that the shaft **51,** if rotated **180°,** would have the same exact appearance as the shaft as illustrated in FIG. **6.** Moreover, the main shaft **51** is also symmetrical with respect to a vertical plane through the axis of the shaft.

A center web or floor **100** extends substantially the entire length of the relatively large diameter cutter unit mounting portion **80.** A thicker center floor web **102** is provided in the central portion **82** and the work piece feed holder mounting portion **81** for defining the inner extent of the longitudinally extending recess **86.** Additionally, slide bearing mounting shoulders **104** and **106** are provided on each side of the recess **86** in the end of the cutter unit mounting portion **80** adjacent the central portion **82** and similar planar mounting shoulders **108** and **110** are provided at the extreme end of the work piece mounting portion **81;** a relatively long cylindrical shaft section extends between the portion **81** and the smaller cylindrical bearing portion **68.**

A cam mounting fitting plate **114** is affixed to the inner surface of the first vertical support pillar plate **26** and a cutter control cam **116** having an outer peripheral cam surface **117** is mounted on the cam fitting plate **114** as best illustrated in FIGS. **1** and **4A.** A cam follower support flange **118** radially extending from main shaft **51** (FIG. **6**) has a central aperture **120** matingly fitted over the oblate portion **79** of the main shaft to which it is fixedly connected by bolts or threaded pins received in the end wall **81** of the relatively large diameter cutter unit portion **80.** A pivot shaft **124** is mounted to transversely extend through the radial cam follower support flange **118** and a bore in a bracket **125** fixed to flange **118.** A cam follower support arm **126** is mounted on the end of the pivot shaft **124** and supports a cam follower roller **128** normally biassed toward the cam surface **117** by compression spring means **130** extending between support arm **126** and a lug **131** fixed to support flange **118.** Cam follower roller **128** is in radial alignment with the outer periphery of the cutter control cam **116** and travels about the cam surface **117** as the support flange **118** rotates with the main shaft **51.** Cam surface **117** is contoured so as to oscillatingly pivot support arm **126** and shaft **124** for providing pivotal movement of a cutter actuator arm **132** fixedly connected to the end of shaft **124** opposite cam follower support arm **126** as best illustrated in FIG. **6.** A threaded adjustable abutment lug **136** is adjustably mounted in the upper end of the cutter actuator arm **132** so as to be radially adjustable for a purpose to be discussed hereinafter.

In the preferred embodiment, two identical removable cutting units, each generally designated **140,** are mounted on the main shaft **51** on diametrically opposite sides of the main shaft as will be apparent from inspection of FIGS. **1** and **7.**

Additionally, two work piece handling units, generally designated **150,** are mounted on diametrically opposite sides of the main shaft **51** with each of the work piece handling units **150** being associated with one of the removable cutter units **140** for receiving raw work pieces **354,** moving the raw work pieces into position to have one end trimmed therefrom by the cutter unit and subsequently removing the trimmed work piece **354'** for discharge from the apparatus.

Each of the removable cutter units includes a rigid box-frame **160** the main elements of which include first and second side walls **162** and **164** (FIGS. **11** and **12**), first and second foot plates **166** and **168** separated by a downwardly extending rectangular channel comprising vertical side plates **170** and **172** and a bottom plate **174.** The ends of the box-frame **160** comprise a first end wall **176** and second end wall **178.** A cap plate **179** connected to the top edges of side walls **162** and **164** and end walls **176** and **178** completes the box-frame **160.**

Box-frame **160** provides support for a number of internal components including a first cutter shaft **182** (FIG. **4A**) supported for rotation by roller bearings **177** in the end wall **176** and a sleeve bearing **183** in rectangular block lug **184** extending outwardly from the second end wall **178.** A first rotary cutter member **186** having a circular cutting edge **187** is keyed for rotation

on the shaft **182** and has an inner radial face **188** in abutting engagement with a radial positioning flange **190** of shaft **182** near the end of the shaft **182.** Rotary cutter **186** is held in position on the end of the shaft by retainer means **192.** A cutter drive input gear **194** is keyed to the outer end of shaft **182** externally of box-frame **160** and a gear **196** is keyed to shaft **182** on the interior of the box-frame **160** in a position best illustrated in FIG. **4A.**

A second rotary cutter knife **200** having a circular cutting edge **201** is mounted on the end of a second cutter shaft **202** supported for rotation by a rocker block **204** (FIG. **14**) positioned within the confines of the box-frame **160.** Rocker block **204** is mounted for pivotal movement on a pivot shaft **206** extending between the end walls **176** and **178** of the box-frame **160.** Rocker block **204** includes first and second leg portions **208** and **210** joined by a base portion **212** through which the pivot shaft **206** extends. Leg portion **208** is apertured to provide support for roller bearings **209** supporting one end of the second cutter shaft **202** and a cylindrical extension **214** extending perpendicularly from the side of second leg **210** includes a sleeve bearing **216** supporting the other end of the second cutter shaft **202** as best illustrated in FIG. **4A.** Additionally, a vertical lug **218** extends upwardly from the corner of the rocker block **204** and includes an aperture **220** in which a coil compression spring **230** is positioned between lug **218** and wall **164** for urging the rocker block in a counter-clockwise direction as viewed in FIG. **12.**

A wear plate **232** (FIG. **13**) is provided in a depression aligned with the spring **230** in alignment with a low-friction roller **234** mounted in the end of a push rod **236.** Push rod **236** is supported in a slide bearing **238** mounted in an aperture in the side wall **162** and includes a positioning flange **239** abutting against the end of the slide bearing **238.** The force of spring **230** urges push rod **236** to the left as viewed in FIGS. **11** and **12** in an obvious manner. The outer end of the push rod **236** is rounded as at **240** for low-friction engagement with the end of abutment lug **136** as shown in FIG. **7.**

A generally circular fitting plate **242** is attached to the external surface of the end wall **178** coaxially with respect to an opening in the wall and a plurality of work piece positioning pins **244** extend outwardly from the fitting plate **242** and a stripper ring **245** having diametrically opposed radial actuator pins **245'** is mounted for reciprocation on pins **244.** Pins **244** are received on the interior of the open end of a cylindrical work piece in a manner and for a purpose to be discussed in detail hereinafter.

It should be noted that the fitting plate **242** is provided with an aperture **246** through which the cylindrical bearing support extension **214** of rocker block **204** extends with the aperture **246** being of larger size than the outer periphery of the cylindrical bearing support extension **214** to permit pivotal movement of the cylindrical extension **214** within the aperture between the limit positions illustrated in FIGS. **11** and **12.**

The removable cutter units **140** are positioned on the main shaft **51** with the lower surfaces of foot plates **166** and **168** resting on the planar upper surface **84** and the vertical side plates **170** and **172** extending downwardly into the longitudinal recess **86** above the center floor web **100.** Machine screws or other equivalent members hold the cutter units fixedly in position on the main shaft.

A gear **248** is keyed to shaft **202** to mesh with the gear **196** so that driving rotation is imparted to shaft **202** via ring gear **40,** gear **194** and gear **196** as shaft **51** rotates with respect to main rotary sleeve **36** in a manner that will be obvious from inspection of FIG. **4A.** The second rotary cutter knife **200** is urged axially outwardly by a compression spring **250** against a radial abutment surface **254** of a retainer **256** threadably received in the end of the shaft **202.** Surface **254** engages and is consequently accurately positioned by the end of the shaft **202** and so as to achieve an exact positioning of the knife member **200** both with respect to the shaft **202** and the first rotary cutter knife **186** which is positioned against the radial surface of the positioning flange **190** on shaft **182.** Consequently, an exact positioning of the knife members with respect to each other is enabled in the cutter unit per se. It is of great advantage that the entire cutter unit can be removed from the machine in the event of any malfunction of any part of the cutter unit and replaced in an expeditious manner without any substantial disassembly of any parts of the cutter support or drive components.

More specifically, each cutter unit **140** is positioned with the lower surface of the foot plate **166** and **168** resting on planar surface **84** and the elements between the vertical side plates **170** and **172** extending downwardly in the longitudinal slots **86** above the foot plate **100.** As thus positioned, the cutter units **140** are held in position by threaded bolts or pins **256** received in apertures **258** in the main shaft **51.** As thus positioned on the main shaft **51,** the cutter unit drive gear **194** is in mesh with the ring gear **40** and rotation of the main shaft **51** consequently results in rotation of the cutter knives **186** and **200** via shaft **182,** gear **196,** gear **248** and shaft **202** in a manner that will become apparent from inspection of FIG. **4A.** It should also be noted that the rounded end **240** of the push rod **236** is positioned in engagement with the adjustable abutment lug **136** on the cutter actuator arm **134.** Consequently, rotation of the shaft **51,** radial cam follower support flange **118** and cam follower **128** etc. will traverse the cam follower **128** about the periphery of cam surface **117** to provide oscillation of pivot shaft **124** to reciprocate the push pin **236** between extreme positions of movement illustrated in FIGS. **11** and **12** to move the rotary cutter knives **186** and **200** between engaged and disengaged positions in timed relationship to the movement of work pieces between the cutter knives by the work piece handling units **150.**

The construction of the identical work piece handling units **150** will now be discussed in detail with initial attention being invited to FIG. **6** which illustrates their main components. Primary support for the components is provided by a bushing block **260** having side flanges supported on shoulders **108** and **110** and held in position by threaded pins or the like **264** (FIG. **1**). It should be understood that there are two identical work piece handling units **150** oriented on opposite sides of the main support shaft **51** and each one of which is associated with a removable cutter unit **140.**

A cylindrical slide bearing **264** is provided in each of the bushing blocks **260** for supporting a slide sleeve **266** for axial reciprocation therein. A work piece drive shaft **268** is mounted for rotation on bearings **270** internally of sleeve **266.** Additionally, a manifold block **272** is sealingly engaged with a central portion of the shaft **268** and includes a circumferential ring-shaped cham-

ber 274 communicating with a radial bore 276 in shaft 268 which has its inner end communicating with an axial bore 278 extending to the outer or left end of shaft 268 as viewed in FIG. 4B. A circular vacuum chuck 280 is mounted on the end of the shaft 268 and has an aperture 282 communicating with the axial bore 278.

A Y-shaped slide plate 300 (FIG. 6) extends forwardly from beneath the lower end of the slide sleeve 266 and includes forward guide plates 302 received in inwardly facing slots 304 of slide bearings 306 mounted on shoulders 104 and 106 of the main shaft 51 (FIG. 6). A stripper ring actuator link 308 extends upwardly from each of the guide plates 302 (only one of which links is illustrated in FIG. 6 for purposes of clarity) and has an open slot 310 at its upper or outer end received on one of the actuator pins 245' of the stripper ring 245 so that reciprocation of the actuator links 308 will move the stripper ring 245 along the work piece positioning pins 244 for a purpose to be discussed.

Timed reciprocation of the slide sleeve 266 and its associated parts including a work piece cradle 312, actuator 308 etc. is achieved by virtue of operation of first and second cam followers 318 and 320 carried by a bracket 330 fixedly connected to the end of sleeve 266 opposite the vacuum chuck 280. The first cam follower roller 318 is keyed to a shaft 332 to which a bevel gear 334 is also fixedly connected. Bevel gear 334 is in mesh with a second bevel gear 336 keyed to the work piece of shaft 268. The surface of roller 318 has a high coefficient of friction and movement of the roller with respect to the side of cam 76 consequently drivingly rotates the roller, shaft 332 and gear 334 to drive the gear 336 and work piece drive shaft 268 and associated vacuum chuck 280. It will be seen that the curvature of cam 76 will shift sleeve 266 etc. inwardly and outwardly of the slide bearing 264 in the bushing block 260 as the main shaft rotates with respect to the fixed cam 76. The two extreme positions of the slide sleeve 266 etc. are illustrated by the upper and lower sleeves in FIG. 4B.

It is necessary that the vacuum chuck 280 be connected to a source of vacuum during a substantial portion of a cycle of operation. Achievement of the foregoing requirement is enabled by the provision of an axial bore 340 extending from the end of the main shaft 51 and communicating with a transverse bore 342 which is plugged at both ends and which communicates with passageways 346 extending between the respective shoulders 108 and 110 on the upper and lower sides of the main shaft 51 as viewed in FIG. 6. The passageways 346 extend upwardly through the bushing block 260 (FIG. 4B) and slide bearing 264 to communicate with an elongated chamber 348 provided in each of the slide bearings 264. A radial bore 350 in sleeve 266 provides communication with the ring-shaped chamber 274 as shown in FIG. 4B.

When the sleeve 266 is in the position of the uppermost sleeve illustrated in FIG. 4B, vacuum introduced through any conventional rotary coupling fitting C to the axial bore 340 is conveyed via elements 340, 342, 346, 348, 350 and 274 to the radial bore 276 in drive shaft 268 so as to apply vacuum to axial bore 278 and the aperture 282 on the face of the vacuum chuck 280. However, movement of the sleeve 266 to the right from the position of the upper sleeve illustrated in FIG. 4B to the position illustrated by the lower sleeve 266 in FIG. 4B serves to position the radial bore 350 in sleeve 266 beyond the extent of the elongated chamber 348 in communication with the external atmosphere so as to dissipate any vacuum in the vacuum chuck in an obvious manner.

Work piece 354 comprising cylindrical members closed at one end and having an unfinished opposite end 356 are fed to the preferred embodiment to have the unfinished end 356 neatly cut from the work piece by knives 186 and 200 to provide a resultant end construction to which a top can be subsequently permanently affixed. Means for feeding and discharging the work pieces will now be discussed.

An infeed conveyor 358 (FIGS. 1 and 5) receives the unfinished work pieces 354 from any conventional supply source such as another conveyor or the like. Trimmed and finished work pieces 354' are discharged from the apparatus by a discharge conveyor 360. Support for both the infeed conveyor 358 and the outfeed or discharge conveyor 360 is provided by first and second vertical standards 362 and 364 extending upwardly from the base plate 20 to which their lower ends are connected.

Infeed conveyor 358 includes an upper transverse plate 372 and a lower transverse plate 374 extending between and connected to the vertical standards 362 and 364. Lower guide rails 376 are connected to the lower transverse plate 374 and upper guide rails 378 are connected to the upper transverse plate 372 with a pivot shaft 380 (FIG. 8) extending between the upper rails 378 for pivotally supporting the inner ends of first and second arcuately curved can infeed guide means 382 medially joined by a transverse angle 384 in which an adjustment lug 386 is threadably received. The lower end of the adjustment lug 386 rests upon a fixed stop member 388 on the frame which limits the extent of downward movement of the infeed guide members 382 about pivot shaft 380 in an obvious manner. Side plates 390 and 392 provide a lateral axial positioning of the unfinished work pieces in the form of cans 354 fed downwardly between the rails 376 and 378.

Discharge conveyor 360 is also supported between the vertical standards 362 and 364 and includes lower floating guide rails 394 supported on a transverse plate 396 (FIG. 8) extending between the vertical standards 362 and 364 and having curved outer ends 394'. A plurality of pins 398 are axially positionable in bores in the transverse plate 396 and have their inner ends fixedly connected to the lower guide rails 394. A coil compression spring 399 us provided on each of the pins 398 so that the pins are urged downwardly to hold the rails 394 in the position illustrated in FIG. 8; however, it will be apparent that the lower rails 394 are flexibly supported and are capable of some limited movement as they are engaged by cans fed onto their outer ends.

Discharge conveyor 360 also includes a pair of upper guide rails 400 supported on a transverse plate 402 and have curved outer ends 404. The upper guide rails 400 are similarly flexibly supported by pin and spring members in the same manner as the lower guide rails 394. Cans received between the rails 400 and 394 are conveyed away from the inventive apparatus to another conveyor or the like as required by the particular manufacturing operation.

Means are provided on the main shaft 51 for removing the lowermost unfinished work piece 354 from the infeed conveyor 358 to be received by the vacuum

chuck 380 etc. during the can end trimming operation. Additionally, the same means employed for removing the lowermost can from the infeed conveyor 358 also serves to rapidly eject a finished can 354' from the rotating work support means 312, 280 etc. into the discharge conveyor 360 in a manner to be discussed.

More specifically, parallel finger discs 406 are mounted on each end of mounting blocks 408 which are fixedly connected to the arcuately curved outer edge surface 82' of the central portion 82 of the main shaft 51 as shown in FIG. 6. Each disc of each pair of discs on each mounting block mutually cooperate with each other. The disc pairs are mounted on opposite sides of the main shaft in the central portion 82. Only one pair of discs is illustrated in FIG. 6 for purposes of clarity. Therefore, it will be seen that a total of four finger discs 406 are employed on the shaft 51.

FIG. 8 illustrates one finger disc of each of the finger disc pairs. Each finger disc 406 has an arcuately curved outer peripheral surface 410 with the center of curvature of the surfaces 410 for the upper or righthand pair of discs in FIG. 8 being positioned above the axis 51' of the main shaft 51 and the center of curvature of the surfaces 410 of the lower or lefthand disc being positioned below the axis 51' as will be evident from inspection of FIG. 8. Each of the discs 406 includes a leading (as rotated in the direction of arrow 414 in FIG. 8) work piece engaging suffface 412 and a trailing surface 413. It will be noted that the dual function surface 412 will engage the lowermost can in the infeed conveyor 358 to remove that can from the conveyor as the apparatus rotates in the direction of the arrow 414 in FIG. 8 and the same surface 412 also serves to eject the finished can 354' onto the outfeed conveyor 360. It should be noted that the arcuate surface 410 trailing behind the dual function work piece engaging surface 412 serves to prevent the next can in the infeed conveyor from moving from the conveyor unit until such time as the trailing surface 413 has rotated past alignment with the lower end of the infeed conveyor 358.

Additionally, a scrap removal chute 416 having side walls 418 and 420 is positioned adjacent the discharge conveyor for receiving scrap rings 354'' trimmed from the can work piece. Side wall 420 has a sharp forward edge 428 for aiding in receipt of the scrap rings 354''.

A complete cycle of operation of the preferred embodiment as illustrated in FIG. 17 will now be discussed with primary reference being to FIGS. 7, 8 and 17. The cycle begins with the elements rotating in the direction of arrow 414 as a lowermost can on the infeed conveyor 358 moves from the trailing portion 413 of the arcuate surface 410 of one pair of finger discs 406 downwardly in front of the following work piece engaging surface 412 of the other pair of finger discs. For reference purposes, various angular positions are illustrated in FIG. 17 with the various positions being designated in roman numerals.

In position I, the surface 412 is engaging the can just deposited on the work piece cradle 312 as discussed above, vacuum chuck 280 is in its retracted position and the aperture 282 is vented to atmosphere with no vacuum being applied thereto. Additionally, in position I, the knife members 186 and 200 are in their open position as shown in FIG. 5 by virtue of the fact thet the cam follower 128 is on a high portion of the cam surface 117.

As the apparatus rotates from position I toward position II, continuously rotating vacuum chuck 280 moves forward to position radial bore 350 in communication with the elongated chamber 348 to which a constant vacuum is being applied by previously discussed conduits 340, 346, etc. Consequently, vacuum is supplied to the aperture 282 in the face of the vacuum chuck and the unfinished work piece adjacent the vacuum chuck is pulled into engagement with the face of the chuck to initiate rotation of the can as the chuck continues to move to the left toward the open cutters 186 and 200. Continued movement of the chuck to the left moves the end of the unfinished container 354 into the dotted line position in which the upper cutter knife 200 is positioned on the interior of the unfinished work piece as symbolically illustrated in the uppermost portion of FIG. 15. At the termination of 70° of rotation at position II, the vacuum chuck has moved to its forwardmost position and during the next 10° of rotation to position III, the upper knife member 200 is rapidly moved downwardly to the cutting position as illustrated pictorially adjacent angular position III in FIG. 17.

It should be noted at this juncture that FIG. 7 illustrates the upper pair of rotary cutter units 186 and 200 in a closed condition and the lower pair of cutter units in an open condition for purposes of comparitive illustration. In actuality, cutter units in the position of the upper units (the twelve o'clock position) would actually be open as figuratively illustrated in FIG. 17 and the upper cutter member does not move to the lower or closed position until it reaches angular position III in FIG. 17. The upper righthand cam follower 128 illustrated in phantom in FIG. 7 is illustrated in the position that the roller 128 would occupy if the upper cutter member 200 was in the lower or cutting position as illustrated in FIG. 7. In actuality, the roller 128 in the upper righthand portion of FIG. 7 would be riding on the higher part of cam 117 and the cutter member 200 would consequently be in an open position in the same manner as the lower cutter member 200.

Spring 230 must be of substantial size and strength in order to provide effective movement of the cutter member 200 downwardly to the cutting position when the pin 236 etc. is retracted by operation of the cam 128, shaft 124 and cutter actuator arm 134.

An important fact to be kept in mind is that the cutter members 186 and 200 are constantly rotating both in the open and closed positions since the gear teeth or gear members 248 and 196 are of sufficient height to maintain the teeth in mesh when the cutter 200 is in its upper or raised position. Similarly, the vacuum chuck 280 is continuously rotating by virtue of the drive from elements 318, 334, 336 and 268.

Following completion of the closing of the knife members at angular position III, the cutting of the can end is effected during the next 90° of rotation to position IV at which point the cam follower 128 engages rise 117' (FIG. 7) of cam surface 117 to rapidly open the knife members by moving the rotary cutter 200 to the open position as pictorially illustrated adjacent positions IV and V with the opening of the cutter members being completed in approximately 10° of main shaft rotation at position V.

Upon completion of the opening of the knife members, the cam 76 begins retraction of the slide sleeve 266, vacuum chuck 280 and Y-shaped slide plate 300 away from the cutters (to the right as viewed in FIG. 1)

to remove the finished can **354'** from its position overlying the positioning pins **244** to clear the can completely from the cutter members and the pins. Additionally, retraction of the slides **300** to the right also results in movement of the stripper ring **245** from the inner position illustrated by the upper stripper ring **245** in FIG. **1** outwardly along the positioning pins **244** to the position illustrated by the lower stripper ring **245** in FIG. **1.** Movement of the stripper ring **245** outwardly to the position substantially adjacent the ends of pins **244** results in the stripping of the scrap end **354''** from the pins **244** so that the scrap ends **354''** are discharged into the scrap removal means **416** etc. as shown in FIG. **1** and similarly in FIG. **17.**

The retracting movement of the sleeve **266** also eventually results in movement of the bore **350** beyond the end limit of elongated chamber **348** to vent the bore **350** and consequently release the trimmed can **354'** from the vacuum chuck **280** as the can reaches a position in alignment with the discharge conveyor **360.** The finished can has been discharged and the vacuum chuck **280** etc. is in its completely retracted position illustrated by the lower vacuum chuck in FIG. **4B** as the elements reach position VI. The chuck **280** etc. is consequently in position to receive the next can as it subseqnently moves into position I.

The employment of the plural cutter units enables a high capacity operation of the preferred embodiment with down time due to cutter failure being kept to a minimum by virtue of the easy replacement of the entire cutter unit in a matter of a few minutes as compared to the prior known devices in which a time consuming substantial disassembly of the components is required in the event of cutter unit failure. It is contemplated that ten or more cutter units could be employed if desired.

FIG. **15** illustrates modified knife members employing relatively small cutting elements enabling replacement of the cutting surfaces which can be replaced at minimum cost. Specifically, the only difference between the cutter means of FIG. **15** and the previously discussed cutter means comprises the employment of an upper relatively thin cutter disc member **288** mounted between the radial flange of retainer means **192** and biassing means including slidable sleeve members **289** and **290** urged toward the end of the shaft **202** by spring members **291.** The shafts **182** and **202** are identical to previously described shaft members **182** and **202** and are consequently provided with the same reference characters as is the retainer means **192.** The upper element **289** can be identical to the cutter members **186** and **200** as previously discussed; however, the member **289** in the modification illustrated in FIG. **15** merely serves to bias the cutting discs **288** rather than actually perform a cutting function. Additionally, it should be understood that the cutting discs **288** can be of different diameters if desired so as to be interchangeable as a larger disc is worn down by use and sharpening.

The lower cutting disc **288'** is fixedly positioned with respect to the surface **187** by means **192'** and **289'** in a manner identical to the positioning of member **186** as previously discussed with the only difference being that the cutting surface is provided by the outer edges of the relatively thin cutting disc element **288'.**

FIG. **16** illustrates outer edge portions of cutter disc members **288** and **288'** (which are structurally identical) employing different outer surface shapes all of which are effective for achieving the cutting function. Disc portion A has a conical outer edge surface A' concentric with respect to the axis of the disc and a shaft on which it is to be mounted. Disc portion B has a concave outer periphery B' and disc portion C has a cylindrical outer periphery C'. It should be noted that each of the disc members provides two cutting edge corner portions defined by the intersection of the planar end surfaces of the disc members with the outer peripheral surfaces.

FIG. **18** illustrates a second embodiment of the invention in which a central cutter knife **440** is employed in conjunction with a pair of diametrically opposed planetary cutters **442** which cooperate with the central knife **400** to trim the ends of containers **354.** In this embodiment, a base or pillar plate **20'** essentially identical to pillar plate **20** provides support for a first vertical support pillar **26'** and a second vertical support pillar **28'.** A work piece positioning control cam flange **76'** is supported on the pillar plate **28'** for cooperation with cam followers **318'** and **320'** associated with a bracket **330'** connected to first and second sleeve members **266'** supported for reciprocation in a transverse bushing block **444** fixedly mounted on a main shaft **446.** Main shaft **446** includes end shaft components supported between the members **26'** and **28'** by rotary bearing means with a central cage type portion including a plurality of connecting rods **448** drivingly joining the transverse bushing block **444** and a transverse cutter support block **449.** Only one of the connecting rods **448** is illustrated in FIG. **16.** Block **444** is connected by sleeve members **510, 512** and **514** to a second transverse block **451'** connected to the shaft component supported in bearings in member **26'.**

Power for the embodiment of FIG. **18** is provided from a main drive shaft **450** driven by an electric motor or other suitable power source in a counter-clockwise direction as viewed from the left end of the main drive shaft **450.** All subsequently discussed directions of rotation will be as viewed from the left end of the main drive shaft **450.**

Counter-clockwise rotation of drive shaft **450** is conveyed through a step-down transmission to a drive chain **452** drivingly connected to an idler sprocket assembly **454** supported for free rotation adjacent the end of shaft **446.** A link **456** connects idler sprocket **454** to the end of a central cutter wheel drive shaft **458** supported for rotation coaxially within the members **446' 449,** etc. to drivingly rotate the knife **440.**

In operation, main drive shaft **450** is driven in a counter-clockwise direction and subsequently drives knife **440** in a counter-clockwise direction via elements **452,** 454, 456 and **458.** At the same time, shaft **450** drives shaft **446** in a clockwise direction via gears **462** and **464** and a chain **466.** The last-mentioned clockwise rotation is provided to elements **444, 449** and **451** as well as vacuum chucks **280'** carried by the members **444** and **449.** Permanent work piece cradles **470** extend from sleeve **266'** over to the area of the planetary cutters **442** and have stripper rims **472** at their outer extremities for removing the waste rings **354''** from pins surrounding the planetary cutters (not shown) in a manner analagous to the operation of elements **244,** 255 of the first embodiment. Additionally, the cage construction between the elements **444** and **449** includes a pair of finger discs **406'** supported by the con-

necting rods **448** etc. for rotation and operation in exactly the same manner as the finger discs **406** of the first embodiment.

Planetary cutters **442** are driven by gear members **474** keyed to the shaft on which the cutter members **442** are mounted and meshing with a sun gear **476** driven in a counter-clockwise direction from central cutter shaft **458.** A cutter knife actuating cam **480** is fixed to the vertical support pillar plate **26'** and serves the purpose of moving the planetary cutter members **442** radially inwardly and outwardly with respect to the sum cutter **440.** This movement is effected by virtue of the fact that the shafts on which the planetary cutters **442** are mounted are capable of inward movement with respect to the central shaft **458** either by the employment of slide bearings in members **449, 451'** or by the supporting of the shafts on the end of a pivotal member provided at one end to means connected to elements **449** and **451** and carrying the shaft supporting cutters **442** at an opposite end in a manner of operation analagous to the operation of the pivot block **204** of the first embodiment. In any event, heavy springs **484** urge the cutter members **442** toward a cutting position overlapping the central cutter **440.**

In operation, unfinished cans **354** are fed by an infeed conveyor **358** to be engaged by the finger discs **406'** and deposited on the cradles **470** in approximately the twelve o'clock position of the cradle members. The vacuum chucks **280'** are concurrently moving forwardly and vacuum is applied to the face of the chucks through passageways in member **444** and sleeves **266'** to support the work piece for axial rotation caused by member **318'** and the bevel gears **334, 336** etc. in a manner essentially identical to the operation of the chuck of the first embodiment. The open can end is moved over the upper cutter **442** adjacent the central cutter **440** since the cutters are in a spaced condition. Operation of cam **480** then moves the upper cutter **442** downwardly in overlapping cutting relation with respect to the cutter **440** so as to trim the scrap ring **364''** from the can end. As the cutter unit approaches the six o'clock position, the scrap ring has been trimmed from the can end and the vacuum chuck **280'**, sleeve **266'** etc. is moving to the right to release the vacuum in the chuck **280'** and discharge the can and the scrap in the same manner as the first embodiment. In the meanwhile, the other container cradle **470** is receiving a new can as the system continues to cycle.

While numerous modifications of the subject invention will undoubtedly occur to those of skill in the art, it should be understood that the spirit and scope of the invention is to be limited solely by the appended claims.

I claim:

1. Rotary cutting means usuable with a like manner as a cutting couple comprising:

a cutter shaft portion having an outer end surface extending radially with respect to its axis,

removable flange means mounted on said cutter shaft portion defining a radial abutment flange surface extending radially outwardly adjacent the outer end surface of the cutter shaft portion,

a rotary knife member formed of a relatively thin cutter disc having planar sides the outer periphery of which define first and second peripheral cutting edges and an axial aperture matingly received over said cutter shaft portion,

a slide sleeve including a radial surface facing said abutment flange surface mounted on said cutter shaft for axial reciprocation with respect thereto, said relatively thin cutter disc being positioned between the radial surface of the slide sleeve and the abutment flange surface; and

biassing means for urging said slide sleeve toward said removable flange means so that one of said planar sides of said relatively thin cutter disc is positively and accurately positioned against said abutment flange to provide an accurate positioning of the cutting edge defining the outer periphery of the planar side engaging the abutment flange surface.

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