United States Patent [19]

Eggert et al.

[11] **3,844,201**

[45] **Oct. 29, 1974**

[54] **APPARATUS FOR CUTTING SHEET MATERIAL**

[75] Inventors: **Ralph H. Eggert,** Cinnaminson, N.J.; **Quentin T. Woods,** Huntingdon Valley, Pa.

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

[22] Filed: **July 25, 1973**

[21] Appl. No.: **382,433**

Related U.S. Application Data

[63] Continuation of Ser. No. 149,302, June 2, 1971, abandoned.

[52] **U.S. Cl.** ..... **93/36 A,** 93/58 R, 93/58.3

[51] **Int. Cl.** **B31b 1/16**

[58] **Field of Search** .... 93/36 A, 36 R, 58 R, 58 ST, 93/58.1, 58.2, 58.3, 58.4

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2,048,301	7/1936	Stokes et al.	93/58 R X
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FOREIGN PATENTS OR APPLICATIONS

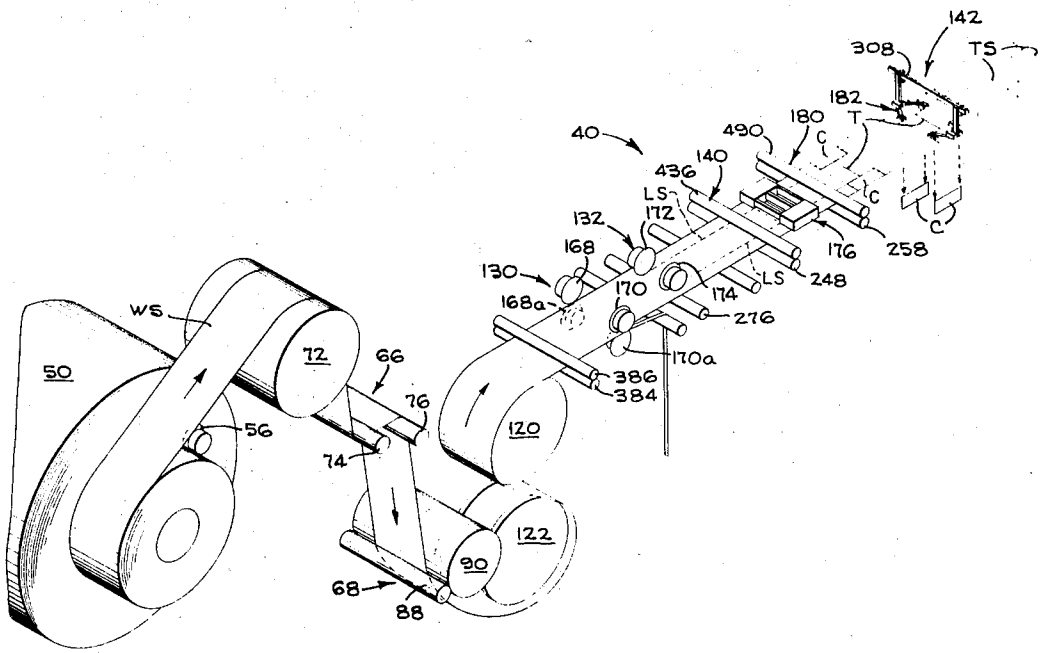
445,179 6/1927 Germany

Primary Examiner—Roy Lake
Assistant Examiner—James F. Coan
Attorney, Agent, or Firm—C. E. Tripp

[57] **ABSTRACT**

The present disclosure relates to an apparatus and method for making rigid box blanks from web strips of a desired length or from a continuous strip derived from a roll of board stock. The machine intermittently feeds the strip of material past a pair of scoring rolls that partially cut the web along lines equally inwardly spaced from its edges thereby providing two laterally spaced longitudinally extending score lines. While the strip is at rest transverse score lines extending between and intersecting the longitudinal score lines are produced. Concurrently therewith the web is substantially completely transversely severed along offset straight lines to produce removable rectangular portions which will constitute the corner pieces for the completed blank. Uncut tab portions are provided for holding the adjacent box blanks in strip form. Thereafter the tabs are ruptured to separate the strip into individual blanks.

10 Claims, 43 Drawing Figures



PATENTED OCT 29 1974

3,844,201

SHEET 01 OF 28

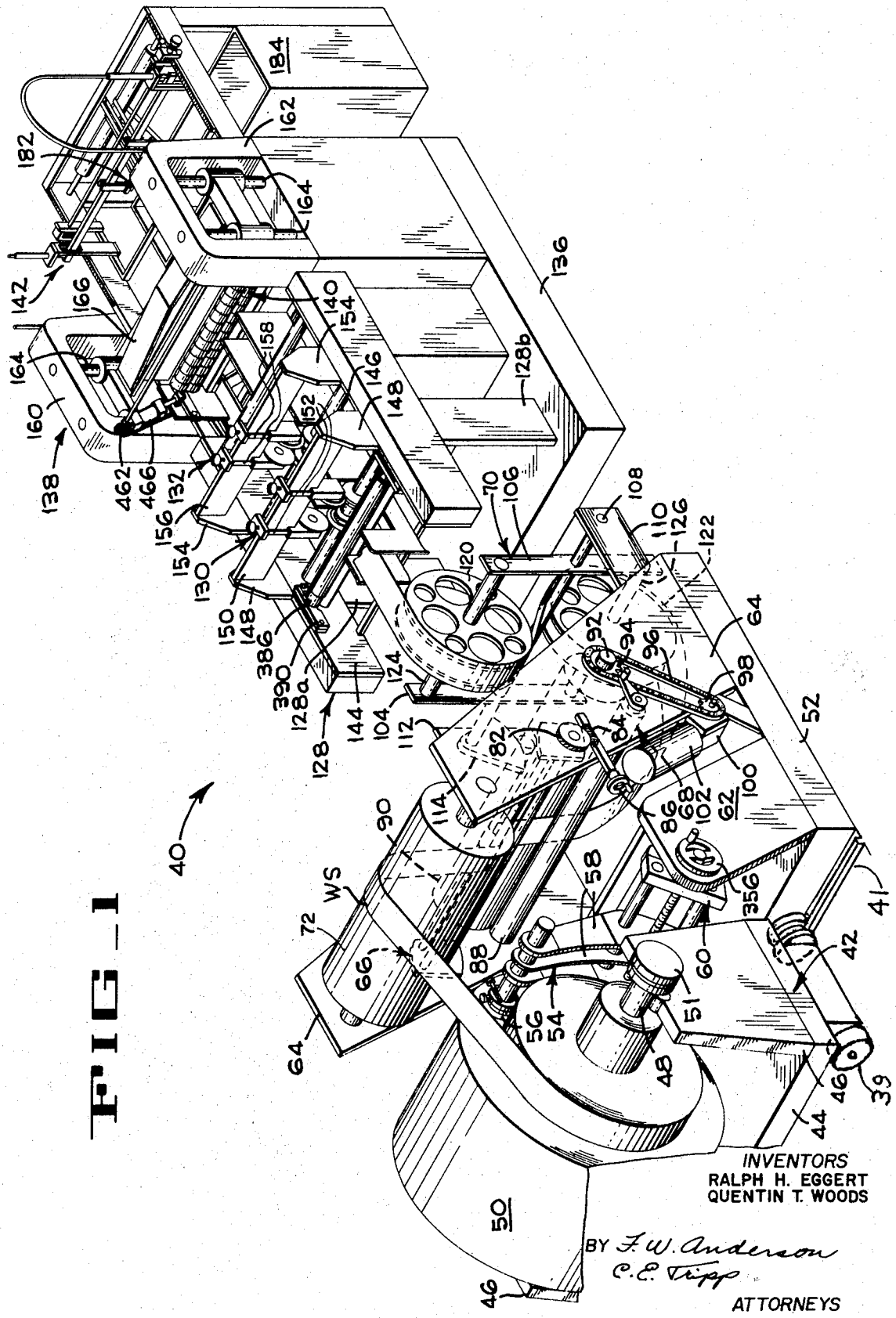


FIG_1

INVENTORS
RALPH H. EGGERT
QUENTIN T. WOODS

BY F. W. Anderson
C. E. Tripp

ATTORNEYS

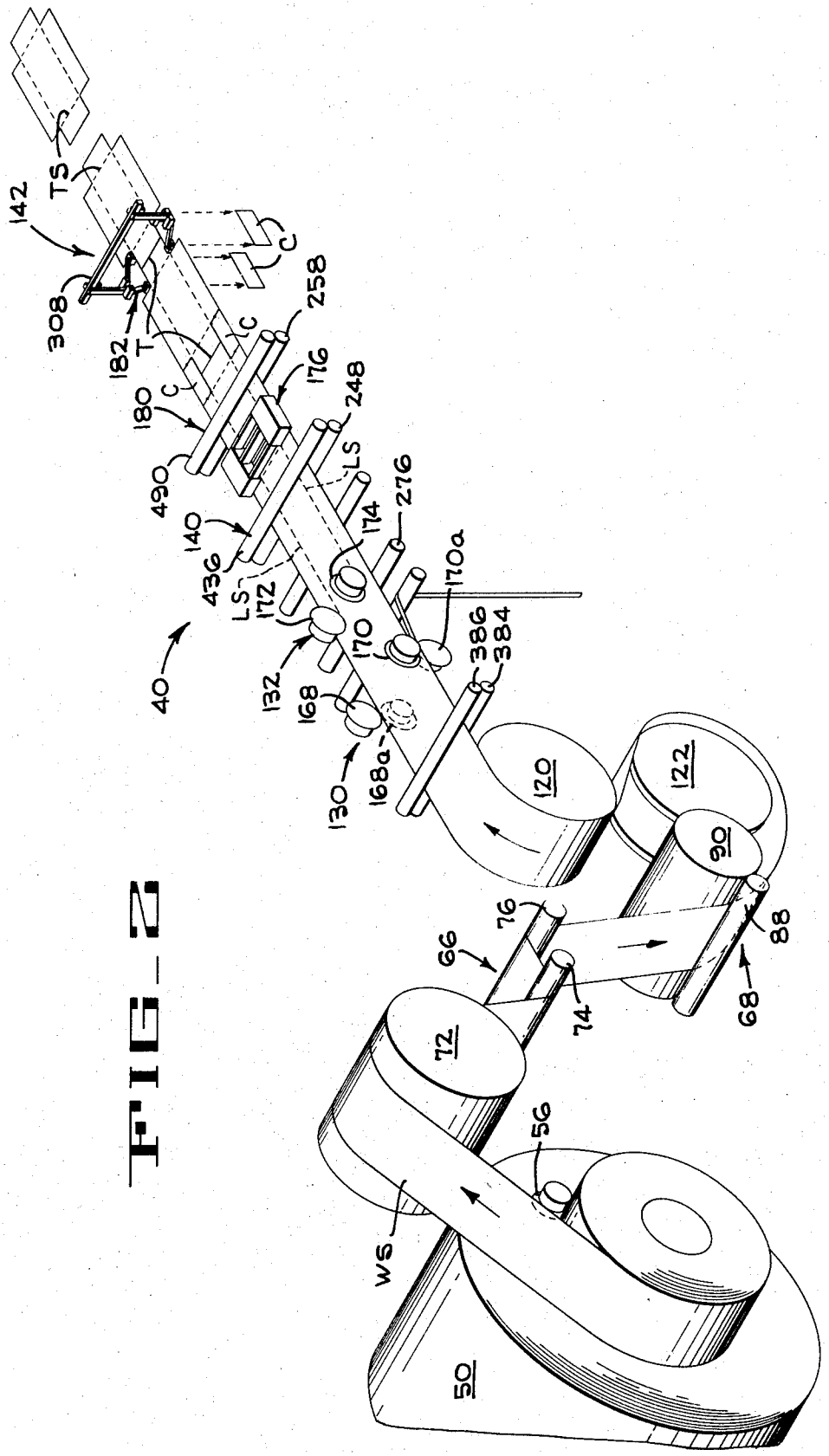

142
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FIG_2

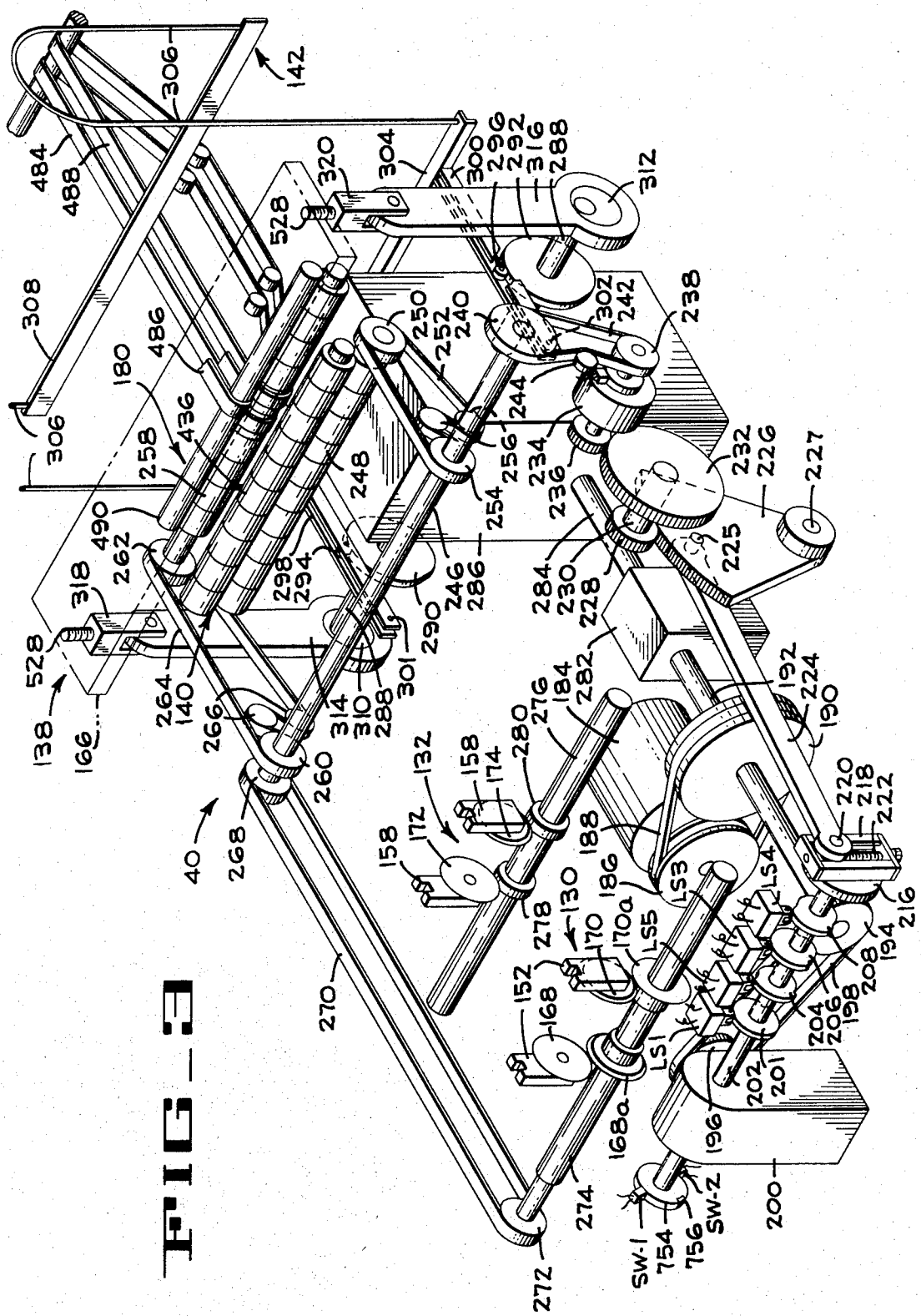

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LS3
LS4
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278
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170a
LS5
216
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194
152
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LS1
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168a
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274
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SW-1
754
756
SW-2
272

FIG-3

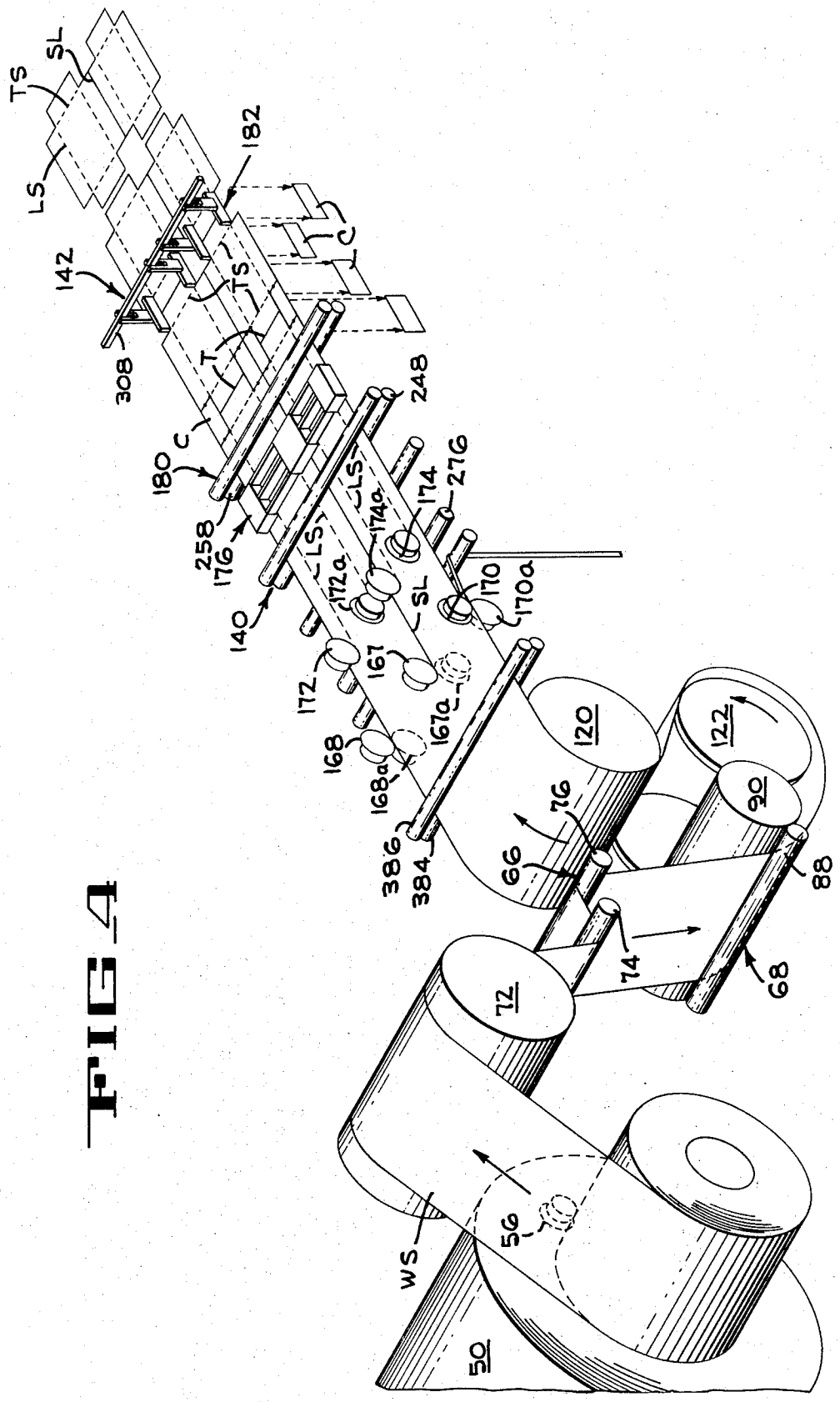

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FIG 4

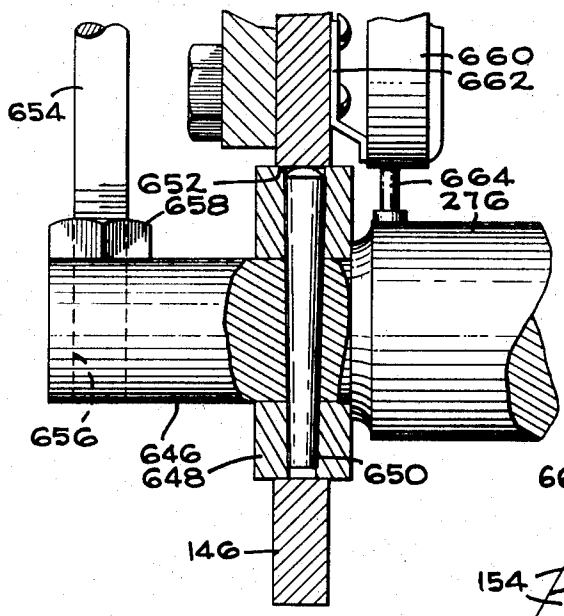

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FIG_5

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654a
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FIG_6

FIG_7A

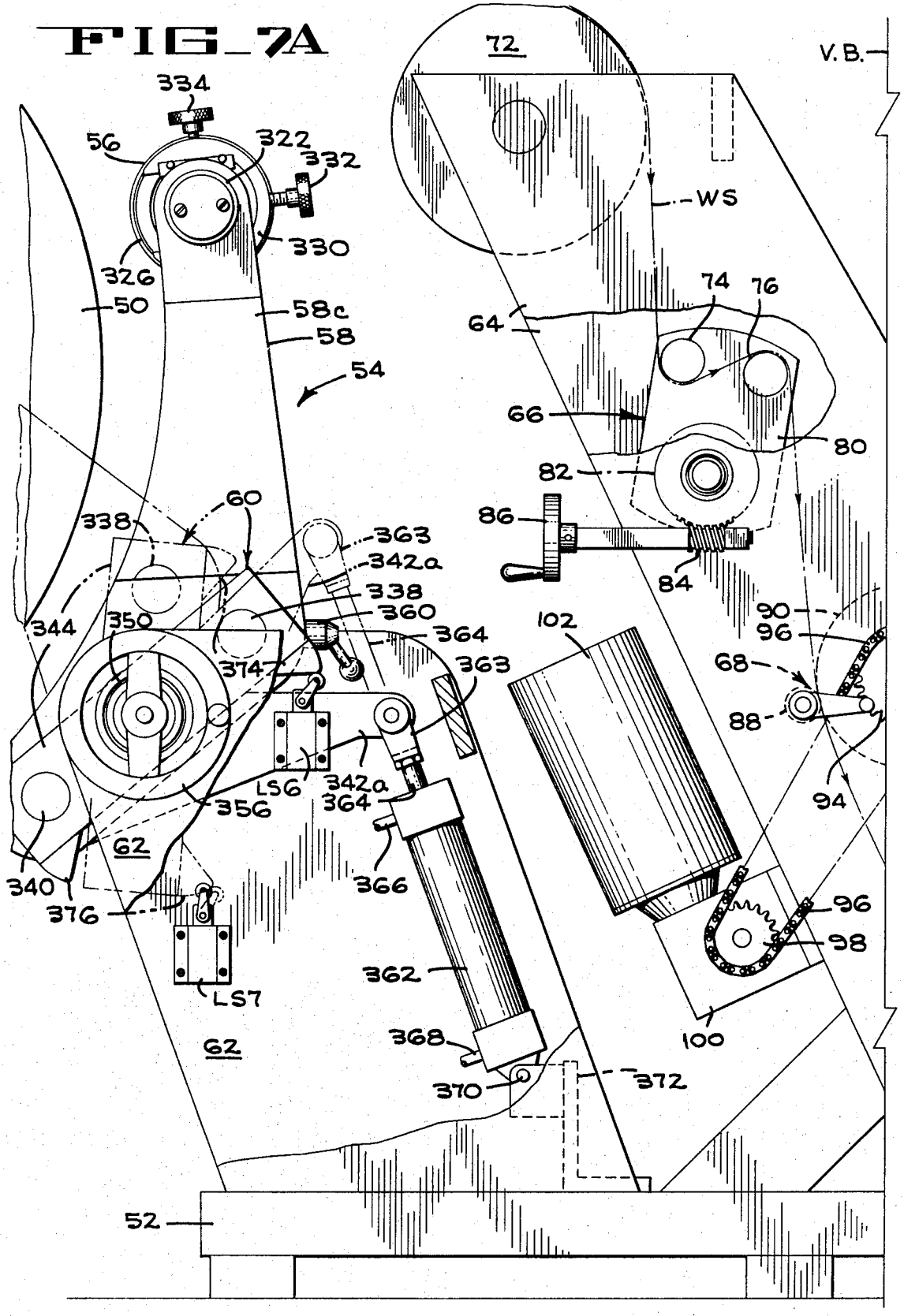
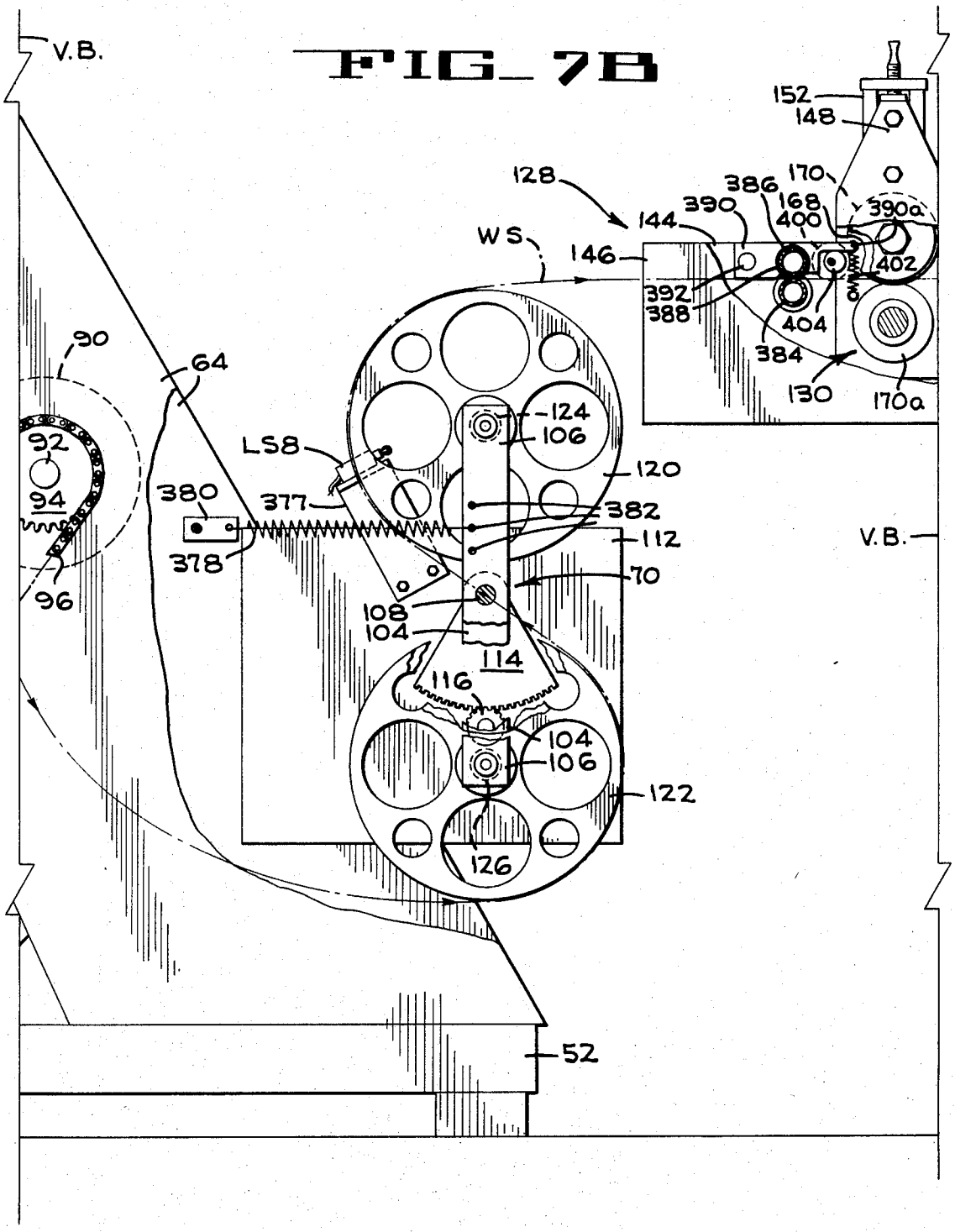

334
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58c
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V.B.
WS
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338
363
342a
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360
364
344
350
374
363
LS6
342a
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356
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LS7
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FIG_7B


V.B.
152
148
128
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386
168
390
390a
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400
WS
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402
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388
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384
130
170a
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64
92
94
96
LS8
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V.B.
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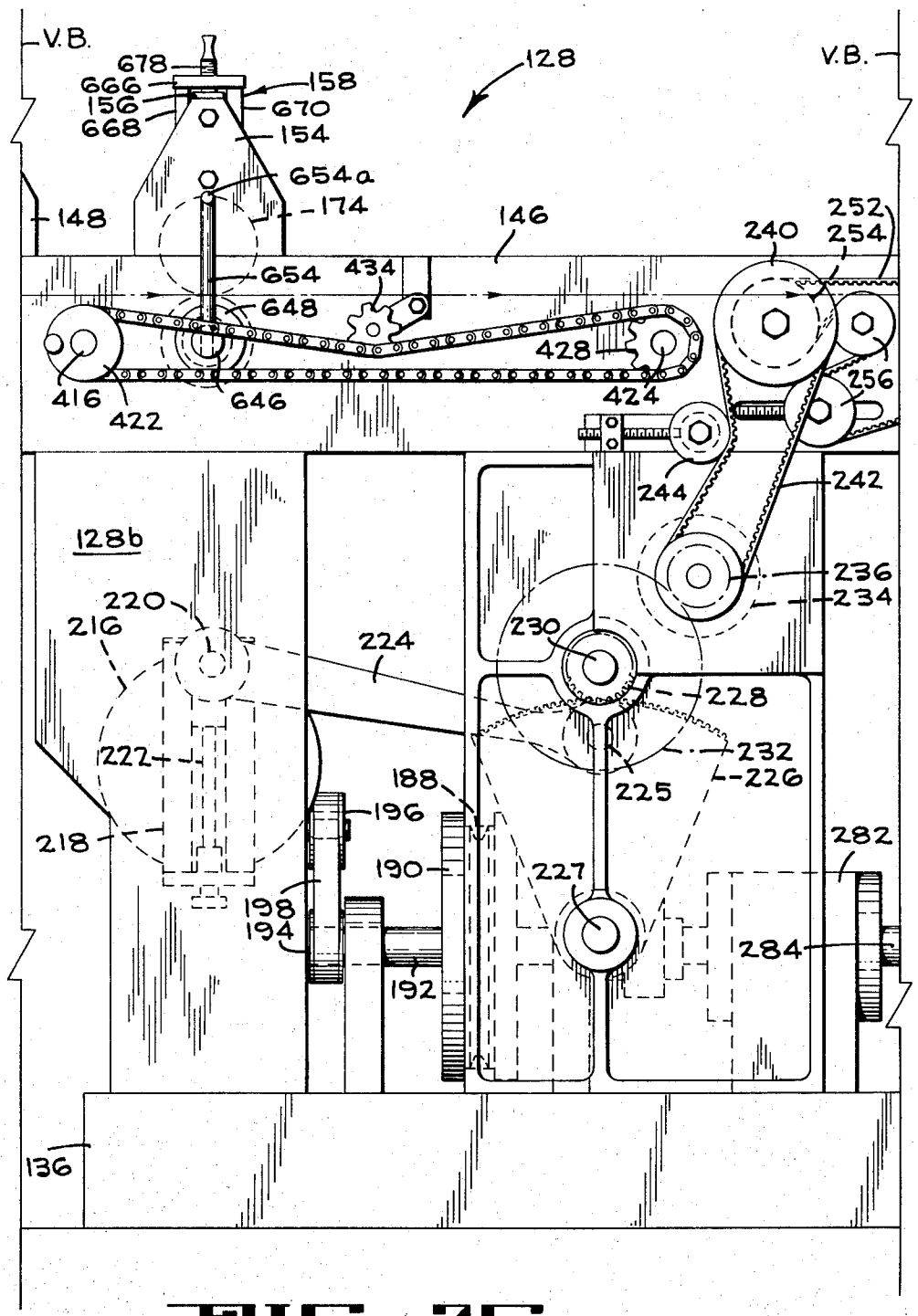

V.B.
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428
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128b
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FIG_7C

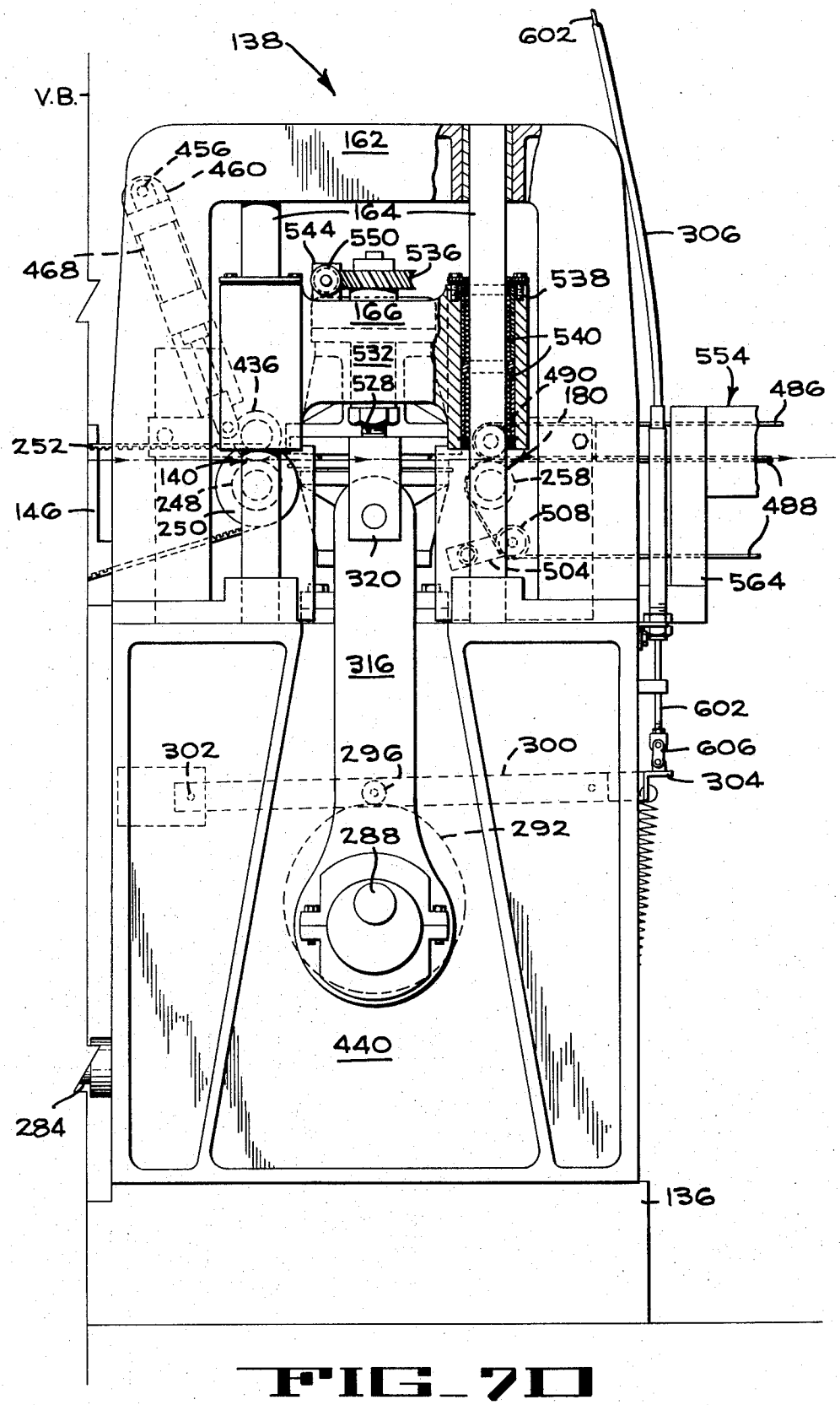

138
602
V.B.
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FIG_70

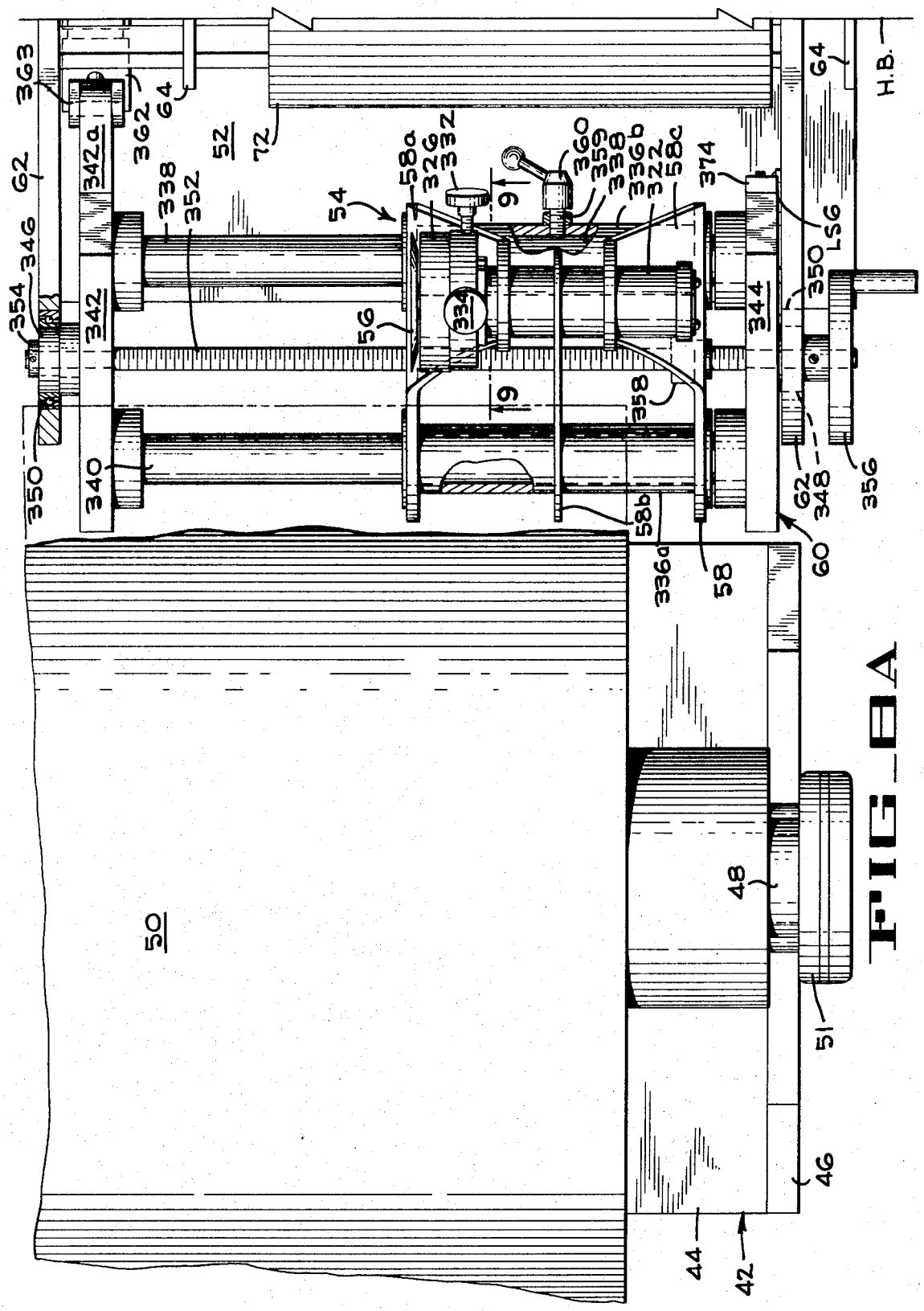

363
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342a
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352
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58a
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336b
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334
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342
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FIG 8A

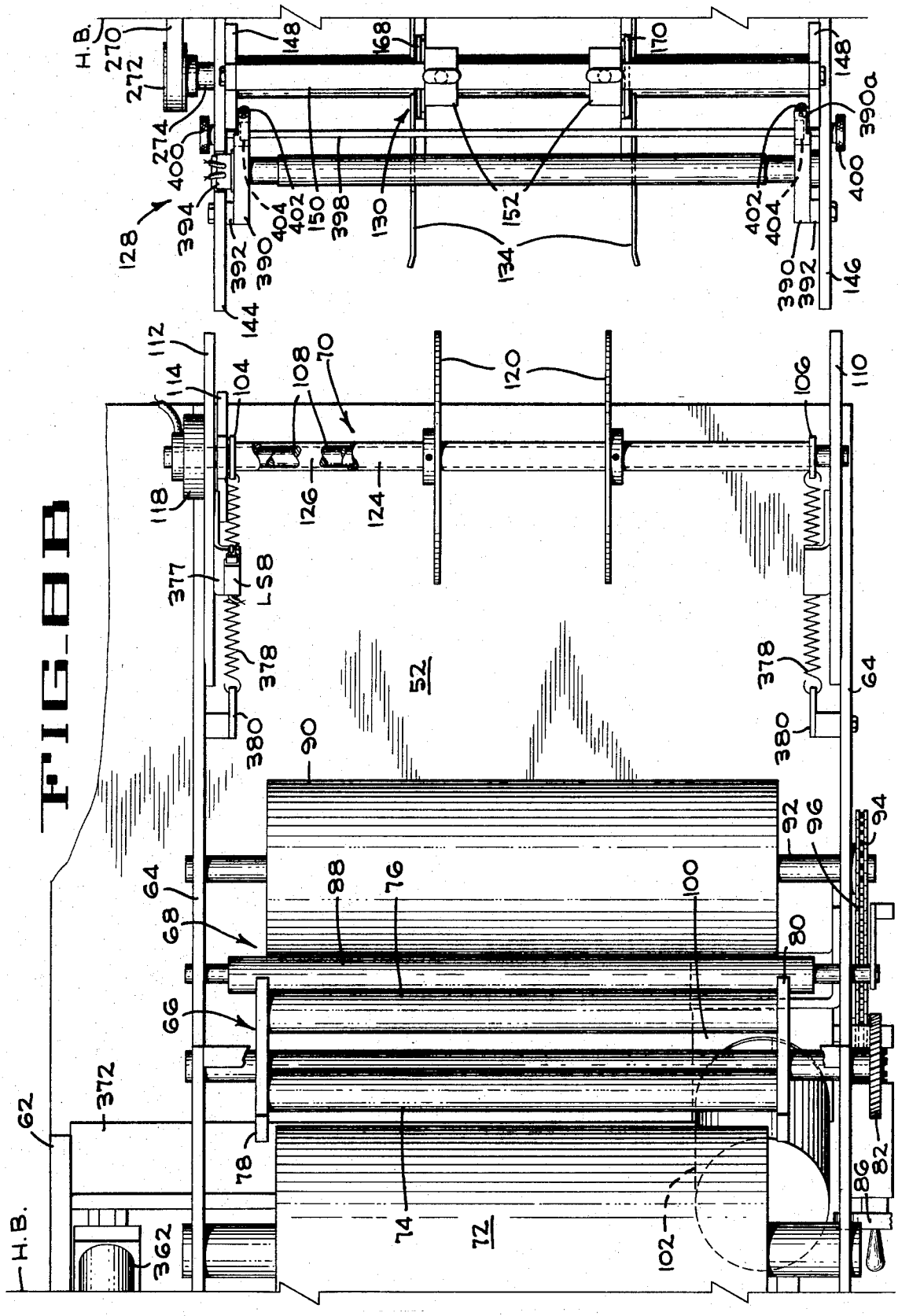

H.B.
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H.B.

FIG-8B

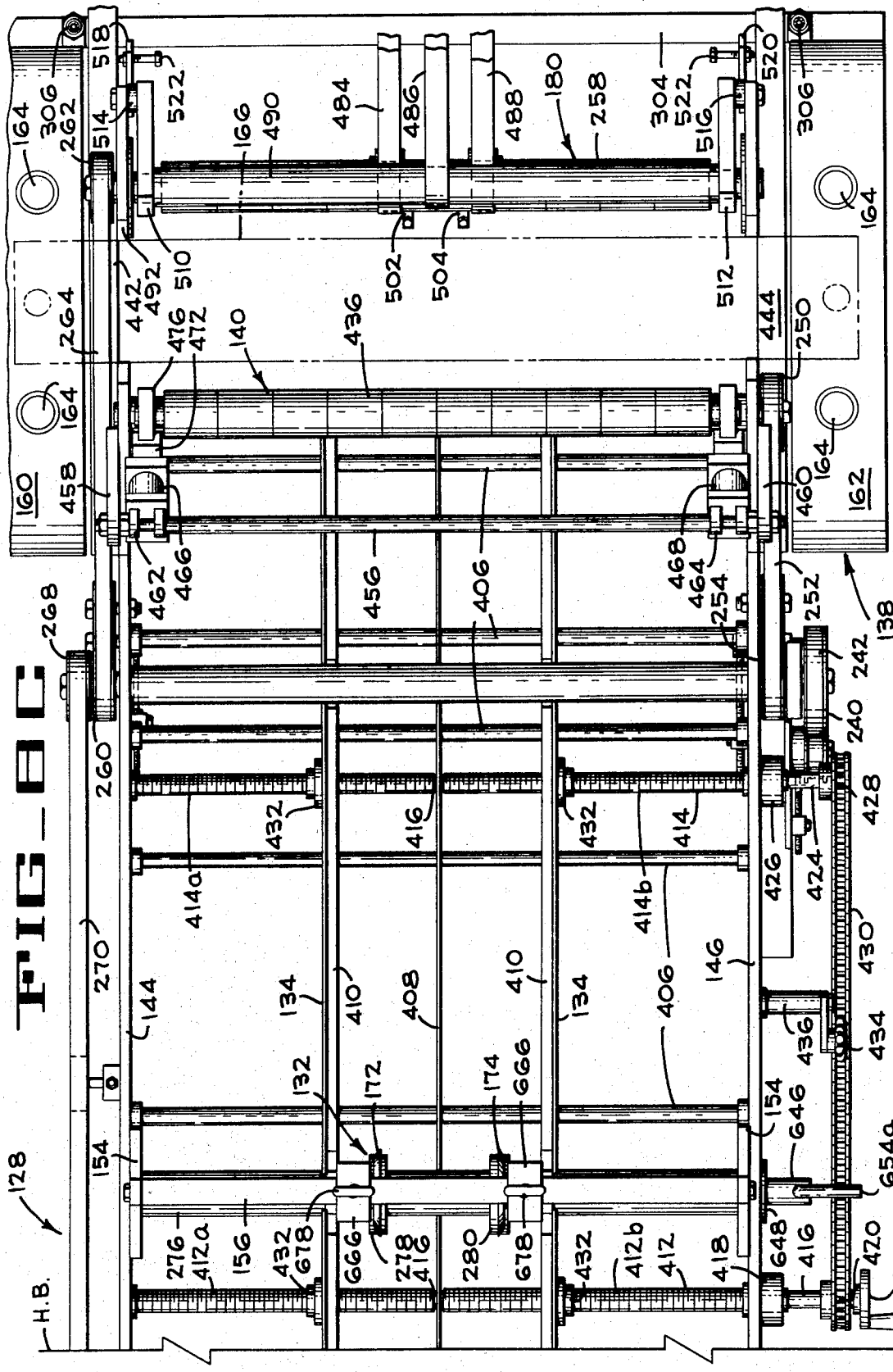
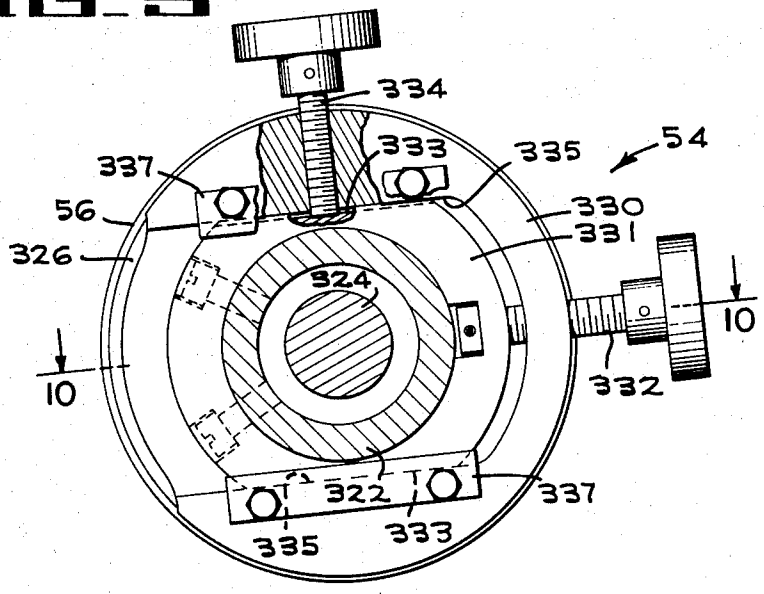

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414b
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654a
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FIG-8C

FIG_9


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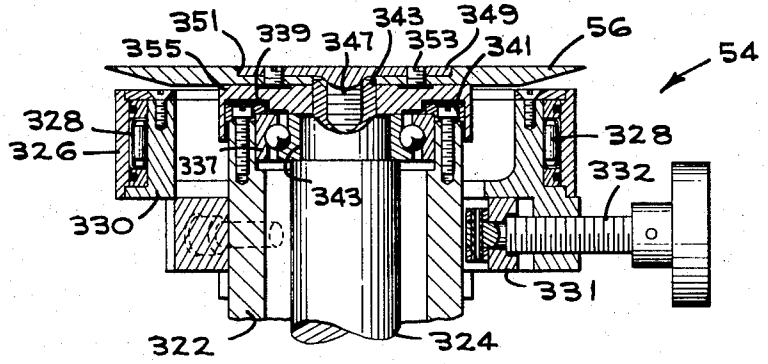
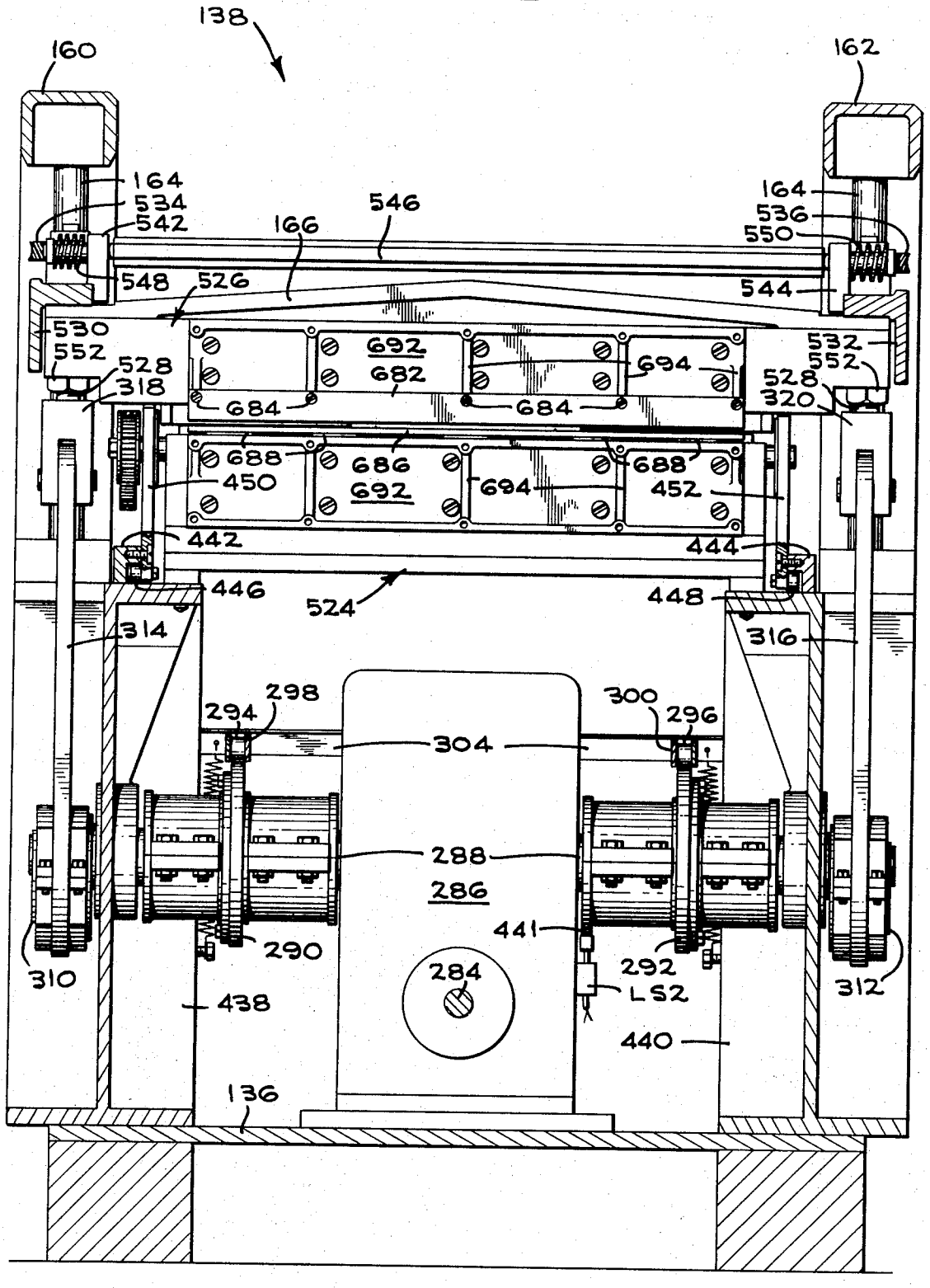

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FIG_10

FIG_11


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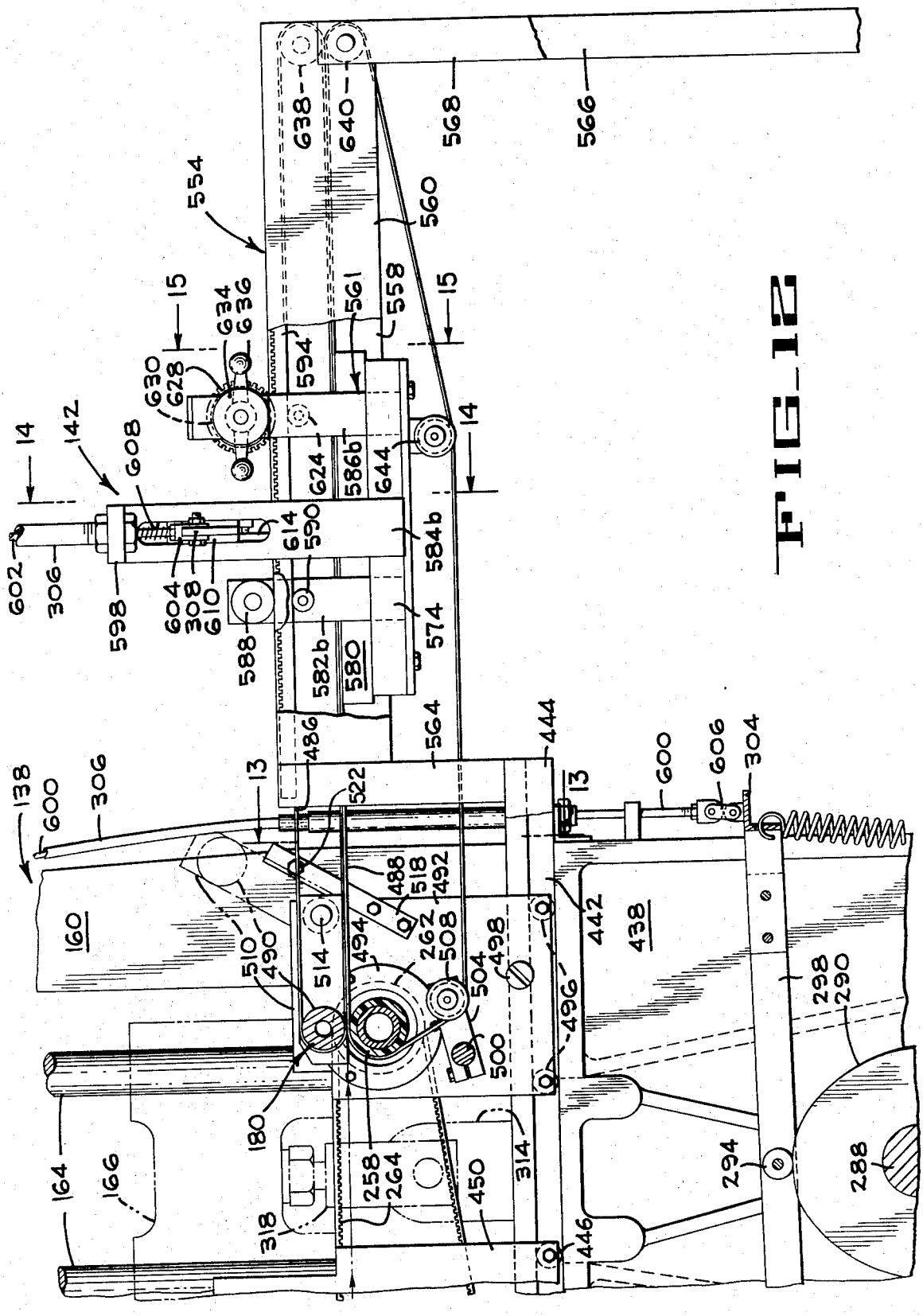

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142
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306
614
590
584b
598
604
308
610
588
582b
580
574
564
444
486
522
138
600
306
13
160
488
518
492
510
490
494
262
508
504
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514
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FIG_12

FIG_13

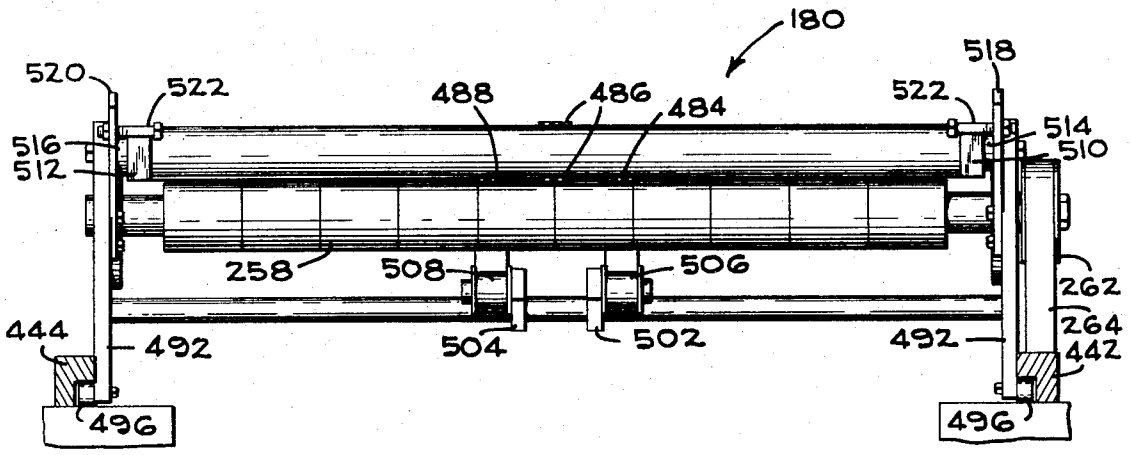


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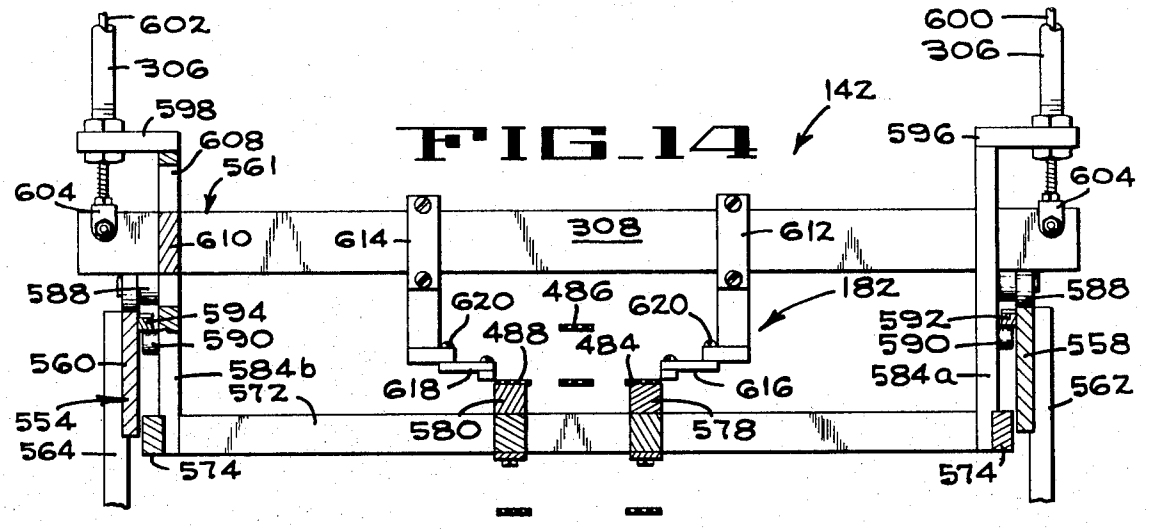


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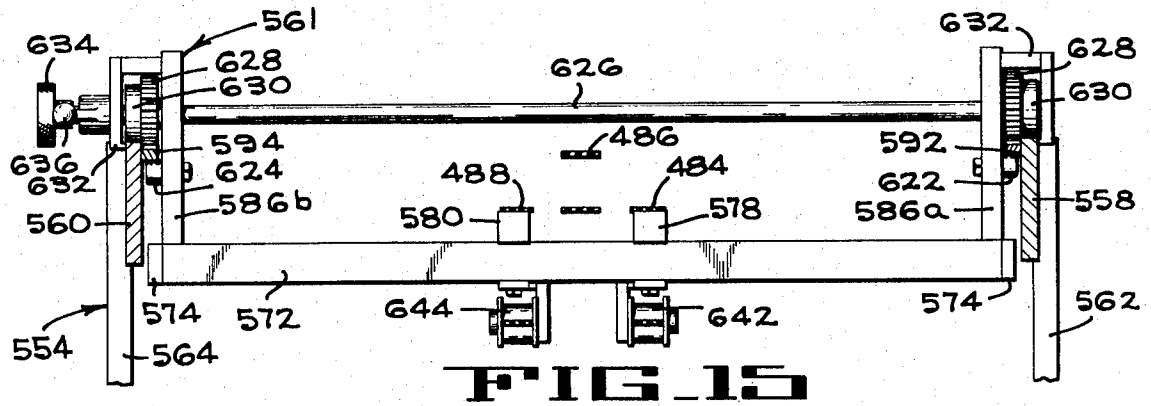


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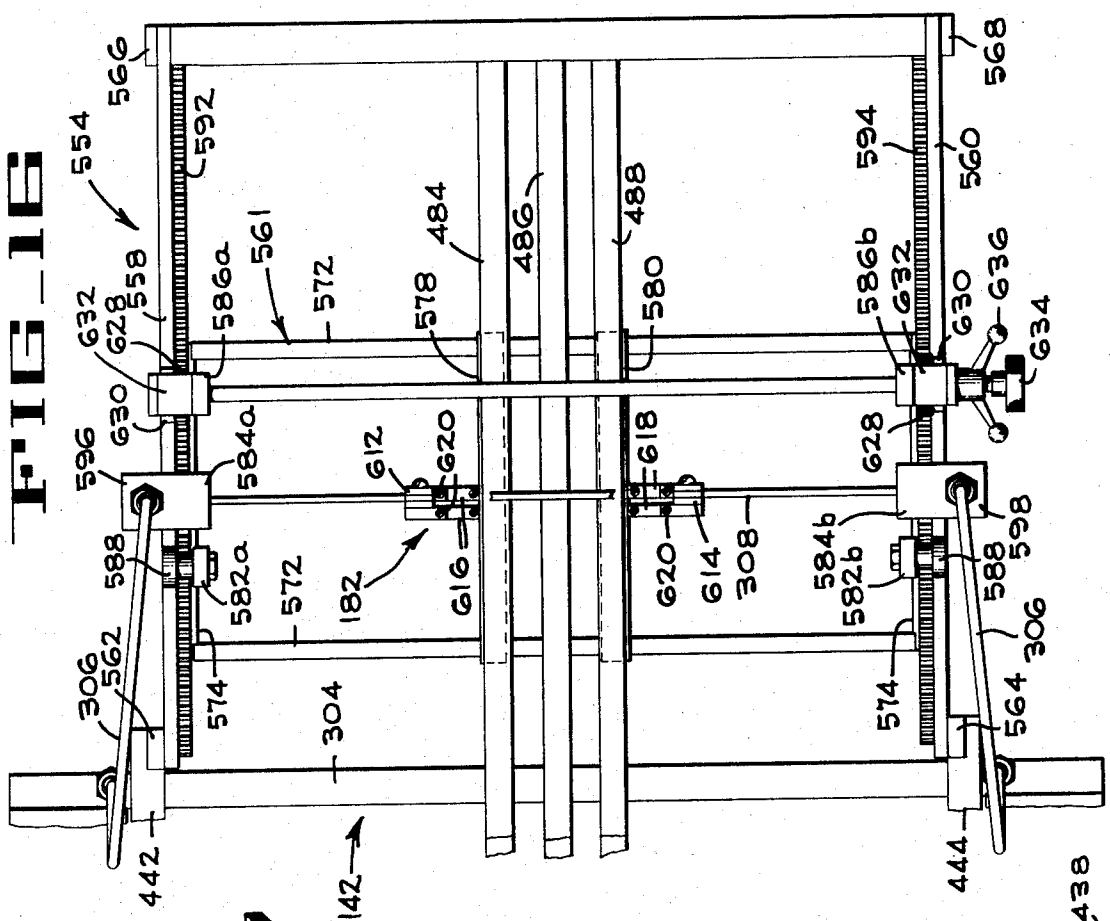

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FIG_17

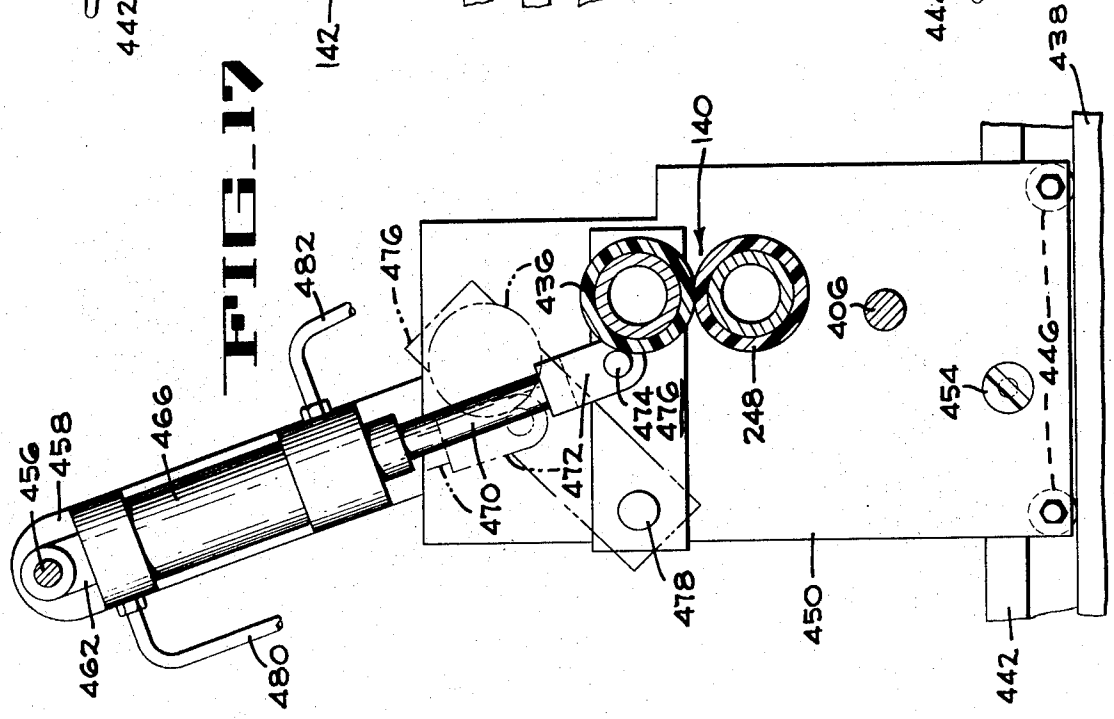

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FIG_18

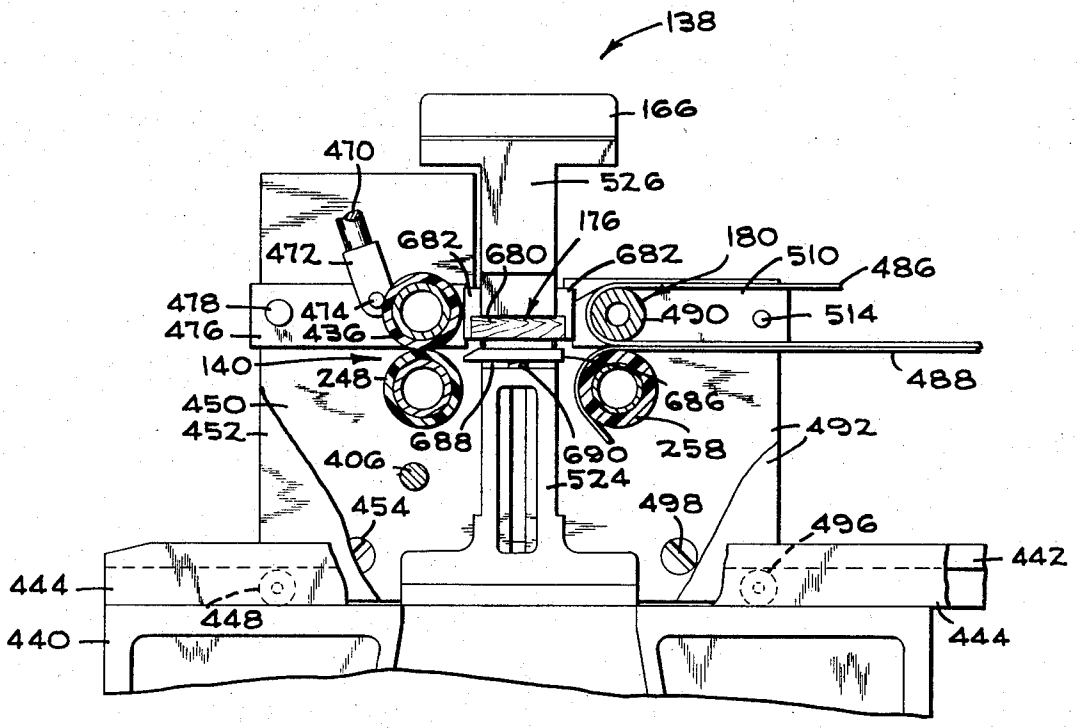

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FIG_19

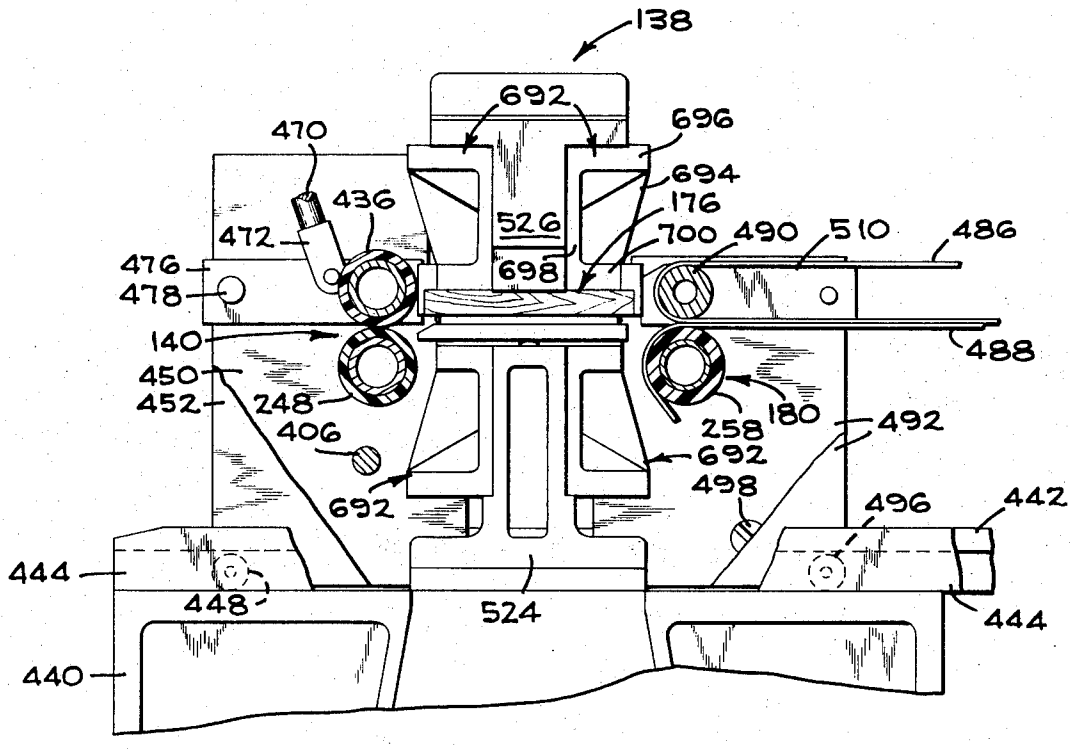

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FIG_20

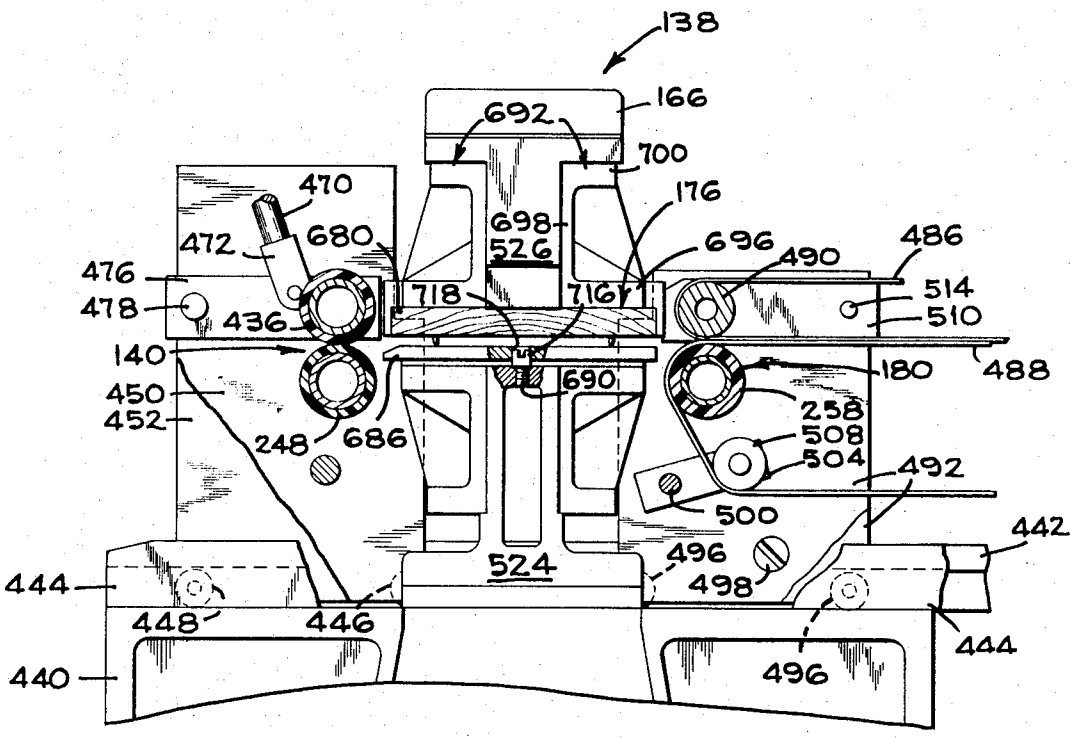

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FIG_21

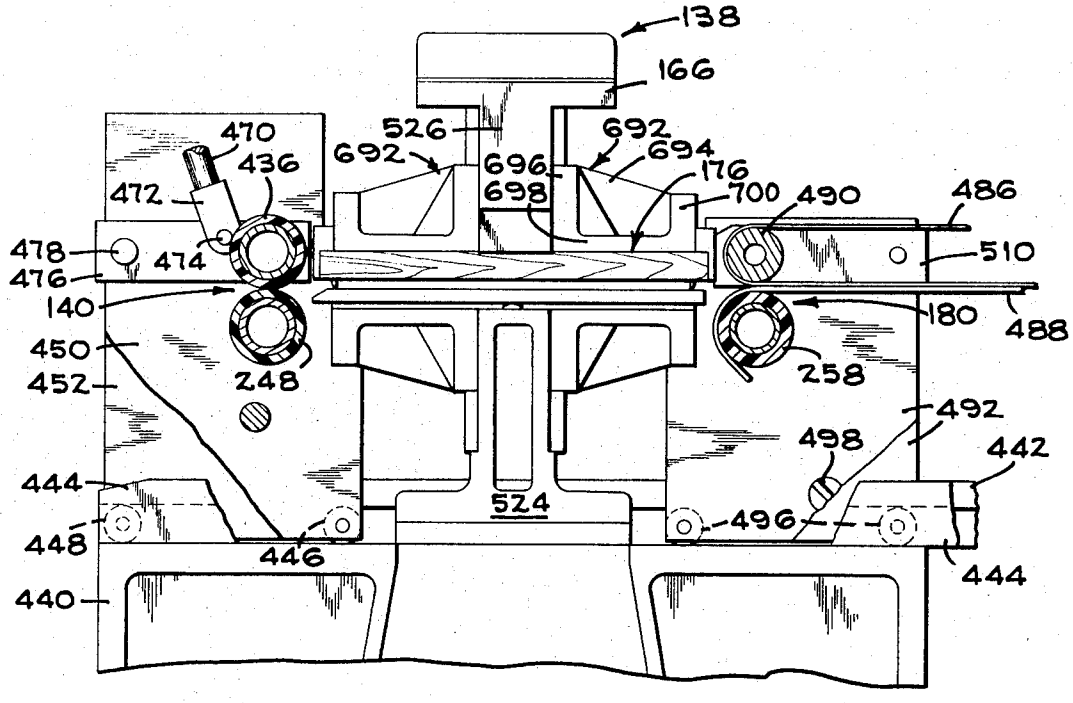

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FIG_22

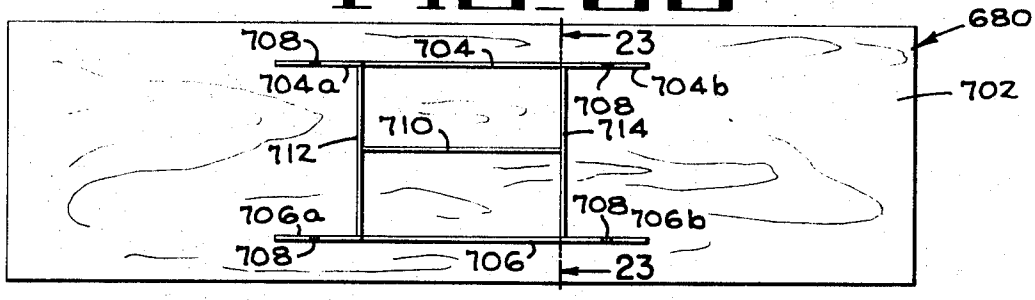


FIG_23

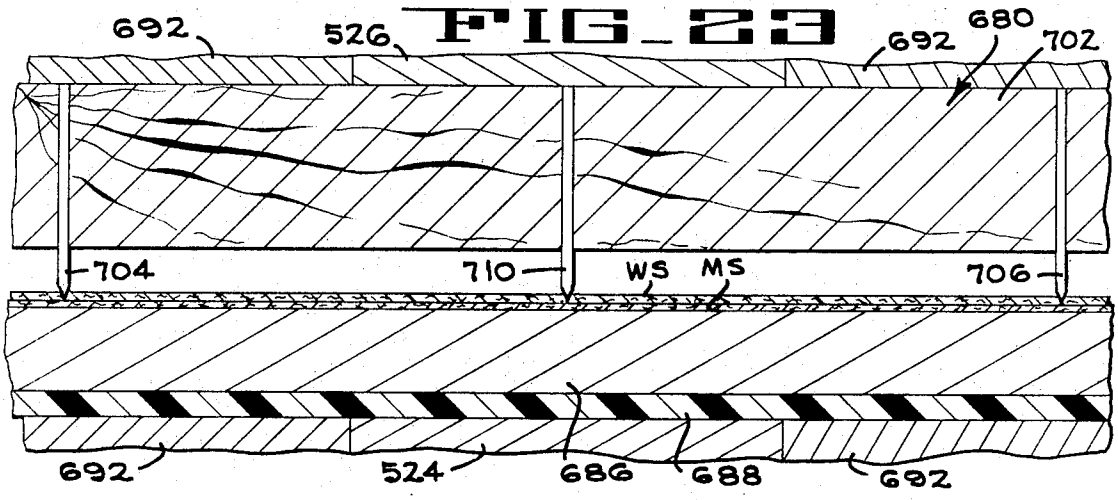


FIG_24

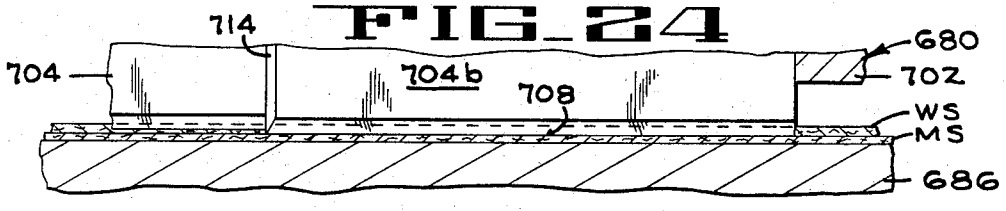
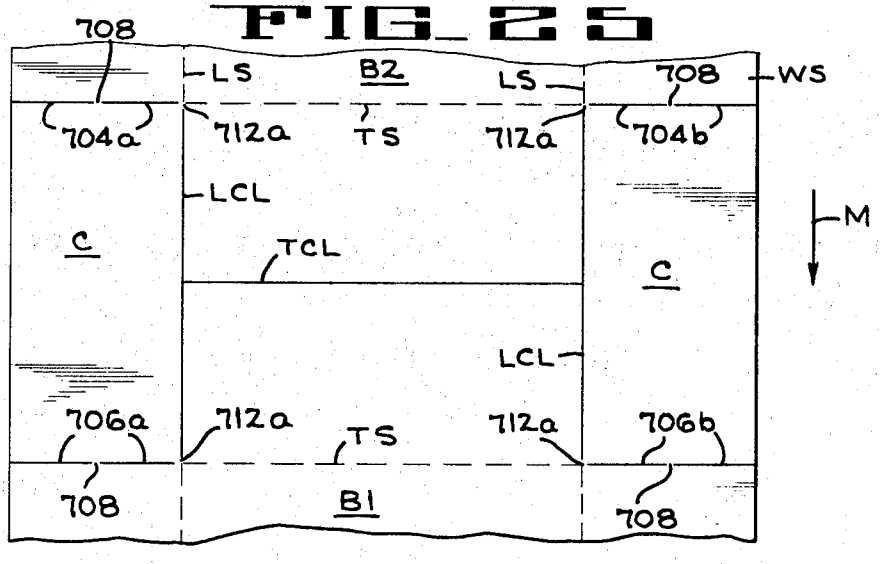


FIG_25



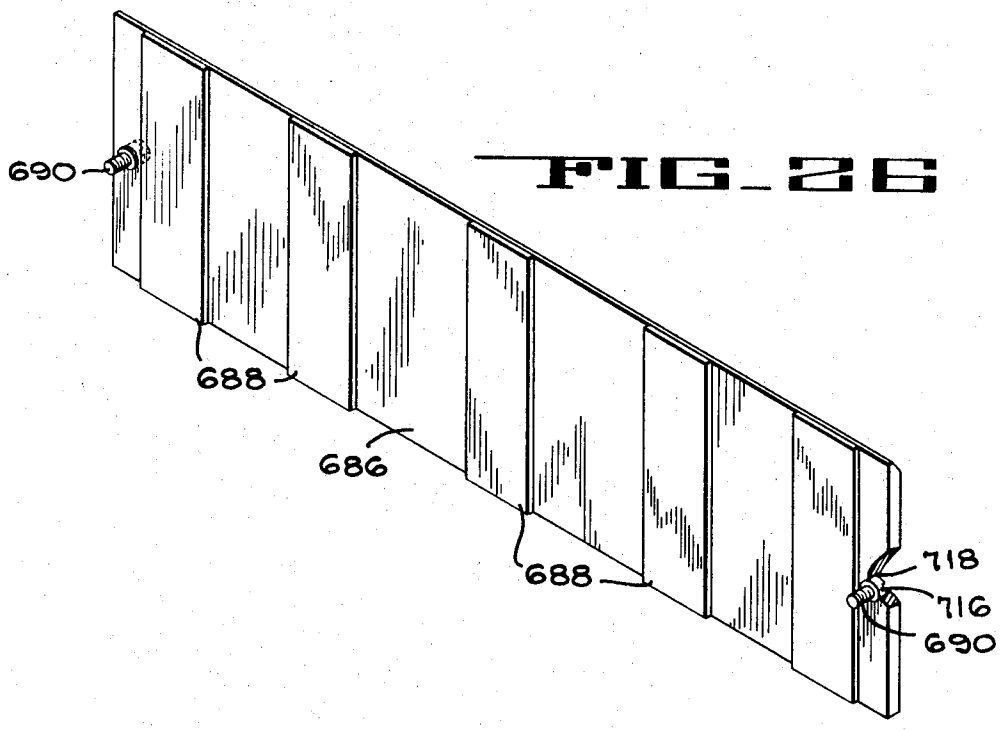


FIG_26

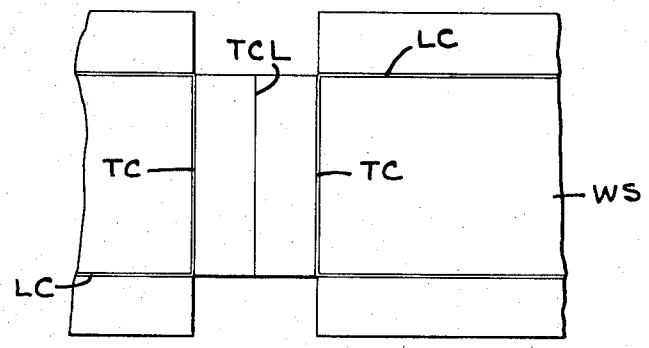


FIG_27

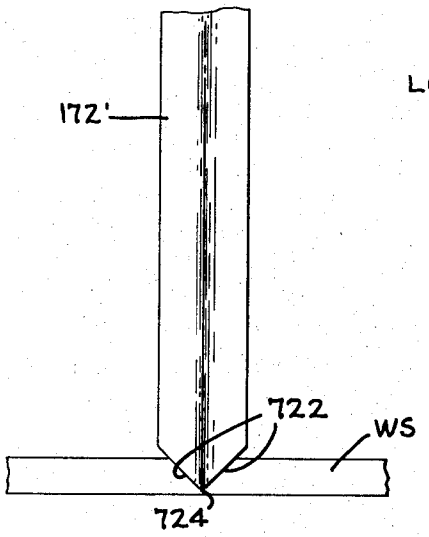


FIG_28

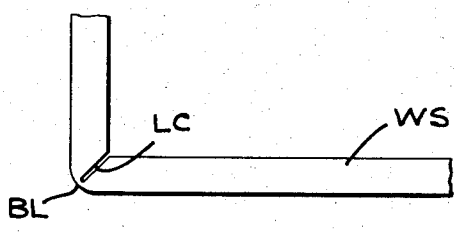


FIG_29

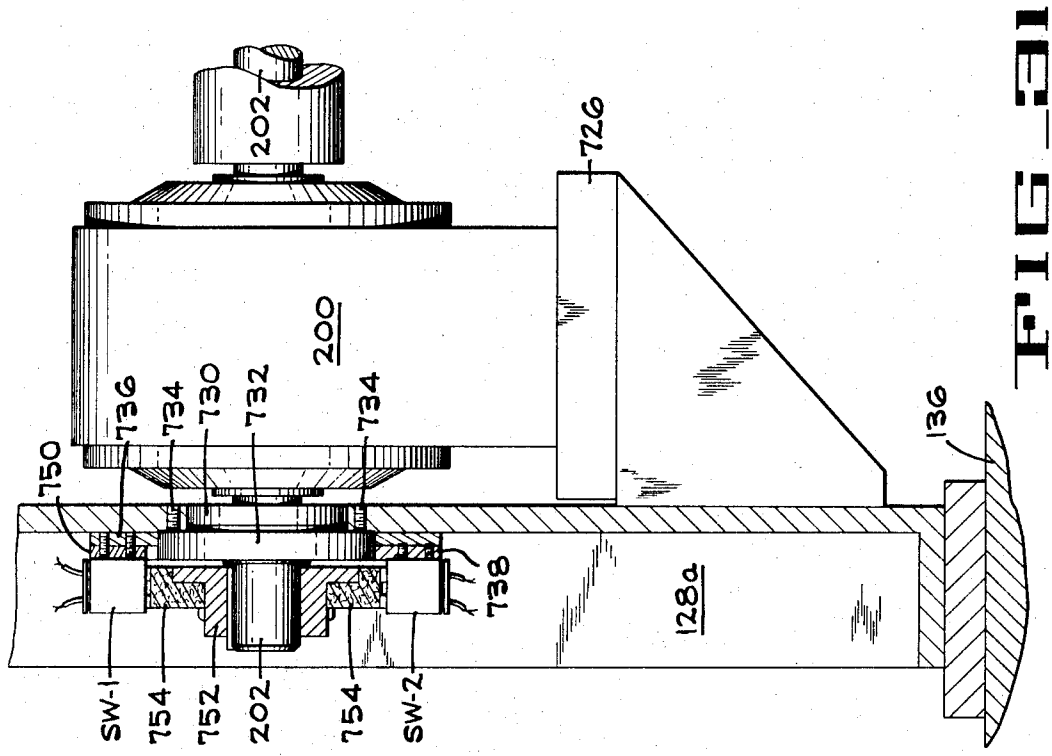

202
726
200
736
734
730
732
734
750
136
738
128a
SW-1
754
752
202
754
SW-2

FIG-31

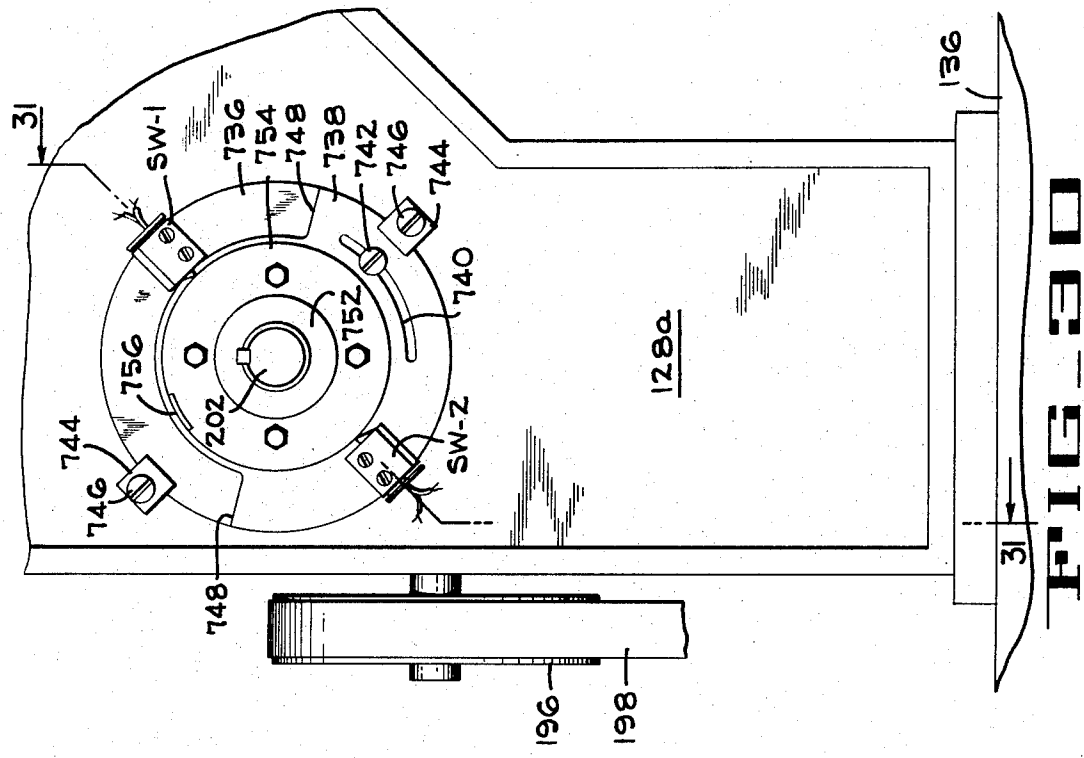

31
SW-1
736
754
748
738
742
746
744
136
740
752
756
202
744
746
SW-2
128a
748
31
196
198

FIG-30

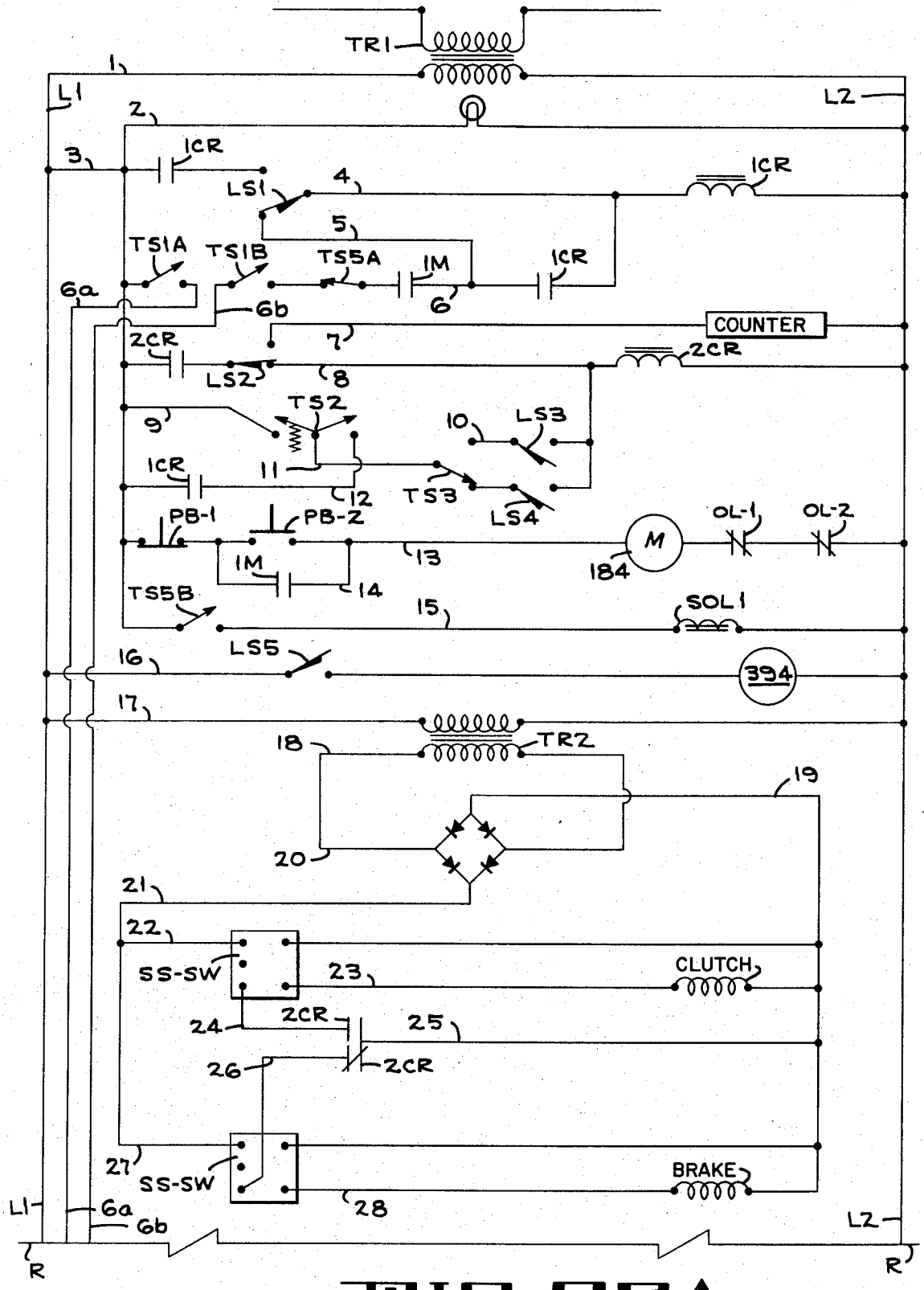
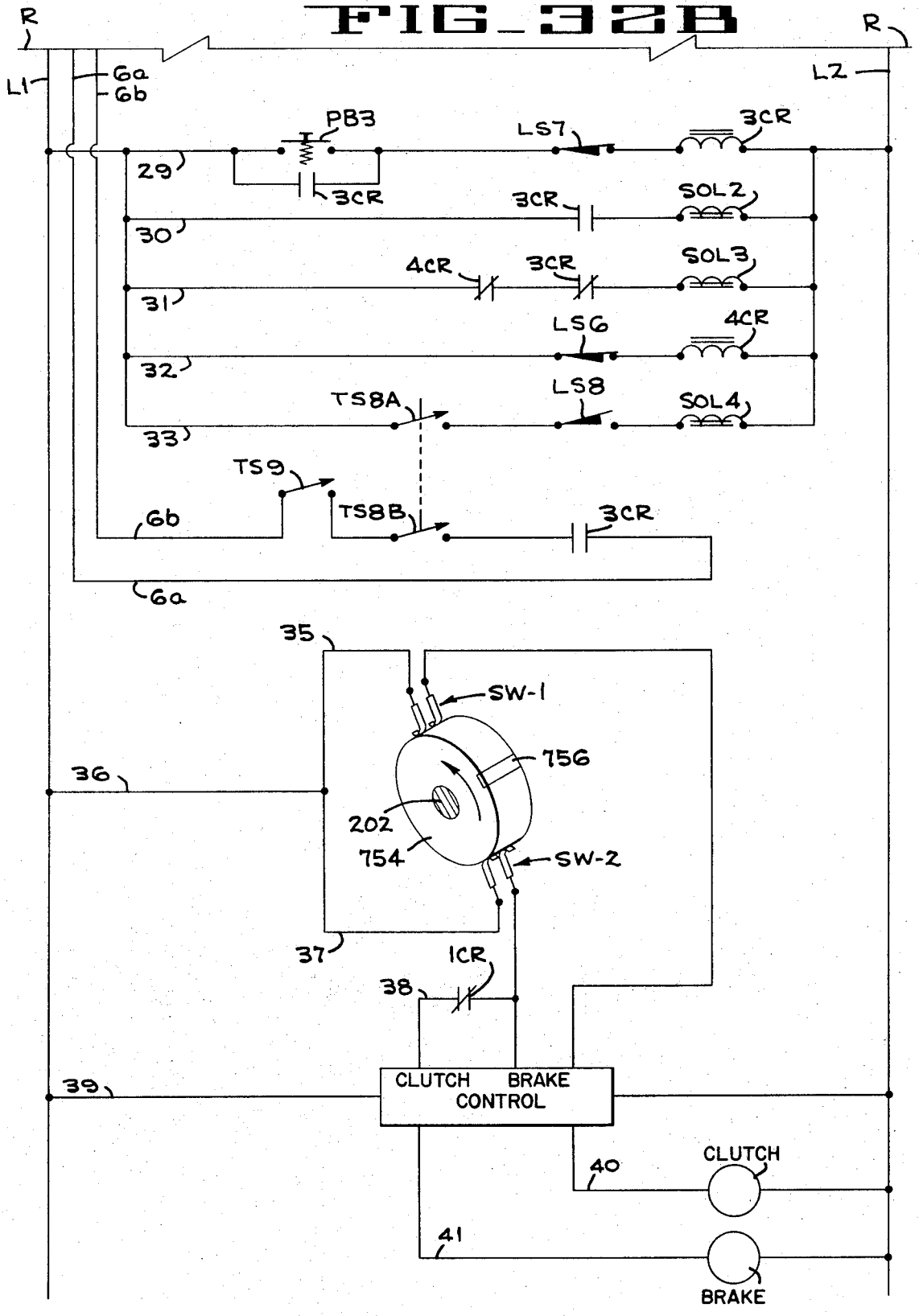

TR1
L1
LZ
1
2
3
ICR
LS1
4
5
TS1A
TS1B
TS5A
1M
6
6a
6b
COUNTER
2CR
7
LS2
8
9
TS2
10
LS3
11
12
TS3
LS4
PB-1
PB-2
13
M
184
OL-1
OL-2
14
TS5B
15
SOL1
LS5
16
394
17
18
TR2
19
20
21
22
SS-SW
23
CLUTCH
24
25
26
27
BRAKE
28
R

FIG_3A

FIG_32B


R
L1
6a
6b
PB3
LS7
3CR
R
L2
29
3CR
3CR
SOL2
30
4CR
3CR
SOL3
31
LS6
4CR
32
TS8A
LS8
SOL4
33
TS9
6b
TS8B
3CR
6a
35
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39
CLUTCH
40
41
BRAKE

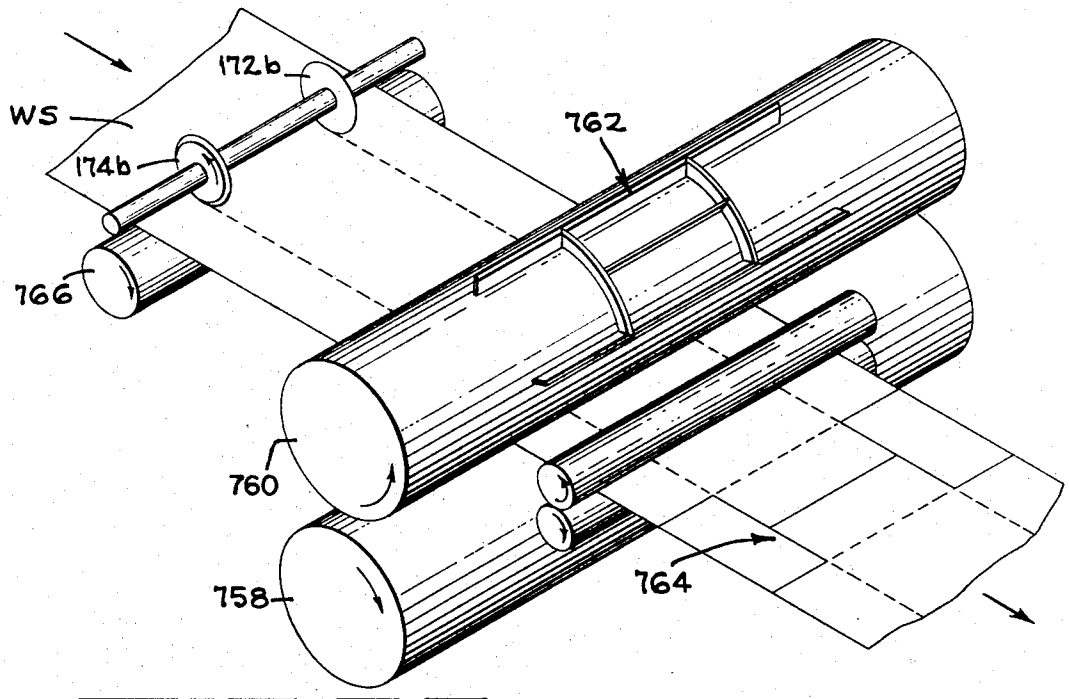
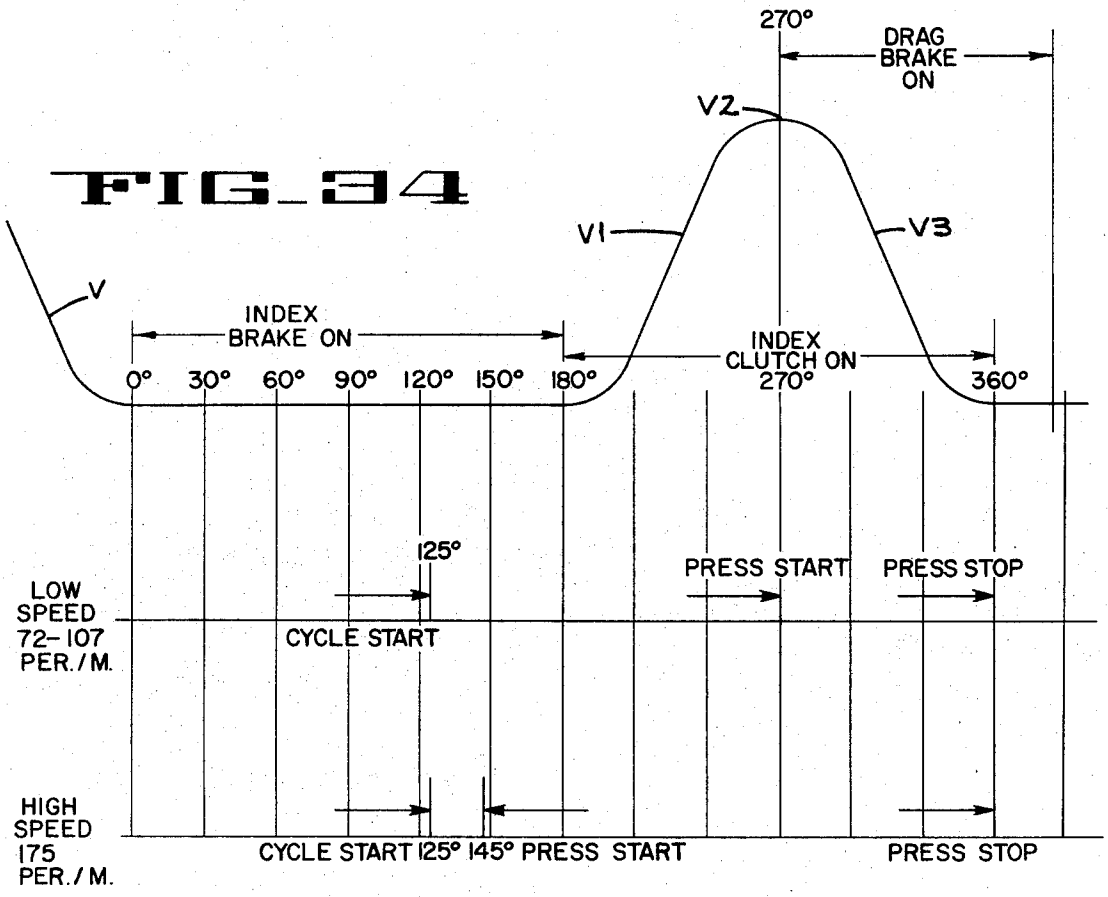

172b
WS
174b
762
766
760
758
764

FIG_33

FIG_34


270°
DRAG BRAKE ON
V2
V1
V3
V
INDEX BRAKE ON
INDEX CLUTCH ON 270°
0° 30° 60° 90° 120° 150° 180°
360°
125°
PRESS START
PRESS STOP
LOW SPEED 72-107 PER./M.
CYCLE START
HIGH SPEED 175 PER./M.
CYCLE START 125° 145° PRESS START
PRESS STOP

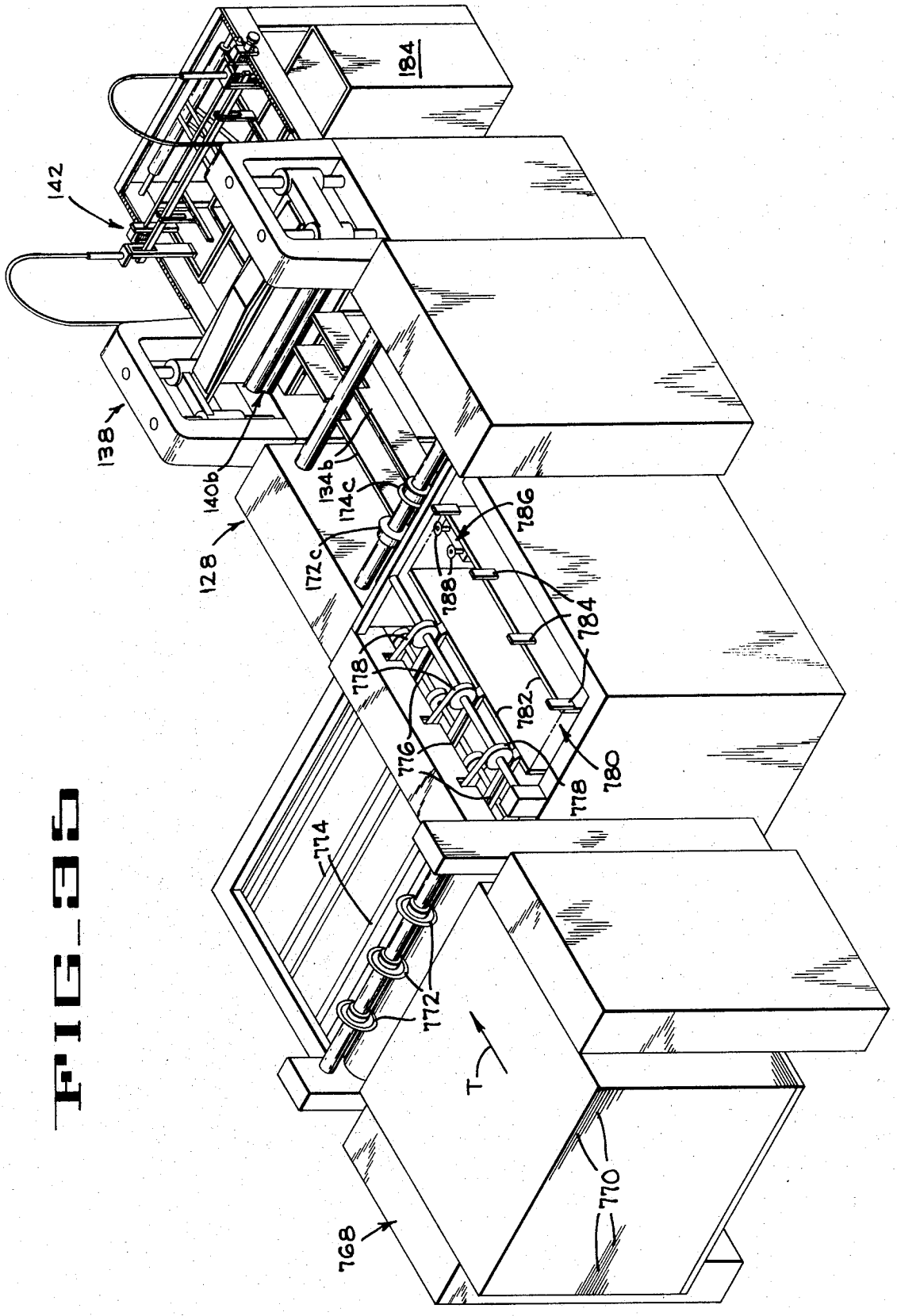

184
142
138
140b
134b
114c
172c
128
786
788
784
778
782
776
780
774
772
T
770
768

FIG_35

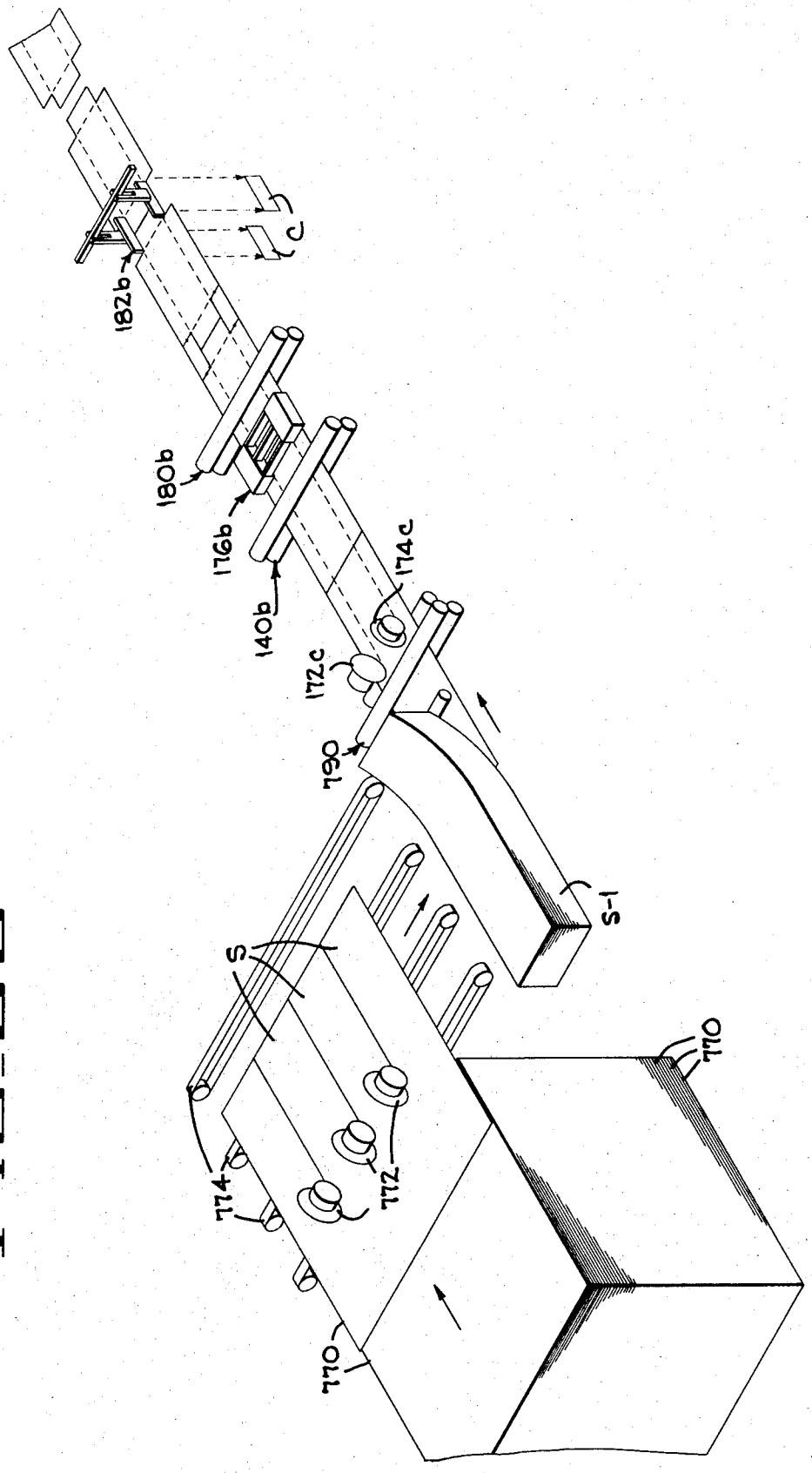


FIG_36

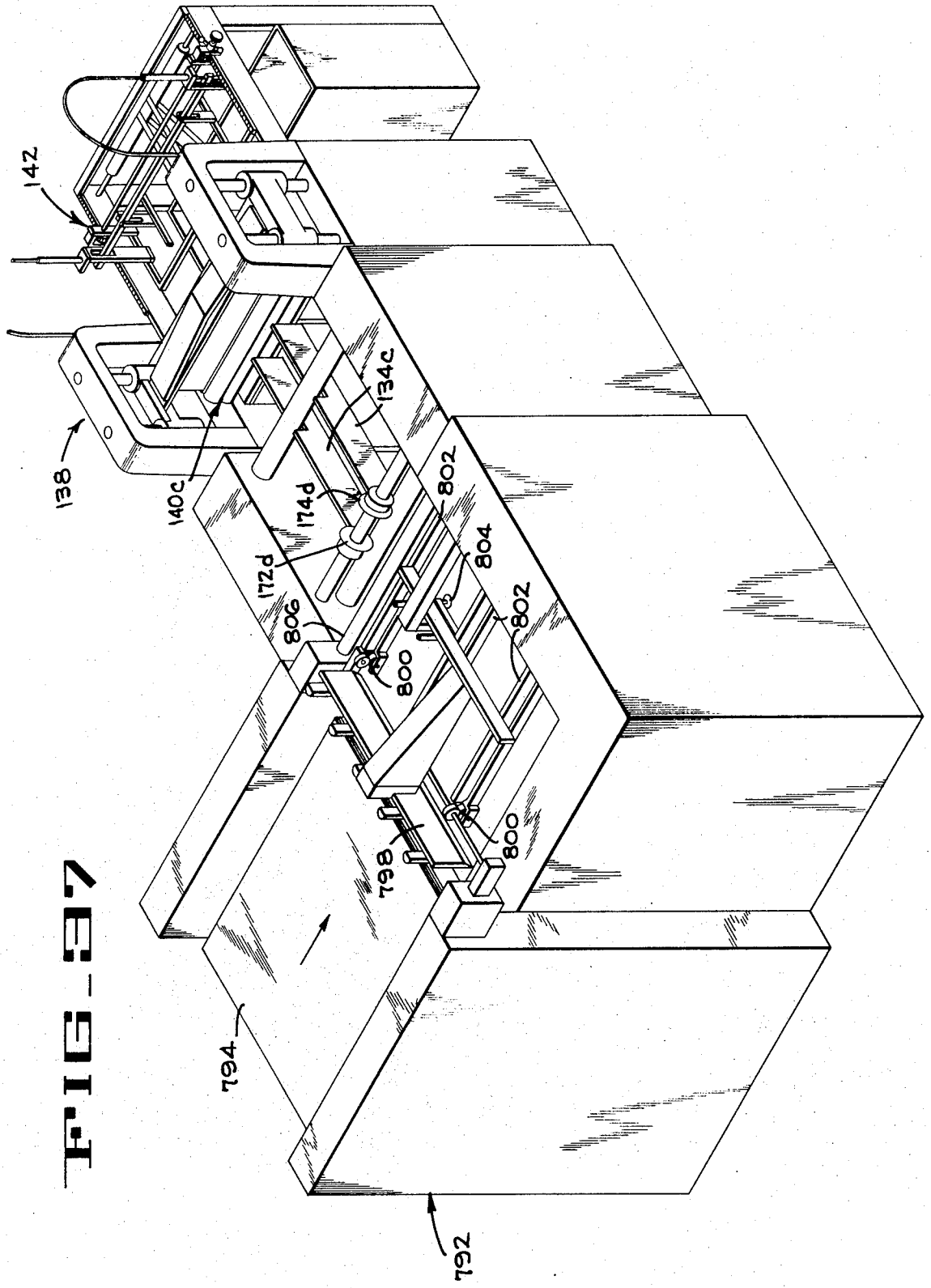


FIG-37

APPARATUS FOR CUTTING SHEET MATERIAL

This is a continuation, of application Ser. No. 149,302, filed June 2, 1971 and now abandoned.

BACKGROUND OF THE INVENTION

In recent years the market share of rigid boxes has experienced a continual decline mainly attributed to the folding carton. The increased demand for cartons is mainly due to the cost of manufacture and shipping rigid boxes. Folding cartons, hereinafter sometimes referred to as erectable boxes, have a decided advantage in their cost of manufacture and distribution. Their manufacture essentially involves printing, cutting and creasing, folding and sometimes gluing. Cartons can be shipped to the user in a collapsed condition. Machinery for producing folding cartons come in various varieties depending upon the production rate desired. Some machinery is completely automated produce creased and cut blanks at very high speed, while some operations utilize semiautomatic or hand-operated equipment where a limited quantity of a particular box size and configuration is required.

In addition to the simplified manufacturing methods applicable to folding cartons, their main advantage lies in the number of cartons that can be shipped per unit volume. Such an advantage naturally results from the fact that folding cartons can be shipped in a collapsed condition thereby achieving maximum density for storage and shipping.

Rigid setup boxes, while retaining an almost exclusive hold on quality packaging for such items as perfumes, toiletries and candy, have continually lost ground to the folding carton.

The basic structure of a rigid box dictates use of a plurality of distinct and essentially uncorrelated machinery. Briefly, the board material is supplied in the form of rectangular sheets, several hundred in number, defining a registered stack mounted on a skid. The skid is positioned in a convenient location adjacent a slitting and scoring machine where an operator removes a quantity from the stack and feeds them, one at a time, through the slitting and scoring machine. Scoring and slitting, depending upon the size of the box desired, reduce the parent sheet to two or more strips with each strip having two score lines parallel to each edge of the strip. After a sufficient number of strips have been slit and scored each of the strips is then scored and slit transversely producing a plurality of smaller rectangular blanks having normally related score lines whose distance from the blank edge is equal to the depth of the box part.

Thereafter, the cut and scored blanks are arranged in a pile and transported to a corner cutting machine for removing a corner portion from each corner of the blank. Some corner cutting operations may include cutting one corner at a time until all four corners are removed, or two or four corners simultaneously. In any event the blanks are manually fed several at a time to a corner cutting machine.

Many factors contribute to a high-quality rigid box but fundamentally the quality of the end product necessarily depends upon the accuracy of the blank. Contributions to blank accuracy are: (1) the quality of the board, (2) Rectangular blanks resulting from sequential crosswise slitting of the board strips and (3) Accurate corner cutting. Presently available machinery does

not produce scores of uniform depth and does not provide for accurate corner cutting. As a result of these deficiencies, when the box blank is erected and corner stays are applied, the walls of the box are usually other than perpendicular to the bottom wall or base of the box. This condition generates problems when a wrap is later applied to the box, since the wrapping sheets are cut on the assumption that the walls of the box are perpendicular to the main panel.

Another procedure followed in producing rigid box blanks is generally referred to as die-cutting. This method involves taking a standard size sheet of board, usually 26 inches by 38 inches, and placing it on the lower platen of a press. The upper platen of the press is provided with a die configuration that produces a series of cut and score lines which are arranged to produce one or a multiplicity of box parts. This method of necessity entails a significant amount of scrap since all of these box parts are located inwardly of the edges the sheet. After the sheet is removed an operator must break out all the box parts and stack them for subsequent erection and staying. The die-cutting method in some instances makes use of roll stock wherein the strip of web is intermittently fed to the die press. This technique requires purchase of a roll stock of a particular width equal to the major or minor dimension of the box blank.

SUMMARY OF THE INVENTION

According to the preferred embodiment of the present invention a rigid box blank making machine is provided which utilizes a full parent roll of board material mounted on an unwind stand. The unwind stand includes a slitting device progressively slitting a strip from the parent roll whose width is equal to one of the major dimensions of the box blank. As the strip of material is unwound from the parent roll it encounters decurling rolls and web drive rolls which are arranged to provide variations in nip pressure determined by a dancer system which is sensible to the tension of the web. Thereafter, the web, whose edges are constrained to follow a linear path, comes under the influence of laterally spaced scoring wheels set to partially cut through the web along lines located inwardly from the web edges. The web with the laterally spaced score lines is then intermittently fed by draw rolls to a press having a lower stationary platen and an upper reciprocating platen carrying rule dies arranged in a geometrical configuration for transversely scoring and severing the web thereby producing completed box blanks. The die for severing and scoring the web in a direction transverse to the longitudinal score lines also includes offset knife portions which remove the two corner sections from adjacent blanks simultaneously. The transverse score line is interrupted to provide a bond holding successive box blanks attached to each other so as to provide a continuation of the web. Discharge rolls assist in feeding the transversely scored and corner cut web to a knock-out device operating when the web is momentarily at rest to remove the corner portions from adjacent blanks and break the transverse bond to produce individual scored and corner cut box blanks.

In contrast to the present practice of making rigid box blanks from rectangular sheets of parent stock the present invention envisions, in its preferred embodiment, use of a full width mill roll from which a web strip of predetermined width is continually generated as the

mill roll is unwound. The width of the strip determines one of the dimensions of the box blank. The generated and continuous unwound strip is continually processed by the apparatus until all of the strip is converted into completed box blanks. Several advantages result from this procedure, the most important of which are:

A. A reduction in scoring labor and elimination of the time and labor involved in the sequential scoring and corner cutting.

B. A highly accurate blank and the elimination of the corner cutting operator.

C. The elimination of transport and labor for manually breaking out partial or completed blanks from the parent sheet.

D. A reduction in floor space, and

E. A decided decrease in waste since the only waste resulting from using roll stock is a thin strip which is sheared from the strip at either end of the roll.

Another benefit derived from using roll stock with means for progressively slitting a band therefrom of a desired width, is that inventory of various sheet sizes is obviated and the waste, usually about a quarter of an inch around the periphery of the sheet, is avoided. Further, purchase of sheet material is more costly as part of its price includes sheeting, stacking and banding on a skid for shipment by the mill. Purchase of the stock in roll form and slitting a portion of the roll as it is being used also establishes one of the dimensions of the box blanks.

While the present invention discloses use of roll stock for making box blanks it has utility in a variety of situations where a band of web material is desirable. For example, the unwind and slitter system can be used in conjunction with core winding machines or processes where a web strip of desired width is not available from the mill, because the width of the web is too narrow, and in situations where one desires to slit a portion from roll stock without rewinding and slitting the entire roll.

Further, in accordance with the present invention it is now possible to simultaneously produce blanks for the top and bottom of a rigid box. By using roll stock the width of the band slit from the roll can be made equal to the sum of the dimensions of the box top and bottom. The apparatus is provided with a shearing mechanism for separating the parent band into two strips each of which are provided with longitudinal score lines as they are intermittently fed to the press section of the machine. The die mounted in the press is arranged to produce the transverse score and cut lines in each length simultaneously.

The fundamental concept of the present invention also allows manufacture of both box parts when sheet material taking the form of elongated strips of a definite length are fed through the machine.

It is another important feature of the present invention to provide a novel die mounting arrangement which reliably insures the platens of the press to assume perfect parallelism in order to insure that the transverse score lines are of uniform depth and to prevent making a feathered or coined edge on the box blank by the cut through knife. To achieve this result the lower platen is mounted on elastomeric material which allows the lower die parts to assume a parallel position with the upper die part carried by the upper platen. It is usual practice when making box blanks by the die cutting approach to shim the lower die in parallelism with the upper die. As can be readily appreciated this is a time consuming and in some instances an unsatisfactory procedure because the thickness of the packing material or make-ready is of such a thickness to cause a break out or coining of the cut edges. Accordingly the concept of the present invention, making use of a resilient foundation, only requires make-ready of two to five-thousandths of an inch. As used in the art "make ready" refers to packing made of kraft paper or any other material which is substantially incompressible and which will prevent dulling of the cut through knives.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective of a box blank making apparatus incorporating the principles of the present invention,

FIG. **2** is a diagrammatic perspective illustrating the process of web slitting, scoring, cutting and corner removal for producing box blanks,

FIG. **3** is a perspective showing a drive train for the web indexing and press drive of the apparatus illustrated in FIG. **1**,

FIG. **4** is a modified form of the method illustrated in FIG. **2** showing the method applied in producing two box parts simultaneously with one part constituting the top and the other the bottom of the box,

FIG. **5** is a section taken along line **5—5** of FIG. **6** showing the mechanism for adjusting the depth of cut of the score wheels,

FIG. **6** is a greatly enlarged fragmentary portion showing a score wheel and its cooperating hardened collar which is adjusted to control the depth of score,

FIGS. **7A**, **7B**, **7C** and **7D** when joined along a vertical break line V.B. illustrate the apparatus in enlarged elevation,

FIGS. **8A**, **8B** and **8C** when joined together along the horizontal break line H.B. constitute a fragmentary enlarged plan of the apparatus shown in FIG. **1**,

FIG. **9** is an enlarged section taken substantially along the line **9—9** of FIG. **8A** showing the web slitting knife and the means provided for regulating the depth of cut,

FIG. **10** is a section of FIG. **9** taken substantially along the line **10—10**,

FIG. **11** is a transverse elevation of the die press which mounts the rule dies,

FIG. **12** is an enlarged fragmentary side elevation partly in section of the press and the corner knockout mechanism,

FIGS. **13**, **14** and **15** are transverse sections of FIG. **12** taken respectively along the lines **13—13**, **14—14** and **15—15**,

FIG. **16** is a plan of the discharge conveyor showing the corner knockout mechanism,

FIG. **17** is an enlarged elevation partly in section of the draw rolls and one of the cylinders utilized for engaging or retracting the draw rolls,

FIG. **18** is a side elvation partly in section of the die area showing a minimum platen area used for making box blanks of minimum size,

FIG. **19** is similar to FIG. **18**, but including transverse rigid beams associated with the upper and lower platens to increase the platen area for making box blanks of larger dimension,

FIG. 20 is similar to FIG. 19, but showing the rigid beams repositioned on the upper and lower platens to define platen areas of yet a larger dimension,

FIG. 21 is yet another arrangement, similar to FIG. 20, showing the rigid beams repositioned to define platen areas of larger dimension,

FIG. 22 is an enlarged plan of the rule die,

FIG. 23 is a greatly enlarged fragmentary section taken along line 23—23 of FIG. 22 showing the upper and lower platens and the rule die in contact with the web strip,

FIG. 24 is a fragmentary enlarged portion of the rule die showing the relationship of the rules to produce cut and score lines. FIG. 24 also shows the tabs or bonds produced for holding the adjacent box blanks together until the corners are removed,

FIG. 25 is a fragmentary portion of the web strip illustrating the pattern of cut and score lines,

FIG. 26 is a perspective of a lower die part which is supported on the lower platen of the press by a plurality of resilient strips,

FIG. 27 is a fragmentary portion of adjacent box blanks formed from a web strip which is made by producing longitudinal and transverse crease lines which define the separation between the walls and the bottom of the box part,

FIG. 28 illustrates a typical creasing tool in engagement with a fragmentary portion of box board material,

FIG. 29 is a fragmentary portion of a box blank made by crease scoring, and shows adjacent panels folded along the crease,

FIG. 30 is an enlarged side elevation of a portion of the apparatus shown in FIG. 1 illustrating the arrangement of the electrical controls for operating the clutch and brake for indexing the web strip,

FIG. 31 is a section taken substantially along the line 31—31 of FIG. 30,

FIGS. 32A and 32B together illustrate a schematic electrical diagram for coordinating operation of the machine shown in FIG. 1,

FIG. 33 shows the modification comprising a rotary steel rule die and a rotary platen roll mounted therebeneath for making the transverse cut and score lines in a web strip.

FIG. 34 is a timing diagram indicating at what point in the cycle the clutch and brake are operated when the machine is conditioned for low speed operation and for operation at high speeds,

FIG. 35 is a modified form of the apparatus shown in FIG. 1 for using sheet material instead of a web roll,

FIG. 36 is a perspective diagrammatic illustrating the operation or the method of operation of the machine in FIG. 35,

FIG. 37 is yet another modified form of the apparatus utilizing rectangular sheets from which strips are cut to be fed to the scoring and cutting sections of the machine.

GENERAL ARRANGEMENT OF THE PREFERRED EMBODIMENT

FIG. 1 shows a perspective of the preferred form of the apparatus, incorporating the principles of the present invention, and is generally identified by the numeral 40. The machine comprises an unwind stand 42 including a base plate 44 mounted on guide rollers 39 which in turn roll on gib tracks (41) parallel to the parent roll rotational axis. This moveable base plate 44 has secured thereto laterally spaced upwardly extending side frames 46. The side frames 46 rotatably support a core shaft 48 on which is mounted a parent roll 50 of web material suitable for making rigid box blanks. A disc brake 51 is mounted on the core shaft for arresting rotation of the shaft 48. Adjacent the unwind stand 42, and in longitudinal alignment therewith, is a base plate 52 supporting a web slitting device, generally indicated by the numeral 54, comprising a rotary slitting knife 56 carried by arms 58. The lower end of the arms are slidably adjustably mounted on a laterally extending guide frame 60 which is pivotally mounted on transversely spaced upwardly extending frames 62 supported on the base plate 52.

Downstream of the web slitting device 54 and also supported on the base plate 52 are upwardly extending side frames 64 between which web decurling rolls, generally indicated by the numeral 66, web drive rolls 68 and a web tension dancer frame 70 are mounted. A web strip WS, cut by the slitting knife 56, is directed over a large diameter idler roll 72 and under and over decurling rolls 74 and 76 (FIG. 7A) which have each end rotatably mounted in blocks 78 and 80 (FIG. 8B). The blocks 78 and 80 are provided with stub shafts rotatably mounted in the side frames 64 and on one of the stub shafts a worm gear 82 is keyed and meshes with a worm 84 keyed to a shaft which is rotated by the handwheel 86 (FIG. 7A), By virtue of this arrangement the degree to which the web strip is recurved or decurled depends upon the attitude assumed by the rolls 74 and 76 which is selectively varied by turning the handwheel 86.

After the web strip traverses the decurling rolls it is received between the web drive roll 68 which includes a small diameter roll 88 and a roll 90 (FIG. 2) of larger diameter. The roll 90 is provided with a short shaft 92 having a sprocket 94 keyed thereon which is driven by a sprocket chain 96 trained about a drive sprocket 98. The drive sprocket 98 is mounted on the output shaft of a reducer 100 operatively connected to a SCR controlled DC motor 102. As will be explained presently, the speed at which the web drive rolls 88 and 90 are rotated is dependent upon the tension of the web which is sensed by the web tension dancer frame 70.

The web tension dancer frame 70 comprises laterally spaced arms 104 and 106 rigidly mounted substantially at their centers on a shaft 108 having one end rotatably mounted on a bracket 110 and the other end extending through and rotatably mounted in a bracket 112. The shaft 108 has keyed thereon, inwardly adjacent the bracket 112, a segment gear 114 (FIG. 7B) meshing with a small pinion gear 116 which is keyed to the shaft of a potentiometer 118 (FIG. 8B) electrically connected to the web drive roll motor 102 which adjusts the speed of the web drive roll 90 in accordance with the tension of the web strip WS.

From the drive rolls the web strip WS is wrapped around low inertia reels 120 and 122 (FIG. 7B) supported by shafts 124 and 126 mounted in parallel relation near the ends of the arms 104 and 106. Since the shaft 108 is mounted for rotation in the brackets 110 and 112, and the arms 104 and 106 are fixed with respect to the shaft 108, variations in the tension of the web strip WS either cause clockwise or counterclockwise rotation of the shaft 108, causing the segment gear 114 to rotate the pinion gear 116 which thereby

changes the resistance of the potentiometer **118.** Such a change in turn controls the input voltage, and hence the speed of the web drive motor **102.** In operation the web tension continually changes due to the intermittent motion of the web, thus resulting in continual oscillation of the arms **104** and **106.**

After the web traverses the web tension dancer frame **70** it is directed to a web guiding and scoring frame **128** mounting shearing means **130** and scoring means **132.** The frame **128** includes laterally adjustable, longitudinally extending, guides **134** which constrain the web strip to follow a predetermined path. The frame structure **128** is mounted on a base plate **136** as is a press **138.** The press comprises vertically opposed parallel platens mounting cooperating die parts for transversely cutting and scoring the web strip WS during that period of time when feeding of the web is interrupted. The web strip is fed to the press by draw rolls **140** which are intermittently operated in synchronism with the actuation of the press **138** to feed the web strip to the press. After the web strip WS has been provided with longitudinal and lateral score lines and is substantially fully cut, it is discharged to a corner knockout mechanism **142** which, as will be explained hereafter, separates the box blanks as a consequence of removing the corner portions from the web strip.

Still referring to FIG. **1** it will be observed that the shearing and scoring means **130** and **132** are mounted, respectively, on longitudinally extending transversely spaced supports **144** and **146.** The shearing means **130** comprises laterally aligned upwardly extending plates **148** mounting a rectangular transversely extending beam **150** supporting laterally adjustable shear wheel support members **152.** In like manner a slitting means **132** comprises upwardly extending plates **154** supporting a transverse beam **156** on which are transversely adjustably mounted score wheel support structures **158.**

The shearing means **130** are used when the first and the last web strip WS are slit from the web roll **50** to remove the exposed end portions of the roll which are unacceptable because they are inevitably damaged during transport and storage. For example, if the machine is set up to slit the web roll **50** from right to left as viewed in FIG. **1,** the righthand shear wheel on the supporting member **152** is utilized to remove a narrow strip, in the order of a quarter of an inch, from the first web strip removed from the parent roll. Of course, this will dictate adjusting the slitting knife **56** to remove a web strip wider than is needed for the box blank. In producing subsequent strips the knife **56** can be set to remove a strip exactly equal to one of the major dimensions of the box blank. When the last strip is removed from the web roll **50** the lefthand scoring wheel is adjusted to remove a narrow strip from the other end of the web roll **50.**

The press **138** comprises massive side frame structures **160** and **162** between which extends, and is mounted for vertical reciprocation on guide rods **164** a cross head or platen **166.** While the arrangement of the press **138** will be explained in greater detail hereinafter, it is to be understood that the cross head **166** is reciprocated downwardly in forcible engagement with the lower platen to produce lateral score and cut lines defining the completed box blank. After the cross head is moved upwardly the web strip is indexed and the adjacent box blanks, which are connected by small easily ruptured tabs, come under the influence of the corner knockout mechanism **142** which includes reciprocating plungers operated in synchronism with the platen **166** to break or rupture the tabs, thus separating the box blanks from each other. The completed box blanks can be stacked or shingled, as desired, or can be integrated to feed a quadstayer.

According to the above described arrangement of the preferred form of the apparatus incorporating the principles of the present invention, it will be appreciated that the mode of operation completely eliminates scoring and corner cutting labor, labor involved in unstacking, restacking and breaking out box blanks, a significant reduction in floor space and a significant reduction in waste of board material.

For purposes of illustrating the basic method of making box blanks in accordance with the present invention, reference is made to FIG. **2** where it will be seen that the slitting knife **56,** which is set to cut at a depth approximately equal to one and a half thicknesses of the web, continually produces a web strip passed over the large diameter roll **72** and through the decurling rolls **74** and **76.** Thereafter the web is received between the nip of the web drive rolls **88** and **90** and is passed around reels **120** and **122** which are part of the web tension control dancer frame **70.** A pair of nip rolls **384** and **386** impart a drag force to the web in order to increase the tension of the web in that portion between the draw rolls **140** and the rolls **384** and **386.** Downstream of the rolls **384** and **386,** web slitting wheels **168** and **170** are provided. As shown in FIG. **2** slitting wheels **170** are located to engage the web strip to remove a narrow waste portion from the first web strip removed from the web roll **50.** Slitting wheels **168** are not in slitting engagement with the web as this edge has been properly cut by the slitting knife **56.** Subsequent web strips removed from the intermediate portion of the web roll **50** do not require operation of the slitting wheel **168** or **170** but when the last web strip is removed from the roll slitting wheels **168** are adjusted to remove a narrow waste strip.

Longitudinal score lines LS, indicated by the dashed lines parallel to the edges of the web strip, are produced by scoring wheels **172** and **174.** Means which will be described hereinafter, are provided for accurately adjusting the score depth of the wheels **172** and **174.** The web strip WS with the longitudinal score lines LS is directed between the draw rolls **140** which are intermittently operated to feed the web strip a distance equal to the longitudinal dimension of the box as related to its direction of movement through the machine. When the web is at rest the press **138** is actuated to move a steel rule die **176.** The die is mounted on the upper platen of the press and transversely severs the web along a line identified by the letter T. Simultaneously therewith, the rule die **176** produces transverse score lines TS On either side of the cut line T and also substantially completely cuts through the web to produce waste corner pieces C which are intersected by the transverse cut line T, and bounded by the longitudinal score lines LS and the edges of the web. The rule die **176,** which is shown in greater detail in FIG. **22,** includes an arrangement whereby tabs or bonds along the line T are provided between the adjacent blanks to hold them together as a continuous web until the corner pieces are removed.

After the die **176** is retracted the web is indexed another blank length. Discharge rolls **180** assist in moving the interconnected box blanks to the corner knockout mechanism **142.** Synchronously operated with the press **138** are reciprocating corner knockout plungers **182** which are part of the corner knockout mechanism **142.** When the web is at rest the plungers **182** are moved downwardly, breaking the tabs connecting the adjacent box blanks together and removing the waste corner pieces C. Suitable collection means may be provided for the waste corner pieces and as shown in FIG. **1** it may comprise a container **184.**

WEB DRAW AND PRESS DRIVE

FIG. **3** illustrates the arrangement of the driving components for intermittently feeding the web to the press **138.** The basic elements involved, in reciprocating the cross head **166** of the press and the manner in which the corner knockout mechanism **142** is synchronously operated, in response to the intermittent feeding of the web are illustrated. For ease of understanding the operation, the major components of the drive and the parts driven thereby are shown in diagrammatic form. A motor **184** has a pulley **186** mounted on its output shaft. By means of a belt **188,** driven by the pulley **186,** a pulley **190** is driven. This imparts rotation to an elongate shaft **192** which is keyed to the pulley **190.** On one end of the shaft **192,** there is keyed a pulley **194** that is connected to a pulley **196** by a belt **198.** The pulley **196** is keyed to the input shaft of a reducer **200.** The gear reducer **200** is provided with the usual output shaft, identified as **202,** having keyed thereon a plurality of cams **201, 204, 206** and **208** respectively actuating limit switches **LS1, LS5, LS3** and **LS4.** The purpose for these switches will be explained in connection with the circuit diagram.

On the end of the shaft **202** there is rigidly secured a disc **216** that drives a mechanism **218** for varying the radial distance of a crank pin **220** from the center of the shaft **202.** Briefly the mechanism **218** comprises a screw **222** threadedly mounted in a block carrying the crank pin **220.** Turning the screw **222** adjusts the radial position of the crank pin **220.** On the crank pin **220** one end of a connecting rod **224** is rotatably mounted, the other end of which is pivotally connected at **225** to a gear segment **226** freely mounted on a pivot pin **227.** In meshing engagement with the gear segment **226** is a gear **228** mounted on a shaft **230.** On the other end of the shaft **230** a large diameter gear **232** is keyed. A clutch-brake **234,** sequentially operated to either apply the clutch or the brake, has a gear **236** mounted on its input shaft which is in meshing engagement with the gear **232.** The output shaft of the clutch-brake **234** mounts a pulley **238** driving a pulley **240** by a belt **242.** A tensioning pulley **244** is adjustably mounted to maintain the belt **242** in proper tension.

The pulley **240** is keyed to a transverse shaft **246** which is substantially equal in length to the width of the frame structure **128.** Power derived from the shaft **246** drives a rubber covered roll **248** which is one of the rolls of the draw rolls **140.** Th roll **248** has mounted on an extended portion thereof a pulley **250** connected to the shaft **246** by a belt **252** trained about a pulley **254** keyed to the shaft **246.** Idler pulleys **256** are adjustably mounted to maintain the belt **252** properly tensioned.

The lower roll **258** of the discharge rolls **180** is also driven by the shaft **246.** This is accomplished by connecting a pulley **260,** keyed to the shaft **246,** to a pulley **262,** keyed to the shaft of the lower roll **258,** by a belt **264.** Idler pulleys are provided for increasing the arc of contact of the belt **264** on the pulley **260** and for providing the proper tension on the belt **264.**

On the end of the shaft **246** a pulley **268** is keyed to drive a belt **270** trained about a pulley **272** which is keyed to a shaft **274.** Shaft **274** mounts laterally adjustable slitting wheels **168*a*** and **170*a*** cooperating with slitting wheels **168** and **170** for slitting the web edge from the first and last web strip removed from the parent roll **50.**

Still referring to FIG. **3,** it will be observed that another laterally extending shaft **276,** which is not driven, is located upstream of the shaft **274.** On this shaft laterally adjustable hardened steel collars **278** and **280,** which may take the form of roller or ball bearings, cooperate with score wheels **172** and **174** to produce the longitudinal score lines LS.

As mentioned above the motor **184** drives the shaft **192** through the pulleys **186** and **190** which are interconnected also by the belt **188.** The shaft **192** is connected to a clutch brake **282** which has an output shaft **284** for driving a speed reducer **286.** The speed reducer **286** drives a transverse shaft **288** mounting cams **290** and **292.** The periphery of the cams **290** and **292** are rollingly engaged by rollers **294** and **296,** rotatably mounted in levers **298** and **300.** One end of each lever **298** and **300** is pivotally connected, at **301** and **302,** to the housing of the reducer **286** and the other ends are rigidly connected to a cross bar **304** to which is connected one end of flexible shafts **306.** The other end of the flexible shafts **306** are connected to a cross beam **308** on which the plungers **182** for the corner knockouts are mounted.

Also mounted on the reducer shaft **288** are cams **310** and **312** for vertically reciprocating upwardly extending links **314** and **316.** Clevis members **318** and **320** are respectively mounted on the upper ends of links **314** and **316.** Rigidly connected to the clevis members **318** and **320** is the cross head **166** as shown in phantom outline. For sequencing operation of the clutch-brake **234** the shaft **202** has a disc **754** keyed thereto. On the periphery of the disc **754** a copper segment **756** is mounted which sequentially renders switches **SW-1** and **SW-2** conductive to signal operation of the clutch-brake **234.**

The drive shown in FIG. **3** operates as follows. Rotation of the shaft **192** by the motor **184** rotates the shaft **202** through the speed reducer **200.** This causes reciprocation of the connecting rod **224** since it is mounted on the pin **220** which is eccentric to the center of the shaft **202.** Such reciprocating motion is imparted to the segment gear **226** which in turn causes clockwise and counterclockwise rotation to the shaft **230** carrying the gears **228** and **232.** The switches **SW-1** and **SW-2,** which are electrically connected to the clutch-brake **234,** sequentially condition operation of the clutch or brake for intermittent feeding of the web. Rotation to the shaft **246** through the pulleys **238** and **240** and the belt **242** is thereby effected. Consequently, rotation of the lower draw roll **248** is effected resulting in feeding the web a desired amount. Web movement is interrupted by energizing the brake and deenergizing the clutch of clutch-brake unit **234.** Before the web termi-

nates its movement, the clutch-brake unit **282,** through limit switches LS3 or LS4, is conditioned to impart rotation to the shaft **288** driving the upper platen **166** downwardly and actuating the corner knockout mechanism **142.** After the press has made its impression on the web it raises and the web is again indexed the predetermined amount. It should be noted at such time that the shaft **246** is rotated the discharge rolls **180** are also rotated through the pulleys **260** and **262** and the belt **264.**

A box blank making machine incorporating the principles of this invention satisfies an objective long sought in the box making industry. Not only is it now possible to produce accurate box blanks in a manner which substantially eliminates handling labor, but also makes it possible to produce two blanks, simultaneously, which may constitute the top and bottom of the completed box. FIG. **4** illustrates, in an easily understandable diagrammatic manner, the minor modifications that can be made to produce two box parts simultaneously. This procedure essentially involves continually slitting the web strip equal to the sum of the lateral dimensions of the box parts. After the web strip has traversed the unwind system which includes the decurling roll **74** and **76,** the web drive roll **88** and **90,** and the reels **120** and **122,** the web encounters an additional set of slitting wheels **167** and **167**a producing two web strips by cutting the web strip WS along a longitudinal line SL. Each web strip is then provided with longitudinal score lines LS which is accomplished by providing additional score wheels **172**a and **174**a. The steel rule die **176** is modified to produce transverse cut lines T and cut lines defining the corner pieces C as in the case of the single web strip shown in FIG. **3.** Transverse score lines TS are also provided. The knock-out plungers **182** mounted on the cross beam **308** are assisted by two additional plungers for removing the corner portions to complete the box blanks.

It will now be appreciated that the concept of the present invention lends itself to a high degree of flexibility as it is now possible to simultaneously produce both blanks for a completeed box or two bottoms or if desired two tops at the same time.

Manufacture of high quality rigid boxes obviously depends upon the accuracy of the blank, since it is a design assumption of the box staying apparatus and the wrapping apparatus that the box blank or the stayed box will come within certain nominal dimensions In addition to insuring that the score lines are normal to each other the depth of the score lines is important. Board used for making boxes has an inherent grain structure. Score lines made in the direction of the grain do not have to be made as deep as the score lines running in a transverse direction. Accordingly it is usual practice to regulate the depth of the score lines with respect to the grain structure of the board. The reason for making the score lines across the grain deeper than those with the grain is to fulfill a condition whereby substantially the same breaking force is required to bend the side walls of the box normal to the base during the staying operation. If the transverse score lines were made the same depth as the longitudinal score lines, that is, those running with the grain, a greater amount of force would be necessary to bend the cross grain walls of the box. The present invention accordingly provides means whereby the depth of the score lines running with the grain of the web can be very accurately maintained and the score lines running against the grain can be made deeper and consistently at right angles to the score lines running with the grain.

FIGS. **6** and **5** show the means provided by the present invention for producing the score lines LS running with the grain. FIGS. **6** and **5** are representative of the construction of both score wheel support structures **158** and the manner in which both ends of the score shaft **276** are mounted. Accordingly, it is intended that this description shall apply to the scoring means as a whole.

FIG. **5** shows the manner in which one end of the score shaft **276** is mounted in the beam **146.** The other end of the score shaft is mounted in the beam **144** in the same manner but the portion shown in FIG. **5** includes other elements which will be described. Each end of the score shaft **276** is provided with a portion of reduced diameter **646** on which is slidably mounted an eccentric bushing **648** fixed to the shaft portion **646** by a tapered pin **650.** The eccentric bushing **648** is rotatably fitted in a bore **652** in order to permit rotation of the bushing **648** relative to the beam **146.** As mentioned, the other end of the score shaft **276** is mounted in the beam **144** in the same manner. On the shaft portion **646** a bent rod **654** defining a handle portion **654***a* (see FIG. 8C) has one end threaded for reception into a threaded bore **656** provided in shaft portion **646.** The rod **654** is held against rotation in the threaded bore **656** by a lock nut **658.**

By virtue of the eccentric bushings **648,** rotation of the score shaft **276** by grasping the handle **654,** moves the hardened collars **278** and **280** toward or away from the scoring wheels **172** and **174.** FIG. **6** illustrates this action by showing the adjusting rod **654** in the full line position locating the hardened collar **280** tangent to the score wheel **174** and in the phantom outline position bringing the hardened collar **280** out of contact with the score wheel. In this way the scoring depth of the longitudinal score lines LS can be accurately determined and maintained.

To provide the operator with a visual indication of the score depth a dial indicator **660,** (FIG. **5**) reading in units of 1,000ths or 10,000ths of an inch, as desired, is mounted on the beam **146** by a bracket **662** in order to locate the plunger **664** of the indicator **660** on the surface of the score shaft **276.**

Two procedures may be followed in setting the depth of the score wheels **174.** One procedure would involve turning the score shaft **276** until the hardened collars **278** and **280** just make contact with the score wheels **172** and **174.** The dial indicator **660** is zeroed at this point. The score shaft may then be rotated withdrawing or lowering the hardened collars **278** and **280** away from the score wheels **172** and **174.** Knowing the thickness of the web and the depth of score desired, the score shaft **276** is located until the indicator **660** indicates a reading from the zero point which will determine the depth of the score. Another way in which the score depth may be set is to take a sample strip of web and locate it between the hardened collars **278** and **280** and the score wheels **172** and **174.** Since the score wheels are not powered and therefore can be turned by hand the shaft **276** can be adjusted until the score wheels make contact with the web. Noting the indicator reading at this time or zeroing the indicator when the score wheels are in like contact with the web, the score shaft **276** is further displaced moving the hard-

ened collars **278** and **280** upwardly until the desired depth of score is indicated on the indicator **660.**

As mentioned previously the score wheel supporting structures **158** are mounted on the transverse beam **156** so that they can be laterally adjusted to make a longitudinal score line LS a predetermined distance inwardly from the edges of the web strip WS. The support structures **158** (FIG. **6**) comprise an upper plate **666** rigidly secured to two downwardly extending struts **668** and **670** which for ease of reference will be referred to as a yoke structure. The struts **668** and **670** are rigidly connected in any suitable manner to a bearing block **672** supporting bearings (not shown) for rotatably mounting the score wheel **174.** The block **672** is formed with a slot **674** slidably receiving a machined tang **676** formed on the lower edge portion of the transverse beam **156.** To lock the support structures **158** to the beam **156** thumb screws **678** are threaded through the plate **666.** As shown in FIG. **6** the thumb screw bears against the upper surface of the transverse beam **156** and by virtue of the bearing block **672** being connected thereto through struts **668** and **670,** the bearing blocks **672** are held in firm engagement with the tang **676.**

FIGS. 7A, 7B and 7C show a portion of the machine of FIG. **1** in enlarged side elevation. In FIG. 7A the web slitting device **54** which carries the web slitting knife **56** is mounted for transverse movement between the laterally spaced and aligned frames **62** which are supported on the base plate **52.** Referring to FIG. **8A,** which shows the web slitting device **54** in plan, it will be observed that the arm **58** comprises three generally L-shaped plates **58***a*, **58***b* and **58***c* having fixed to the upper end a tubular spindle **322** within which is rotatably mounted a shaft **324** (FIG. **9**) carrying the web slitting knife **56.** A depth gauge roller **326,** (FIG. **8A**) rotates by making contact with the surface of the web to be removed from the board stock supply roll **50** and is adjustable to control the depth of cut of the slitting knife **56.** The roller **326** (FIG. **10**) is rotatably mounted by means of a roller bearing **328** fixed on a hub **330.** The hub **330** is adjustable, by means of a knob adjusted shaft **332** to set the depth of cut of the knife **56.** The adjustment is maintained by a locking shaft **334.** To adjust the surface of the roller **326** relative to the cutting edge of knife **56** a collar **331,** having diametrically opposed flats **333,** is clamped to the spindle **322.** The hub **330** is also provided with diametrically opposed flat surfaces **335** dimensioned to be slidably fitted on the flats **333.** Strips **337** secured to the hub **330** retain the hub **330** and the collar **331** in assembled relation.

The tubular member **332** is designed so that the web slitting knife **56,** the depth roller gauge **326** and the hub **330** can be mounted on the opposite end of the tubular member **322.** This is accomplished by making both ends of the spindle **322** identical. As shown in FIG. **10** the spindle **322** is counterbored for reception of a bearing **337** which is retained therein by a ring **339** secured by screws **341.** The shaft **324** is formed with reduced diameter portion **343** being bored and threaded for reception of a stud **347.** The stud is an integral part of disc **349** received in a recess **351** formed in the knife **56.** The disc **349** is secured to the knife by screws **353.** Once the disc is attached to the knife **56** the stud is threaded into the thread bore of the shaft portion **343.** An end cap **355** is centrally bored so that the shaft portion **343** projects therethrough. The cap **355** protects the bearing **337** from the dust of the web generated during the cutting operation.

The other end of the spindle **322** is made in an identical manner to mount the knife **56** on the opposite end of the spindle **322.** The two-way mounting is provided for those instances where the web strip to be slit may be too narrow to provide a sufficient area of contact for the depth roller and therefore mounting the depth adjustment and the slitting wheel on the other end of the tubular member **322** will allow the depth roller gauge **326** to ride along or on a large area of the roll.

The arms **58** are interconnected and secured to tubular sleeves **336***a* and **336***b* (FIG. **8A**) slidably mounted on transverse rods **338** and **340** having their ends fixed in links **342** and **344.** Each of the links **342** and **344** are rotatably mounted, by means of a short stub shaft extension **346** and **348,** in the frames **62.** As shown in FIG. **8A,** bearings **350** are provided for rotatably mounting the stub shafts **346** and **348.** A threaded rod or lead screw **352,** held against axial movement by a collar **354** and a hand wheel **356,** extends through the side frames **62** and through the links **342** and **344.** Rod **352** is threadedly received in a bushing **358** rigidly attached to the arm **58***c*.

While the nominal adjustment made for removing a web strip WS of desired width is made by laterally moving the unwind stand **44** transversely relative to the longitudinal axis of the machine, minor adjustments can be made by turning the hand wheel **356** which rotates the screw **352** allowing transverse movement of the web slitting device **54.** A locking device comprising a screw **359** fixed to a handle **360** serves to lock the web slitting device **54** against transverse movement by engaging the end of the screw **359** with the shaft **338.**

The web slitting device **54** is provided with the ability to controllably rotate about the axis of the lead screw **352.** In order to produce a continuous web strip of a desired width the slitting knife **56** must travel in a plane normal to the axis of the web roll **50.** Aside from the alignment of the unwind stand **44,** the arms **58** must provide a degree of rigidity which will constrain the slitting knife **56** to travel in a predetermined path. One of the factors significantly contributing to this result is to insure that the cutting force the knife **56** imposes on the web is substantially constant as the knife pivots or moves in an arc from the outer wrap of the web roll to the core. For this purpose, and in accordance with a feature of the present invention, a pneumatic cylinder **362** (FIG. **7A**) is provided. The link **342** is formed with an extension **342***a* having connected thereto a clevis **363** suitably secured to the end of the piston rod **364.** Conduits **366** and **368,** respectively, connected to the rod end and the head end of the piston **362,** are connected to suitable controls supplying pressure fluid simultaneously to the conduits **366** and **368** such that the net force or turning moment imparted to the link **342,** and accordingly to the slitting wheel **56,** is regulated to a predetermined amount. The lower end of the piston **362** is pivotally connected at **370** to a bracket **372** secured to the base plate **52.**

Means are provided on the web slitting device for initiating and terminating pivotal movement of the arms **58** about the axis defined by the lead screw **352.** Such means preferably comprise limit switches LS6 and LS7 mounted on the frames **62** (the frame as viewed at the bottom to FIG. **8A**) actuated by lobes **374** and **376** secured to link **344.** As shown in FIG. 7A the lobe **374**

is in contact with the arm of LS6 conditioning the control circuit to interrupt pressure fluid to the cylinder **362** and it should be noted that the slitting knife is at this time out of contact with the web roll **50.** Switch LS7 is contacted by the lobe **376** which determines the limit of counterclockwise movement of the web slitting device **54** and this limit is set so that cutting of the core supporting the web roll is prevented. When limit switch LS7 is actuated the control circuit is conditioned to exhaust fluid from the head end of the cylinder **362** and admit pressure fluid through the conduit **366.** The limit of counterclockwise rotation of the web slitting device **54** is shown in phantom line where the limit switch LS7 is actuated terminating such movement and conditioning the circuit to retract the piston rod **364** of the piston **362.**

FIG. 7B shows another fragmentary enlarged elevational view of a portion of the unwinding apparatus illustrating in greater detail the web tension dancer frame **70** and a portion of the frame structure **128** which supports the shearing means **130.** As was mentioned above the dancer frame **70** continually oscillates about the axis of the shaft **108** in order to maintain constant web tension. Clockwise and counterclockwise oscillation of the arms **104** and **106,** which are keyed to the shaft **108,** cause oscillation of the pinion gear **116** by virtue of its meshing engagement with segment gear **114** keyed to the shaft **108.** Oscillation of the pinion **116** conditions the potentiometer **118** (FIG. 8B) to increase or decrease the speed of the motor **102** (FIGS. 1 and 7A). When the arms **104** and **106** are in their extreme clockwise position, as viewed in FIG. 7B, this is a position of maximum web tension while the condition of minimum web tension is in the opposite direction.

To insure that the tension of the web is within limits that can be tolerated without breaking, a limit switch LS8, mounted on a bracket **377,** is located in the plane of the arm **104** and is actuated thereby in the event web tension achieves a level which may cause rupture. Actuation of limit switch LS8 interrupts feeding of the web and thus reliably prevents web rupture. Since the amount of tension the web strip WS can tolerate is a function of its width, the bracket **377** can be repositioned to interrupt web feeding before the tension limit is reached. For example, a web in the order of **3** or **4** inches in width may dictate location of the limit switch LS8 closer to the vertical plane containing the axis of the shaft **108.**

To impose a predetermined amount of tension to the web by the dancer frame **70,** tension springs **378,** having one end attached to a block **380** and the other end looped in one of a plurality of holes **382** in the arms **104** and **106** are provided. The moment arm of the force generated by the springs can be varied by moving it in the hole closest to the axis of the shaft **108** or in the hole farthest away from such axis.

FIG. 7B shows that portion of the frame structure **128** including the slitting means **130.** The web strip leaving the upper reel **120** is received between a non-powered lower roll **384** and an upper roll **386** which has applied thereto, a rubber covering **388.** The lower roll **384** is rotatably mounted in side beams **144** and **146** while the upper roll **386** is rotatably mounted in levers **390** (see FIG. 8B) which are pivotally mounted at **392** to the side frames **144** and **146.** Keyed to one end of the shaft **386** is an electromagnetic brake **394** (FIG. 8B) which is connected to a DC source through a potentiometer which can vary the voltage and consequently the braking power imparted to the shaft **386.** A brake found suitable for this purpose is manufactured by Sterns Electric of Milwaukee, Wisconsin, and it is designated as style SMB. As will be noted by reference to FIG. 8B, the brake **394** is flange mounted to one of the levers **390.** The side frame **144** is appropriately relieved to allow freedom of movement of the brake **394** for a purpose presently to be explained. Longitudinally adjacent the rolls **384** and **386** a manually rotatable rod **398** is located and freely rotatably mounted in the side frames **144** and **146.** On each end of the rod, knobs **400** are secured to facilitate manual rotation thereof.

Each of the levers **390** is formed with an offset portion defining a finger **390***a* on the end of which is attached a tension spring **402.** The other end of the spring **402** is attached to the frames **144** or **146.** The springs bias the levers **390** in a clockwise direction as viewed in FIG. 7B. In sliding engagement with the lower surface of the fingers **390a** are cams **404** which are keyed to the rod **398.** Under operating conditions the springs **402** are effective to maintain the rolls **384** and **386** in pressure engagement and thus impart a nip pressure to the web strip WS.

The brake **394** imparts a retarding torque to the shaft **386** which is in opposition to the direction of web movement. Since the web strip WS is intermittently fed through the machine, the inertia of the web and some of the web directing and feeding apparatus, such as the web tension dancer frame **70,** the longitudinal scoring wheels **172** and **174** have a sufficient amount of inertia to cause buckling or deformation of the web upstream of the draw rolls **140.** The brake **394** solves this problem by imposing an additional tension to the web strip between the rolls **384** and **386** and the draw rolls **140.** Other approaches are available to solve this problem. Providing a longitudinal rail overlying and closely adjacent to the upper surface of the web will prevent buckling of the web strip. Such means may be incorporated in place of or in addition to the brake **394.**

FIG. 7C shows, in enlarged elevation, the portion of the frame structure **128** downstream from the inlet portion shown in FIG. 7B. In describing the illustrated structure reference should also be made to FIG. 8C which includes the same portion of the apparatus in plan. Referring first to FIG. 8C, it will be observed that the side plates **144** and **146** are held in spaced parallel relation by a series of transverse rods **406** which extend through the longitudinal web guides **134** and through a central plate **408** that serves to support the central portion of the web strip. Each of the web guides **134** have rigidly attached thereto a strip **410** which has its upper surface located in the same horizontal plane as the upper edge of the central plate **408.** Thus, the strips **410** and the central plate **408** provide a guide structure which prevents sagging and lateral movement of the web strip.

The web guides **134** are provided with means for simultaneously moving them toward or away from the central plate **408.** Such means comprise screws **412** and **414** mounted for rotation in the side plates **144** and **146.** Each of the screws are undercut substantially at their mid section **416** to clear the plate **408** and to define the demarcation or dividion of the screws into equal length. The screw portion **412a** is formed with a lefthand thread while the screw portion of **412***b* is

formed with a righthand thread. The same arrangement applies to the screw **414** and this is indicated by the numerals **414***a* and **414***b*. The screw **412** is formed with an extension **416** extending through a bearing **418** mounted in the side plate **146.** On the extension **416** a sprocket **420** and a handwheel **422** are keyed. In like manner, the screw **414** is formed with an extension **424** extending through a bearing **426** also supported in the side plate **146.** On the extension **424** there is keyed a sprocket **428.** A sprocket chain **430** is trained about the sprockets **420** and **428.**

Each of the longitudinal web guides **134** have rigidly secured thereto threaded hubs **432** which are in threaded engagement with the screw portions **412***a*, **412***b*, **414***a* and **414***b*. Rotation of the handwheel **422** effects concurrent rotation of the screws **412** and **414.** By virtue of the left and right hand thread portions of these screws, the web guides **134** are silultaneously moved toward or away from each other in order to conform to the width of the web strip removed from the web roll **50.** Accordingly, the guides **134** can be adjusted to conform to the width of the web strip WS. As shown in FIG. 7C, tension on the chain **430** is maintained by a sprocket **434** pivotally mounted at **436** to the side frame **146.**

Still referring to FIG. 8C, it will be observed that the longitudinal guides **134** terminate adjacent the draw rolls **140** thereby providing horizontal and lateral guidance of the web until it enters the press **138.** The draw rolls **140** are arranged to impart a substantial nip pressure to the web strip so as to prevent any slippage, since the longitudinal dimension of the box blank is in part determined by the number of revolutions made by the driven draw roll **248** (FIG. 3). The draw rolls **140** include an upper draw roll **436** associated with means, presently to be described, for bringing the upper draw roll **436** in pressure engagement with the lower draw roll **258** when the machine is in operation.

Referring now to FIGS. 8C, 7D and **11,** the preferred form of mounting the draw rolls, which includes means for displacing the upper draw roll **436** out of engagement with the lower draw roll **248,** is shown. Referring first to FIG. **11,** it will be observed that the side frame structures **160** and **162** of the press **138** are each mounted on lower frames **438** and **440** secured to and extending upwardly from the base plate **136.** On respective horizontal surfaces, and located inwardly adjacent the side frame portions **160** and **162,** guide rails **442** and **444** are secured. Each of the guide rails provide, in conjunction with the upper horizontal surface of the frames **438** and **440,** an elongate slot in which are disposed rollers **446** and **448** rotatably mounted adjacent the lower edge of plates **450** and **452.** A screw **454** (FIG. **17**) rigidly secures the plates **450** and **452** to a selected position along the guide rails **442** and **444.** The reason for such an adjustment will be explained in connection with FIGS. **18–21.**

The support plates **450** and **452** have the ends of the lower draw roll **248** mounted therein for rotation. The plates are also interconnected by one of the transverse rods **406** and a transverse rod **456** the ends of which extend through upwardly extending brackets **458** and **460** which, as shown in FIG. **17,** assume an acute angle relative to a vertical plane. Lugs **462** and **464** are rigidly attached to the head end of cylinders **466** and **468** and are slidably received on the rod **456.** The cylinder **466** includes a projecting rod **470** having rigidly secured to its end a clevis **472.** A pin **474** pivotally connects the clevis **472** to a link **476** pivotally connected to the support plate **450** by a pin **478.** The cylinder **466** includes conduits **480** and **482** which supply, respectively, the head end and the rod end of the cylinder with fluid under pressure. The support plate **452** is identical in construction and engagement to the plate **450** shown in FIG. **17** and it is intended that the above description apply equally to the support plate **452.**

The ends of the draw roll **436** are suitably rotatably mounted in the links **476,** and, by virtue of the pins **474,** the draw roll **436** can be raised to the phantom outline position shown in FIG. **17** whenever fluid is supplied to the conduit **482** while the fluid is exhausted from the conduit **480.** It is advantageous to raise the draw roll **436** whenever the machine is inactive or shutdown for any length of time or when it is desired to rethread a new web strip through the machine. If the draw rolls **436** and **248** were to remain in pressure contact while the machine is inactive, flat spotting of the rolls **248** and **436** would occur, resulting in noisy operation and inaccurate feeding of the web.

The discharge rolls **180,** serving to convey the temporarily interconnected box blanks to the corner knockout device **142** comprise, in addition to the lower roll **158,** an upper idle roll **490.** These rolls are associated with belts **484, 486** and **488** which assist in conveying the temporarily interconnected box blanks to the corner knockout mechanism **142.** As in the case of the draw rolls **140,** the discharge rolls **180** are mounted for longitudinal adjustment on the guide rails **442** and **444.** Such an adjustment is necessary since the discharge rolls are located in close longitudinal adjacency to the press platens. The press platens are made so that they can be adjusted to define a plurality of platen areas resulting in dimensions, in the direction of web feed, which necessitate longitudinal adjustment of the draw rolls **140** and the discharge rolls **180.**

FIG. **12** shows the manner in which the discharge rolls **180** are mounted for longitudinal adjustment. While the arrangement illustrated is applicable to one end of the discharge rolls it is to be understood that the other end is arranged in an identical manner. The lower roll **258** is rotatably mounted in a bearing (not shown) rigidly attached to a plate **492** by means of a flange **494.** The plate **492** has adjacent its lower edge rollers **496** rotatably mounted thereon and disposed within the slot defined by the guide rail **442** and the upper surface of the lower frame **438.** The plate **492** is provided with a clamping device **498,** preferably taking the form of a screw, for holding the plate **492** in a longitudinally adjusted position. The plate **492** rigidly supports the ends of a transverse rod **500** which has clamped thereon arms **502** and **504** (FIG. **13**) rotatably supporting, respectively, flanged idler pulleys **506** and **508.**

The upper discharge roll **490** has each end rotatably mounted in links **510** and **512** (FIG. 8C) which are in turn freely pivotally mounted at **514** and **516** to the plates **492.** The nip pressure produced between the rolls **490** and **258** is that which results from the weight of the roll **490** and the links **510** and **512.**

At times it is desired to raise the upper roll **490** out of contact with the lower roll **258.** Such occasions may occur when the end of a new web strip is threaded through the machine. To accomplish this all that is necessary is to grasp the upper roll **490** and rotate it about the axis of the pivots **514** and **516.**

Means are provided for limiting the amount of rotation of the links **510** and **512** and such means comprise bars **518** and **520** rigidly attached to the plates **492** to define an acute angle relative to a vertical plane. On each of these bars a bolt **522** (FIG. **13**) is rigidly attached so that its shank is in the plane of rotation of the links **510** and **512** thus performing the function of a stop. The orientation assumed by the links **510** and **512** when the upper roll **490** is pivoted upwardly is shown in phantom outline in FIG. **12.**

The press **138,** shown in side and front elevation in FIGS. **7D** and **11,** respectively, will now be described. Spanning the lower frames **438** and **440** is a lower stationary platen **524** which is made sufficiently rigid to withstand the pressure of the upper platen **526** which is connected to the crosshead **166.** The crosshead **166** is reciprocated vertically by virtue of its connection to the links **314** and **316.** Each of the clevis members **318** and **320** are formed with a stud **528** that extends through clearance holes (not shown) formed in the ends of the crosshead **166,** through webs **530** and **532** and have threadedly mounted on their end portions gears **534** and **536.** As shown in FIG. **7D,** the web **532** is an integral part of a casting **538** formed with parallel bores containing the roller bushings **540** which are slidable relative to the guide rods **164.** It is to be understood that roller bushings are associated with each of the guide rods **164.**

Means are provided for adjusting the spacing between the lower platen **524** and the upper platen **526** in order to accommodate die sets of various thicknesses. To accomplish this result transversely aligned bearing blocks **542** and **544** (FIG. **11**) are rigidly attached to the webs **530** and **532.** A hexagonal rod **546,** having its ends dimensioned to extend through the bearing blocks **542** and **544,** has keyed on each end worms **548** and **550** which are in meshing engagement with gears **534** and **536,** respectively. Each of the studs **528** have threaded thereon a lock nut **552,** which, when tightened, firmly holds the crosshead **166** relative to the studs **528.** When it is desired to adjust the spacing between the lower platen **524** and the upper platen **526** the lock nuts **552** are loosened moving them downwardly toward the clevises **318** and **320,** and the hexagonal rod **546** is turned, by means of a wrench, causing rotation of the worms **548** and **550.** Concurrently therewith the gears **534** and **536** are rotated, and by virtue of their being threaded on the studs **528,** the crosshead **166** can be raised or lowered. After the adjustment is completed, the lock nuts **552** are tightened holding the crosshead in the adjusted position.

In accordance with the present invention, the box blank material which has been longitudinally and transversely scored and provided with transverse offset cut lines to define the corners of the box blank are interconnected by uncut tab portions that are of sufficient strength to retain the continuity of the strip until the corner knockout mechanism **142** is encountered. The mechanism **142** is coordinated with the operation of the press **138** such that when the web strip is at rest the corner pieces are removed which results in separation of the web strip into individual box blanks. Referring now to FIG. **12** it will be observed that the knockout mechanism **142** is carried by a longitudinally extending frame structure **554** comprising transversely spaced, longitudinally extending, raisl **558** and **560,** (see FIGS. **14** and **15**), interconnected to the guide rails **442** and **444** by braces **562** and **564.** Legs **566** and **568** are rigidly secured to the rails **558** and **560** for supporting the end of the frame structure **554.**

The knockout mechanism **142** is mounted for longitudinal adjustment on the frame structure **554** and such adjustment is necessary to properly align the knockout mechanism with the draw length of the web strip. For example, box blanks having a total length of **6** inches would dictate location of the mechanism **142** at one point along the rails **558** and **560** while box blanks of a greater length necessitate adjustment to another point. The corner knockout mechanism essentially consists of a carriage **561** which is slidably mounted for longitudinal movement to any selected point along the rails **558** and **560.** The constructional details, presently to be explained will make reference to FIGS. **12, 13, 14** and **15.** The carriage **561** comprises a rectangular frame structure having lateral members **572** interconnected to longitudinal members **574.** The members **572** have composite support for bars **578** and **580,** on the upper surface of which ride, the box blank transporting belts **484** and **488.** Extending upwardly and attached to the longitudinal members **574** are brackets **582***a*, **582***b*, **584***a*, **584***b*, **586***a* and **586***b*. The pair of brackets **582***a* and **582***b* each rotatably support a roller **588** in rolling engagement with the upper surface of the rail **558** and **560** and a roller **590** in rolling engagement with the lower surface of racks **592** and **594** which are secured to the inner surfaces, respectively, of the rails **558** and **560.** FIG. **12** shows the relationship of the rack **594** relative to the rail **560.**

The brackets **584***a* and **584***b* are provided with ear portions **596** and **598** to which are attached the flexible shafts **306.** Interiorly of the shafts **406** cables **600** and **602** are slidably mounted and the cables are secured to the cross beam **308** by clevises **604.** The other end of the cables are attached, by linkages **606** (FIG. **12**), to the knockout cross bar **304.** The brackets **584***a* and **584***b* are formed with an elongate slot **608,** which, in combination with gibs **610,** constrain the cross beam **308** to reciprocate vertically.

Adjustably secured in transversely spaced relationship on the cross beam **308** are plungers **612** and **614.** On the base of each plunger and extending laterally inwardly toward each other, are pairs of fingers **616** and **618.** The fingers are mounted so that they can assume a divergent relation relative to each other. For this purpose the fingers **616** and **618** are mounted on the base of the plungers **612** and **614** by screws **620.** It will be noted by reference to FIG. **14** that the plungers **616** and **618** are located on the cross beam **308** so that the fingers are closely adjacent the bars **578** and **580** which support the belts **484** and **488.** The reason for such a relationship is that the longitudinal score lines of the box blanks are located inwardly adjacent the inner reach of the fingers **618** and **620** this enables removal of the waste corner pieces C without unduly bending the web.

The pair of upright brackets **586***a* and **586***b*, which are also secured to the longitudinal members **574,** rotatably mount rollers **622** and **624** which are in rolling engagement with the lower surface of the racks **592** and **594,** respectively. A transverse rod **626** is rotatably mounted in the brackets **586***a* and **586***b*. At each end of the rod there is keyed a spur gear **628** and a roller **630.** The spur gears **628** are in mesh with the racks **592** and **594** while the rollers **630** ride along the upper sur-

face of the rails **558** and **560.** Brackets **632,** of generally L shaped configuration, are rigidly attached to the brackets **586***a* and **586**b to provide support for the ends of the rod **626.** The rod **626** is provided with an extension on which a handwheel **634** is keyed so that upon rotation of the rod **626** the corner knockout mechanism **142** can be adjusted longitudinally relative to the rails **558** and **560.** A hand operated locknut **636,** screwed on a threaded portion of the rod **626** prevents rotation of the rod **626** and accordingly maintains the corner knockout mechanism **142** in its desired adjusted position.

The belts **484, 486** and **488** for guiding the scored and cut web to the knockout mechanism **142,** are trained about pulleys **638** and **640** rotatably mounted in close vertical adjacency on the ends of the rails **558** and **560** as shown in FIG. **12.** The belts **488** and **484** are trained about the lower discharge roll **258,** the flanged pulleys **506** and **508,** flanged pulleys **642** and **644** depending from and rigidly mounted on one of the lateral members **572,** and the pulley **640.** It should be recalled tha the upper run of the belts **484** and **488** ride along the bars **578** and **580** so as to provide support for the box blank at such time when the plungers **612** and **614** remove the corner pieces. The upper belt **486** is trained about the upper discharge roll **490** and the pulley **638.** As shown in FIG. **16** the belt **386** is located substantially midway between belts **484** and **488.** The lower reach of belt **486** makes contact with the upper surface of the web strip to thereby assist in conveying the connected box blanks to the knockout mechanism **142.**

The corner knockout mechanism **142** is coordinated with the operation of the press **138** by virtue of the cams **290** and **292** fixed to the output shaft of the reducer **282.** In describing the operation of the knockout mechanism **142** reference is made to FIG. **12.** Let it be assumed that the web has been indexed and is in a state of repose. The cross head **166** is moved downwardly by the links **314** and **316** which are connected to the cams **310** and **312.** The cams **290** and **292,** which are also connected to the shaft **288,** oscillate the levers **298** and **300** displacing the cables **600** and **602** to cause downward reciprocation of the cross beam **308** and the plungers **612** and **614** which are fixed thereto. The fingers **616** and **618** encounter the corner pieces removing them from the adjacent box blanks by rupturing the tabs thereby separating the leading box blank from the web. As the cross head **166** rises the levers **298** and **300** pivot downwardly drawing therewith the cables **600** and **602** thereby raising the cross beam **308.** The web is then indexed for another cycle of operation.

FIGS. **18, 19, 20** and **21** show the various modifications that can be made to the press platens **524** and **526** for increasing the platen area in order to produce box blanks of various dimensions. The apparatus of the present invention is designed to produce box blanks having a minimum length of 1½ inches and a maximum length of 33 inches. Machine cycle rates for box blanks from 1½ inches to 11 inches in length is approximately 175 cycles per minute while box blanks having a length of 33 inches dictate a lower cycle rate of approximately 70 cycles per minute. To accommodate such size variations the present invention discloses means whereby the areas of the upper and lower platen can be changed to suit these requirements. FIG. **18** shows the press setup with a minimum of platen area which would be the set-up for making boxes of smaller sizes. The upper platen **526** is an integral part of the crosshead **166** and as shown in FIG. **18** it is of T configuration. A steel rule die **680** is fixed to the upper platen **526** by clamping strips **682** which are secured to the upper platen by a series of screws **684** which are shown in FIG. **11.** While the construction of the steel rule die **680** will be described in greater detail hereinafter it essentially consists of a wooden plate provided with a pattern of grooves for receiving the steel rules for transversely scoring and cutting the web as shown in FIG. **2.** On the upper surface of the lower die **524** a plate **686,** having a plurality of resilient strips **688,** preferably urethane, is mounted. Pilots **690** (only one of which is shown in FIG. **18**) extend through clearance holes formed in the plate **686.** The pilots serve to prevent lateral or longitudinal movement relative to the platen **524** but will however allow vertical movement of the plate **686** occasioned by the compression of the strips **688.**

When the machine is setup for minimum platen area as shown in FIG. **18** the draw rolls **140** and the discharge rolls **180** are located as close as possible to the inlet and discharge of the dies. Since the plates **450** and **452** which rotatably support the draw rolls **140** and the plates **492** which rotatably support the discharge rolls **180** are mounted for longitudinal movement by virtue of the rollers **446, 448** and **496** the draw rolls and discharge rolls can be located immediately adjacent the press platens **524** and **526.** Locating the draw rolls **140** and the discharge rolls **180** in close adjacency to the platens insures proper feeding of the web to and from the press **138.**

FIG. **19** illustrates essentially the same structure but includes means, associated with the upper and lower platens **526** and **524,** respectively, for increasing the platen area when it is required to produce larger box blanks. The means for increasing the platen area comprise reinforced channels **692** substantially equal in length to the upper and lower platen **526** and **524.** Each channel has formed integrally therewith gussets **694** (also see FIG. **11**) interconnecting webs **696, 698** and **700.** Each web is of different length when viewed in cross section.

When the reinforced channels **692** are mounted as shown in FIG. **19,** the webs **700** define an extension and accordingly an increase in the platen area. The size of the steel rule dies **680** and the plate **686** are made consistently larger for the increased platen area. The plates **450** and **452** and the plates **492** are adjusted along the rails **444** and **442** to accommodate the larger platen area and thus position the draw rolls **140** and the discharge rolls **180** in close adjacency to the platens.

FIG. **20** shows the platen areas to be further increased by mounting the reinforced channels **692** so that the web **696** define extensions of the platens **524** and **526.** Again the steel rule die **680** and the floating plate **686** are accordingly increased in size and the draw rolls **140** and the discharge rolls **180** are positioned in close adjacency with the new die area.

FIG. **21** shows yet another increase in the die area by positioning the webs **698** to define an extension of the platen area **524** and **526.** It should again be noted that the draw rolls **140** and discharge rolls **180** are positioned in close adjacency to the transverse margins of the platen area.

Contributing significantly to the production of accurate box blanks the present invention provides a novel construction to the steel rule die **680** and a novel

mounting for the floating plate **686** which together contribute for making accurate blanks. As stated above present commercial methods of making box blanks result in inaccurate scored depths and inaccurate corner cutting. To fulfill the objective of requiring substantially the same force to break the box blank along the longitudinal and transverse score lines desirably requires making the score lines running transverse to the grain of the web deeper than the scores running with the grain. Too much breaking resistance along the transverse score line has the tendency of creating a slight non-planar deformation to the cross grain side panel of the box.

The steel rule die **680** of the present invention carries the steel rules in a geometrical pattern and impresses the web with a plurality of cut and score lines to simultaneously produce the corner cuts, the transverse score lines and a transverse severance defining the individual box blanks. The rule die produces the corner cuts and the transverse score lines on two adjacent blanks simultaneously as shown in FIGS. **2** and **4.** The cutting edge of certain portions of the steel rule dies are interrupted to provide tabs, connecting the adjacent blanks, which are ruptured by the corner knockout mechanism **142.** By sequentially producing the longitudinal scores and thereafter the transverse scores and corner cutouts, the amount of force required of the press **138** is substantially diminished allowing the press to be operated much as a punch press, therefore impulsing the crosshead **166,** and the platen **526,** toward the plate **686** supported by the lower platen **524.** Blanks made by presently available die presses, which cut and score the entire blank, require substantially greater die pressures substantially increasing the amount of time required for a cycle. Further, producing box blanks by the die press method substantially increases waste of web material.

Referring now to FIG. **22** which shows a plan view of the steel rule die **680** it will be observed that it comprises a rectangular base of hard wood **702** which is milled or appropriately slotted for receiving steel rule dies **704** and **706** which concurrently produce the transverse score line for a leading box blank and a transverse score line for the trailing box blank. Steel rule dies **704***a* and **704***b* define an extension of the steel rule **704.** In like manner the steel rule **706** is provided with extensions **706***a* and **706***b*. Each of the steel rules **704***a*, **704***b*, **706***a* and **706***b* have their cutting edges interrupted or nicked at **708** to provide an easily rupturable tab located in the bands defined by the longitudinal score lines and the edges of the web strip WS. Substantially midway between the rules **704** and **706** a rule **710,** being equal in length to the rules **704** and **706,** is set in the hardwood base **702** in parallel relation with the rules **704** and **706.** The rule **710** has its cutting edge projecting beyond the cutting edges of the rules **704** and **706** in order to completely sever the web along a transverse line initiating and terminating between the longitudinal score line LS. Extending perpendicular to the rules **704, 706,** and **710** are rules **712** and **714** arranged to cut the web strip along a line congruent with the longitudinal score lines LS for a distance equal to the distance between the rules **704** and **706.**

FIG. **25** illustrates a typical portion of the web strip which is cut and scored by the rule die shown in FIG. **22,** however, FIG. **25** is enlarged for clarity of illustration. The uncut portions or tabs produced by the rule die portions **704***a*, **704***b*, **706***a* and **706***b* are indicated by **708,** while the cut lines produced by these steel rule die portions are indicated by the same numeral. The cut lines produced by the steel rule dies **712** and **714** are indicated by the letters LCL (being an abbreviation for longitudinal cut lines while the impression of the rule) dies **710** is indicated by the letters TCL (being an abbreviation for transverse cut line. The direction of web) movement of the web portion shown in FIG. **5** is indicated by the arrow M and the two blank portions are indicated as **B-1** and **B-2,** the leading and trailing blank, respectively. The intersection of the cut lines LCL with the steel rule die cut portions **704***a*, **704***b*, **706***a* and **706***b* define uncut portions **712***a*. Such tabs or uncut portions together with the tab portions **708** retain the slugs C to the web until the web is positioned over the corner knockout mechanism **142** which ruptures the tabs and separates the adjacent box blanks.

FIG. **23,** which is an enlarged section of FIG. **22** taken substantially along the line **23—23,** shows the relative position or projection of the rules **704, 710** and **706.** It should be noted that the rules **704** and **706,** which produce the transverse score lines TS, partially cut through the web strip WS while the rule **710** cuts entirely through the web strip. While FIG. **23** only shows three rules, all the rules illustrated in FIG. **22** extend completely through the hardboard **72** to define contact with the upper platen composed of the reinforced channels **692** and the central platen portion **526.** This serves to retain the rules in their desired relationship.

As mentioned above the plate **686** is provided with a plurality of resilient strips **688** (see FIG. **26**) floating the plate **686** on the lower platen made up of the reinforced channels **692** and the lower central platen portion **524.** The purpose for the reislient strips **688** is to allow the plate **686** to assume a parallel relation with the rule dies carried by the hardwood plate **702.** It should be recognized that the rules which are sized to cut through the web strip, for example rules **710, 712** and **714** together with the rules **704***a*, **704***b*, **706***a* and **706***b*, should not make contact with the plate **686** since the cut-through rules would become dull.

To prevent contact with the plate **686** a sheet of material such as Kraft paper is interposed between the web strip WS and the floating plate **686.** In the art, providing this laminate, which is secured or held in place in any suitable manner, is called "make ready" and it is identified by the letters MS. The thickness of the make ready is held to an absolute minimum by vurtue of the resilient strips **688** which flost the plate **686.** Present practice requires extensive trial and error to pack or shim under the make ready to insure proper score depth for the scoring rules and obviously proper depth for the cut through rules. In some instances packing is required behind the steel rule dies in addition to shimming or packing under the make ready. In some instances the packing becomes too thick causing the steel rule dies to coin or produce a slight bending along the cut through lines which condition reduces the quality of the blank. Accordingly the present invention obviates these problems by floating the plate **686** resulting in a thin and uniform thickness of make ready MS.

Referring to FIG. **26** which shows a perspective of the plate **686** having the resilient strips **688** applied thereto, it will be noted that the pilots **690,** which in essence are bolts threaded into the lower platen **524,** are provided with elongate ground heads **716** slidably fitted

in bores **718** formed in the plate **686.** These serve the purpose of retaining the plate **686** in a predetermined location and allow the plate to float when the upper rule die comes into contact therewith.

The concept of making a plurality of successive box blanks in accordance with the concept of the present invention lends itself to a variety of modifications One modifiaction of present commercial value is illustrated in FIGS. **27, 28** and **29.** The modification essentially invovles the substitution of creasing wheels for the scoring wheels **172** and **174** and modification of the steel rule dies **704** and **706** to produce crease scores. An illustrative example of the shape taken by the creasing wheels substituted for the scoring wheels **172** and **174** and the rule dies **704** and **706** is shown in FIG. **28.** A portion of the web strip WS is shown in pressure engagement with a crease score wheel **172'** having its periphery formed with sloping sides **722** which define an included angle of approximately 90° and a slight radius **724** blended into the side **722.** Pressure engagement of the wheel **172'** with the web strip crushes or compresses the fibers engaged thereby reducing the thickness of the web in the zone of the radius **724** to 15 or 20 percent of its original thickness.

In FIG. **27,** the action of the creasing wheels of the type illustrated as 172' produce longitudinal creases identified as LC and the rule dies corresponding to **704** and **706** of FIG. **22** produce transverse crease lines TC which are analogous to the transverse score lines TS of FIG. **25.** The remaining rules of the steel rule die perform the same function in cutting out the corner pieces and transversely severing the web along the line TCL.

FIG. **29** shows the web strip portion WS of FIG. **28** broken along a longitudinal score line LC. It should be noted that the fibers of the web strip along the brake line BL are relatively close to the neutral axis of the longitudinal crease line, therefore, imposing relatively small value of compression and tension to the fibers and consequently preventing rupture thereof. As is known to those skilled in the art, crease scoring is widely practiced in making setup cartons and the technology is sufficiently established to indicate crease scoring of web material for rigid boxes is desirable.

The frame structure supporting the web guiding and feeding mechanism **128** comprises vertical supports **128*a*** (FIG. **1**) and **128*b*** secured to and extending upwardly from the base plate **136.** The vertical support **128*a*** is shown in FIGS. **30** and **31.** FIG. **30** shows the speed reducer **200** mounted on a bracket **726** carried by the support **128*a***. The shaft **202** of the reducer **200** is mounted in a bearing **730** carried by the support **128*a***. The shaft **202** also extends through an annular disc **732** which is fixed by means of a plurality of bolts **734** to the vertical support **128*a***. Adjustably rotatably mounted on the disc **732** are a pair of annular plates **736** and **738.** The switches SW1 and SW2 are mounted, respectively, on the annular plate **736** and the plate **738.** In the plate **738** an arcuate slot **740** is provided through which is disposed a screw **742** threaded into the plate **736.** Clamps **744** are attached to the vertical support **128*a*** by screws **746** holding the plate **736** and **738** stationary relative to the vertical support **128*a***. The plate **738** is formed with a circumferential portion of reduced radius as indicated by the line **748** and such reduced radius portion is substantially equal to an arc subtended by an angle of 180°.

A spacer block **750** locates the switch SW1 in substantially the same plane as the switch SW2. Keyed to the shaft **202** is a hub **752** having rigidly attached thereon a dielectric rim **574** whose surface is slidably engaged by pairs of brushes associated with each of the switches SW1 and SW2. A peripheral portion of the dielectric rim **754** has inserted therein a copper strip **756** serving to momentarily electrically connect the brushes in the switches SW1 and SW2 in order to sequentially energize and deenergize the clutch-brake **234** which intermittently feeds the web strip. Loosening of the screw **742** and the clamps **744** makes it possible to adjust the switches SW1 and SW2 relative to each other and thereby establish when it is desired to actuate the clutch-brake unit **234.**

The shaft **202** establishes the operational sequence of the apparatus since it carries the cams and limit switches determining the sequence of operation of the various components of the apparatus. This will be made more evident when the control circuit is described. In any event, however, the shaft **202** is the reference, timing or one-time shaft which determines the sequence of operation.

The circuit for synchronizing operation of the preferred embodiment is shown in FIGS. **32A** and **32B** which when joined along break line R-R comprise the complete circuit. A transformer TR1 steps down the voltage from 220 to 115 volts with the low voltage winding in line **1** being connected to lines L1 and L2. Before the machine can run automatically the circuit is conditioned by actuating push buttons and toggle switches connecting certain elements across the lines L1 and L2. The main motor in line **13** is energized by depressing the actuator of a switch PB-2 connecting the motor **184** to line L1 through the overload contacts OL-1 and OL-2 to the line L2. Concurrently therewith contacts **1M** in line **6** and line **14** are closed. The contacts in line **14** constitute a holding circuit maintaining the motor **184** connected across lines **21** and **22.** Toggle switches TS1A and TS1B in line **6** as well as toggle switch TS5A, in the same line, are manually closed and the relay coil **1CR** in line **4** is energized through the normally closed limit switch LS1. Energization of the relay coil 1CR closes normally open 1CR contacts in lines **3, 6, 12** and opens normally closed contacts **1CR** in line **38.** Limit switches LS3 and LS4 in lines **10** and **12,** respectively, are actuated by cams **206** and **208** mounted on the reference shaft **202.** It will also be recalled that the limit switch LS1 in line **4** is also actuated by cam **201** mounted on shaft **202.**

Toggle switch TS3 in line **11** can be selectively adjusted to electrically connect limit switch LS3 or LS4 into the circuit. The cam **206,** actuating the limit switch LS3, conditions the machine for high speed operation which is in the order of **175** cycles per minute, while limit switch LS4, actuated by the cam **208,** is for low speed operation which is in the order of 60 to 100 cycles per minute. Accordingly, depending on the speed one desires to operate the machine, the toggle switch TS3 is positioned to electrically connect the limit switch LS3 or LS4 in the control circuit. A toggle switch TS2 between lines **9** and **11** is a three position switch and is shown in its neutral position. When it is actuated against the bias of a spring, it connects line **9** to line **11.** The coil **2CR** in line **8** is energized closing the contacts **2CR** also in line **8** through the normally closed limit switch LS2 actuated by a cam **441** fixed to

the shaft **288** (FIG. **11**) of the press **138.** Energizing the coil 2CR also opens normally closed contacts 2CR disconnecting line **25** with line **26** while closing normally open contacts 2CR connecting line **25** with line **24.** The clutch brake **282** is thus sequentially operated releasing the brake in line **28** and actuating the clutch in line **23** causing the press to complete one cycle. This mode of operation is provided during the setup of the machine to test the imprint of the steel rule die **680.**

The toggle switch TS5B, line **15,** and solenoid SOL **1** are for operation of the pinch roll cylinders **466.** Whentoggle switch TS5B is open the solenoid is positioned to supply pressure fluid to the conduit **480** extending the rod **470** to hold the upper draw roll **436** in pressure contact with the lower draw roll **248.** To retract the piston rod **470,** the switch TS5B is closed, energizing the solenoid to apply pressure fluid to the rod end of the cylinder **466** through the conduit **482.** Accordingly during normal operation the toggle switch TS5B remains open.

The control for the press unit **138** includes a transformer TR2 having the primary coil in line **17** and the secondary coil connected to a full wave rectifier that provides power to identical solid state switches identified as SS-SW in lines **22** and **27.** The contacts 2CR, operable to connect lines **24** or **26** to the line **25,** determines clutch and brake operation and these contacts are sequentially opened and closed by the limit switches LS3 and LS4, depending on whether high speed or low speed operation is desired, and the limit siwtch LS2. It should be appreciated therefore that the limit switches LS3 and LS4 overlap or are actuated at the time the limit switch LS2 is actuated in order to momentarily deenergize the coil 2CR.

Between the toggle switches TS1A and TS1B in lines *6a* and *6b*, there is connected, in series with toggle switch TS9, toggle switch TS8B and relay contacts 3CR (FIG. 32B). In order for the relay coil 1CR in line **4** to be energizable it is necessary that toggle switches TS9, TS8B and relay contacts 3CR are closed.

The circuit elements in lines **29-33** integrate the operation of the web slitting device **54,** which includes the slitting knife **56,** and the unwind stand **42,** with the web feed. This circuit includes elements which will stop operation of the entire machine when the last wrap of the web strip is removed. As shown in FIG. 7A the limit switches LS6 and LS7 are operated in response to the position of the arms **58.** LS7 is actuated when the slitting knife **56** reaches the core of the web roll and at such time the cylinder **362** is conditioned by a solenoid to exhaust pressur fluid from the head end through conduit **368,** and supply pressure fluid to the rod end by the conduit **366.** This of course rotates the arms in a clockwise direction as viewed in FIG. 7A, at which time such movement is arrested by the actuation of limit switch LS6. To guard against operation of the machine when a web strip has been exhausted the limit switch LS8 in FIG. 7B is actuated by the arm **104** of the web tension dancer frame **70.** When no web strip engages the wheels **120** and **122** the spring **378** is effective to rotate the frame **70** for actuation of the limit switch LS8 which energizes solenoid SOL **4** in line **33** applying the brake **51** to stop rotation of the web roll **50.**

The circuit elements in lines **29–34** are conditioned for operation when the toggle switches TS1A, TS1B and TS5A, contacts 1M and 1CR are closed energizing relay coil 1CR in line **4.** Depressing the actuator of a switch PB3 in line **29** energizes relay coil 3CR through normally closed limit switch LS7. Contacts 3CR in line **30** then close, holding the relay coil 3CR energized. Upon the energization of the coil 3CR normally open contacts 3CR in line **30** are closed while normally closed contacts 3CR in line **31** are opened. Solenoid SOL **2** in line **30** is energized to admit pressure fluid to the cylinder **362** rotating the web slitting device **54** toward the web roll **50.** Opening contacts 3CR in line **31** deenergizes solenoid SOL **3** allowing fluid from the rod end of the cylinder **362** to be exhausted through the conduit **366.**

When the web slitting device moves toward the roll **50** the limit switch LS6 in line **32** is opened, deenergizing coil 4CR in line **32,** and opening contacts 4CR in line **31.** It should be noted that energization of the relay coil 3CR in line **29** also closes normally open contacts 3CR in line *6b* which must be closed since it is in series with the circuit for energizing the relay coil 1CR. It should also be noted that the toggle switch including poles TS8A and TS8B, in lines **34** and *6b*, respectively, must be closed to complete this circuit.

The drag brake **394,** schematically shown in line **16,** is sequentially energized by limit switch LS5 mounted for actuation by the cam **204** on the shaft **202.** As will be further explained in connection with FIG. **34,** the drag brake is energized increasing the tension on a portion of the web during that point of the cycle determined by the cam **204.** In line **38** normally closed contacts 1CR, operated by the relay coil 1CR in line **4,** are provided for controlling the overexcitation to the Warner clutch brake control shown in line **39.**

To summarize the preconditioning that must occur before automatic operation of the machine is achieved, the following circuit elements must be manually actuated.

1. PB2 in line **13** is depressed, energizing the main motor and closing contacts 1M in lines **6** and **14.**

2. Closing toggle switches TS1A and TS1B and TS5A in line **6.**

3. Closing toggle switch TS2 connecting line **12** to **11** and closing toggle switches TS8A and TS8B in lines **33** and *6b*.

4. Closing toggle switch TS9 in line *6b* and depressing push button PB3 in line **29.**

The main motor is now operating, rotating the shaft **202.** The cams **201, 204, 206** and **208** are now actuating limit switches LS1, LS5, LS3 and LS4 respectively. Concurrently therewith, the dieletric hub which is keyed to the shaft **202** is also rotating passing the copper strip or insert **756** by the switches SW1 and SW2 which, as will be explained, control the clutch and brake **234** for the web feed. Assume the toggle switch TS3 in line **11** is actuated to electrically connect limit switch LS4 to condition the circuit for low speed operation. the limit switch LS2, which remains closed for approximately 355° of rotation of the press shaft **288,** maintains the relay 2CR energized for approximately that period of time during each cycle. When the cam on the press shaft actuates LS2 connecting it to line **7** a pulse is recorded on a counter mounted in line **7.** Immediately thereafter LS2 returns to its normally closed position completing the circuit in line **8.**

When the copper strip **756** electrically connects the brushes in SW1 the clutch brake control in line **39** energizes the clutch in line **40** and deenergizes the brake in line **41** indexing the web a distance determined by

the radial adjustment of the crank pin **221.** At the instant the brushes SW2 are electrically connected by the copper strip **756** the clutch is deenergized and the brake is energized stopping the web.

Immediately thereafter the limit switch LS4 is closed by the cam **208** energizing the relay 2CR in line **8** since the contacts 1CR in line **12** and the toggle switches TS2 and TS3 are closed. Energization of the relay coil 2CR closes contacts 2CR in line **8** and closes the relay contacts connecting line **24** with line **25** while disconnecting the contacts between line **25** and line **26.** Closing the contacts 2CR connecting lines **24** and **25** operates the press clutch while opening the contacts between lines **27** and **26** releasings the brake causing the press to actuate for one cycle and the rule die to form the transverse score and cut lines in the web. the cycle of the press is terminated by the opening of limit switches LS4 by the can **208,** and LS2 by the cam **441** mounted on the reducer shaft **288.** The limit switch LS2 makes contact with line **7** pulsing the counter and deenergizing the relay coil 2CR. Accordingly, in response to the rotation of the shaft **202,** web indexing is initiated and terminated and upon termination of web movement the limit switch LS4 energizes the relay 2CR opening and closing its contacts for operation of the press **138.**

The apparatus will continue to operate in the above described manner until the web slitting device actuates limit switch LS7 in line **29** deenergizing relay coil 3CR which opens the holding contacts 3CR in line **29.** Normally open contacts 3CR in line **30** open and normally closed contact 3CR in line **31** close. Normally open contacts in line **6*b*** open. Since contacts 3CR in line **6*b*** are in series with relay coil, the coil in line **4** 1CR is deenergized which in turn opens contacts 1CR in line **12** thereby electrically disconnecting the limit switch LS4 from the circuit. Accordingly when the web strip is exhausted the machine is rendered inactive.

When one web strip is exhausted the limit switch LS8 in line **33** is closed energizing solenoid SOL **4** which applies the disc brake **51** (FIG. **1**) holding the core shaft **48** against rotation. Before the core shaft can be rotated the disc brake must be released and this is done by actuating toggle switch TS8A and TS8B. Upon deenergization of the coil 3CR in line **29** the solenoid SOL **3** in line **31** is energized through the normally closed contacts 4CR and 3CR rotating the web slitting device **54** to the position shown in 7A. The limit of its travel in this direction is determined by limit switch LS6 in line **32** which is actuated deenergizing coil 4CR which opens normally closed contacts 4CR in line **32.** The unwind stand is moved laterally a sufficient distance equal to the width of the web required. Once this adjustment is made cutting of the web roll can commence. Initially a sufficient portion of the strip is cut to thread the web to the draw rolls **140.** At this time the web dancer frame **70** is moved away from the limit switch LS8 causing it to open thus insuring that the disc brake is not applied during normal operation of the machine.

After the web is threaded the toggle switches TS8A and TS8B are closed. PB3 is depressed energizing relay coil 3CR in line **29** through the now closed limit switch LS7. The coil 3CR thus closes contacts 3CR in line **29,** closes contacts 3CR in line **30,** opens contacts 3CR in line **31** and closes contacts 3CR in line **6*b*.** Closing contacts 3CR in line **31** energizes the solenoid SOL **2** to effect pressure engagement of the cutting knife **56** with the web roll. The machine again operates in the manner described above.

FIG. **34** is a graphical representation of approximately one cycle of the box blank making apparatus. The curve indicated by the letter V represents the periods of repose and movement of the web. When the web is being indexed it generally describes an increasing velocity cruve V_1 reaching a maximum at V_2 and decelerating to zero along the curve V_3 which is substantially a mirror image of V_1. The zero degree line is that point of the shaft **202** where the crank pin **221** is in the horizontal plane at the point of maximum web draw, since it will be recalled that the draw length of the web is dependent upon the radial distance of the crank pin **221** from the center of the shaft **202.** When the point of maximum draw is achieved the brake of the clutch-brake **234** (FIG. **32B**, line **41**) is energized. 125° of rotation of the shaft **202** causes the cam **201** to close limit switch LS1. Closing LS1 energizes relay coil CR1, in line **4,** closing its normally closed contacts and opening the normally closed contacts 1CR in line **38** of FIG. **32B.** At **180** degrees of rotation of the shaft **202** the index clutch, line **40,** is actuated and simultaneously therewith the index brake is deenergized causing the web to index following the curve portions V_1, V_2 and V_3. At 270° of rotation of the shaft **202** the limit switch LS4 closes energizing relay coil 2CR in line **8.** Press operation is initiated at this point and it is effected by energizing the clutch in line **24 23** and deenergizing the brake in line **28.** It should be noted that the press is actuated while the web is at its maximum velocity indicated by V_2. The web then is decelerating as indicated by the graph segment V_3 and the moment its movement is arrested the rule die **680** engages the web.

The FIG. **34** low speed operation is determined by electrically connecting limit switch LS4 to the circuit by positioning the toggle switch TS3 connecting line **11** with line **12.** Low speed operation is in the range of **72** to **107** cycles per minute.

For high speed operation, which occurs when the toggle switch TS3 in line **11** is actuated to make contact with line **10** and limit switch LS3, the same general procedure is followed with the exception that the cam **206** operating LS3, closes LS3 when the shaft **202** is at its **145** degree position at which time the web is at rest. Thus, before the index brake in line **41** (FIG. **32B**) is deenergized and the clutch in line **40** energized, the press is actuated moving its upper platen downwardly. The press reaches its lowest point of travel where it engages the web at the **360** degreee point which is one complete revolution of the shaft **202.** As indicated in FIG. **34** the cycle rate for high speed operation is approximately 175 strokes per minute.

In FIG. **33** one modification that can be incorporated in the apparatus of the present invention involves the provision of a platen roll **758** underlying a rule die roll **760.** These rolls would be continuously operated and the web strip WS would be passed continuously through the machine. The rule die, generally indicated by the numeral **762,** makes the same cut and score pattern as in the preferred embodiment and the cuts and scores on the web are collectively identified by the numeral **764.** The longitudinal score lines are made in the identical manner by providing score wheels **172*b*** and **174*b*** bearing against a lower platen roll **766.**

By providing a rotary rule die the basic machine can be substantially simplified since the complexities, mechanical and electrical, of intermittently feeding the web are avoided.

The concept of the present invention can be adapted, with minor modifications, to use sheet stock. FIG. **35** shows such a modification and it includes an elevating platform structure **768** supporting a stack of rectangular sheets indicated by the numeral **770.** The uppermost sheet can be fed by hand or by known feeding devices, in the direction of the arrow T, to a plurality of slitting wheels **772** that shear the sheet into four strips. A series of belts **774,** which are continuously driven, transport the strips for reception between support bars **776** and the lower reaches of another series of belts **778.** The belts **778** feed each strip onto a platform **780** comprising longitudinal support bars **782** provided with lugs **784** for constraining the strips to assume a registered pile. The upper edges of the longitudinal support bars **782** are located substantially coplanar with the longitudinal guides **134***b*.

A feeding device **786,** including vacuum cups **788,** is arranged for longitudinal reciprocation and serves to strip the lowermost sheet from the pile and transfer it to a pair of nip rolls **790** (FIG. **36**) feeding the web strip to the longitudinal score wheels **172***c* and **174***c*. The guides **134***b* direct the sheet or strip to the draw rolls **140***b* which are intermittently driven, as in the preferred embodiment, to advance the sheet between the platens of the press **138.** The strip, provided with the longitudinal score lines and the transverse cut and score lines then encounters the corner knockout mechanism **142** separating the interconnected box blanks in the same manner as described in the preferred embodiment. Control devices may be provided to detect the leading or trailing portion of the strip to insure that the maximum number of blanks are made from each strip.

FIG. **36** is a diagrammatic representation illustrating the operative sequence of the apparatus shown in FIG. **35.** A rectangular sheet **770** is shown in the process of being slit by the slitting wheels **772** to produce a plurality of strips S. The strips are then fed by the belts **774** to assume a registered pile S-1 which is in longitudinal alignment with the guides **134***b*. Successively, the bottom strips of the pile S-1 are fed to the draw rolls **790** which feed the web strip past the longitudinal scoring wheels **172***c* and **174***c*. It should be noted that the feed rolls **790** are intermittently operated simultaneously with the draw rolls **140***b* in order to retain the strips in a single file without causing overlap or too much separation between the leading and trailing edges of adjacent strips. When the web strip is at rest the steel rule die **176***b* is actuated producing the transverse score and cut lines. At the appropriate time the plungers **182***b* are operated to remove the corner pieces C thereby producing individual box blanks.

Another form of the apparatus incorporating the principles of the present invention is shown in FIG. **37.** The apparatus comprises a magazine **792** carrying a registered stack of rectangular sheets **794** which are fed sequentially and intermittently between a shearing blade **798,** arranged for vertical reciprocation, and a stationary cutter bar (not shown). When the shearing blade **798** is actuated downwardly a portion of the sheet is cut defining a strip of material which is fed by rollers **800** between a plurality of support bars **802.** The upper surface of the sheet is firmly engaged by vacuum cups **804,** which are mounted for longitudinal reciprocation, serving to feed the leading edge of the strip between pinch rolls **806** directing the strip to longitudinal score wheels **172***d* and **174***d*. Longitudinal guides **134***c* direct the sheet to draw rolls **140***c* operated to intermittently feed the web strip to the rule dies carried by the press **138.** As in the case of the embodiment of FIG. **35,** the corner knockout mechanism **142** removes the corner pieces and separates the individual strips into box blanks.

In view of the above detailed description of the preferred embodiment it is apparent that by using roll stock associated with a slitting device, operable to progressively produce a web strip of desired width, the percentage of usable web material is substantially increased as the only waste occurs at either end of the roll which is usually damaged by handling and storage. As opposed to the usual slitting machinery, which requires slitting and rewinding of an entire roll, the present invention gives the option of removing any portion of the web roll desired without unwinding the remaining portion of the web roll. Ordinarily converters will not supply slit and rewound portions of a web roll below a minimum size. In addition the cost to the user of sheet stock is greater since the purchase price includes cutting the mill roll size web roll into sheets which must be strapped and mounted on a skid for transportation.

Roll stock also provides the user with the ability to progressively slit web material for wrapping the rigid box. The machine of the present invention can be supplied with a rule die having the rules arranged in a pattern to cut individual wraps from the strip of web material.

The web slitting and pattern cutting arrangement of the present invention provides manufacturers of gaskets, corrugated boxes, plastic products and other materials, where scoring, cutting and embossing operations are required, individually or in combination, with the ability to use roll stock.

The concept of the present invention also results in producing blanks for rigid boxes wherein the score lines transverse to the web grain are deeper or of greater depth which facilitates erection of the box on the quad ayer as substantially the same amount of force is necessary in bending or breaking the side walls of the box. Such a result is achieved in part by initially providing the web strip with the longitudinal score lines and which is thereafter transversely scored and cut. Segregating the scoring functions makes it possible for the press to be of lighter construction since the forces involved are substantially reduced. In addition, since the press is driven by a drive train including a heavy fly wheel (**190**) which imparts its stored energy to a reducer (**282**) for impulsing the upper platen this, permits the press to operate much like a punch press. Such a dynamic condition is preferable to the slow action, high-pressure design of presses making box blanks by the die cutting method, because the scoring and cutting is achieved more rapidly and with a less massive structure.

Another significant advantage of the present invention is that by floating the lower die plate, parallelism between the platens is assured, resulting in transverse score cuts of uniform depth. Floating the lower plate

also reduces to an absolute minimum the thickness of the make-ready.

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.

We claim:

1. An apparatus for making box blanks from elongate strips of web material, comprising means for slitting a sheet of the material into a plurality of strips; means for transporting said strips into a registered pile; means for successively feeding each strip from said pile; means for partially cutting the strip along lines spaced equally inwardly from the edges of the strip to define longitudinal score lines; means for making a pair of longitudinally spaced transverse score lines extending from one longitudinal score line to the other, means for transversely severing the strip along a line equally spaced from said transverse score lines and for partially severing a portion from each edge of the strip bounded by the transverse and longitudinal score lines to thereby define the corner pieces, said partial severing providing rupturable uncut portions which retain the adjacent box blanks connected, and means for rupturing said uncut portions to separate the completed blanks from the strip.

2. Apparatus for making box blanks comprising means rotatably supporting a mill roll of web material, cutting means engaged with said roll for progressively severing a strip of web material as wide as one dimension of a finished box blank from said roll in response to rotation thereof, means for advancing said web endwise, means for longitudinally scoring the web during said endwise movement, and repetitively operative means for simultaneously effecting the remaining scoring, severing and tear line perforating operations necessary to outline the remaining sections of the box blank, successive box blanks longitudinally of said web strip having a common tear line so that the web provides a continuous series of interconnected box blanks.

3. An apparatus for making box blanks from an elongate strip of web material comprising means for feeding the strip; means for partially cutting through the strip along lines spaced equally inwardly from the edges of the strip to define longitudinal score lines; die means comprising scoring means for making longitudinally spaced, transverse score lines extending from one longitudinal score line to the other; said die means also including cutting means, effective substantially simultaneously with said transverse scoring means, for completely cutting the strip along an intermediate transverse line equidistant from the transverse score lines and extending from one longitudinal score line to the other, said die means further including cutting means for forming removable side corner portions by making cuts aligned with said transverse score lines and having a width defined by the edges of the strip and the longitudinal score lines and by making cuts coincident with said longitudinal score lines and having a length equal to the distance between said transverse score lines; said cutting means having means for leaving readily rupturable tabs between the corner portions and the strip to prevent separation of the strip at the cut lines, and means located adjacent said transverse scoring and cutting means for rupturing said tabs to simultaneously remove said side corner portions and separate the completed box blanks.

4. The apparatus of claim 3, comprising means for trimming off the side edges of said elongate web before forming said longitudinal score lines.

5. The apparatus according to claim 3, wherein said means for making said longitudinal score lines comprises score wheels, means mounting said wheels on a support extending across an upper portion of the apparatus, said score wheel mounting means being laterally adjustable along said support to locate said score wheels at any desired point inwardly relative to the edges of the strip, rotatable anvil rolls associated with each score wheel, said anvil rolls being mounted on a shaft for location below said score wheels, and means for adjusting said shaft relative to said score wheels to locate the anvil rolls a desired distance from the periphery of said score wheels to thereby determine the depth of the longitudinal score lines.

6. The apparatus according to claim 5, wherein said adjusting means comprises eccentric bushings supporting said anvil roll shaft.

7. An apparatus for making box blanks from a strip of web material which has been provided with longitudinal score lines spaced from and parallel with the edges of the web strip, said apparatus comprising a die, engageable at predetermined longitudinally equally spaced portions of the strip, for transversely cutting the strip between the longitudinal score lines and transversely scoring the strip on opposite sides of the transverse cut, said die including means for simultaneously cutting the blank between the longitudinal score lines and the edges of the blank in alignment with the transverse score lines, said die also including means for cutting the blank along the longitudinal score lines between the transverse score lines to provide corner pieces for the leading and trailing box blanks, the cutting means of said die being formed to leave the corner pieces weakly attached to the strip, and means for simultaneously detaching the corner pieces from the strip downstream of said die.

8. The apparatus according to claim 7, wherein certain cutting edges of said die are interrupted to provide the weakly attached, easily rupturable corner pieces to thereby retain the box blanks defined by said die connected.

9. The apparatus according to claim 3, wherein said means for making said longitudinal score lines comprises score wheels, means mounting said wheels on a support extending across an upper portion of the apparatus, said score wheel mounting means being laterally adjustable along said support to locate said score wheels at any desired point inwardly relative to the edges of the strip, rotatable anvil rolls associated with each score wheel, means for mounting said anvil rolls below said score wheels, and means for adjusting said anvil roll mounting means relative to said score wheels to locate the anvil rolls a desired distance from the periphery of said score wheels to thereby determine the depth of the longitudinal score lines.

10. An apparatus for making blanks from an elongate strip of web material comprising means for feeding the strip; die means including cutting means for completely cutting the strip along a transverse line that stops short of and is equidistant from the longitudinal edges of the strip, said die means also including cutting means for simultaneously forming removable side corner por-

tions; said corner portion cutting means including cutting means for making longitudinally spaced, lateral cuts extending in from both edges of the strip for a distance that at least equals the distance by which said simultaneous transverse cut stops short of the edges of the strip, said corner portion die means further including cutting means for simultaneously making longitudinal cuts substantially parallel to each strip edge, each longitudinal cut extending at least between the inner ends of the associated lateral cuts and intersecting said transverse cut to form said removable side corner portions.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,844,201
DATED : October 29, 1974
INVENTOR(S) : RALPH H. EGGERT

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

Col. 9, line 62, before "roll" change "Th" to -- The --.
Col. 16, line 65, change "dividion" to -- division --.
Col. 18, line 7, change "engagement" to -- arrangement --.
Col. 19, line 66, change "raisl" to -- rails --.
Col. 24, line 49, change "vurtue" to -- virtue --.
Col. 26, line 4, change "574" to -- 754 --.
Col. 29, line 51, change "32" to -- 31 --.
Col. 30, line 9, change "cruve" to -- curve --.
Col. 30, line 31, delete "24".

Signed and Sealed this

twentieth Day of *January 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks