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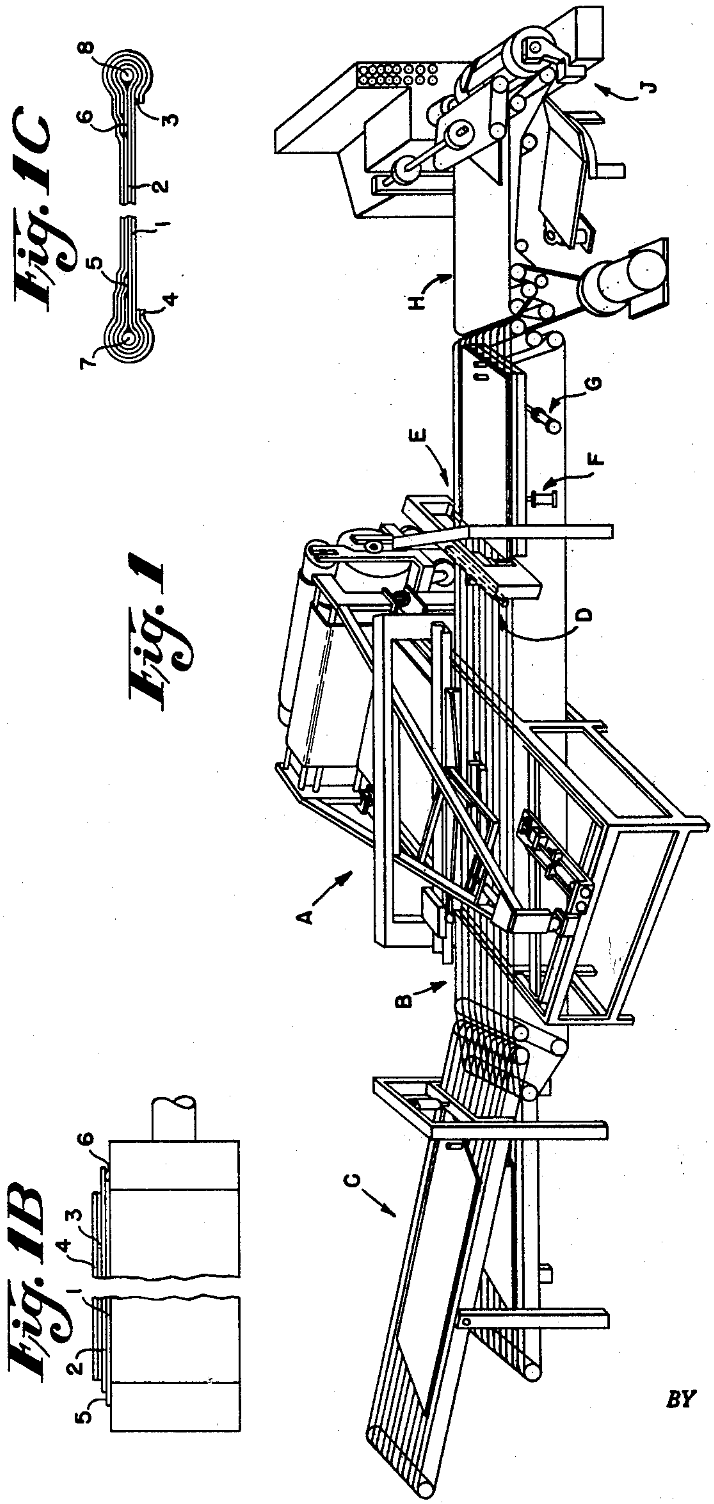

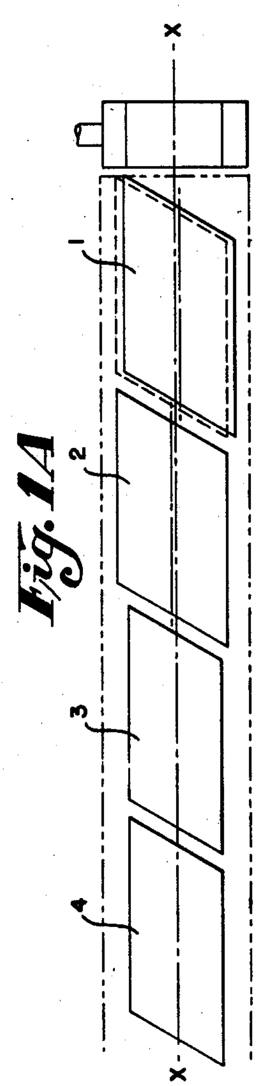

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TIRE BUILDING APPARATUS

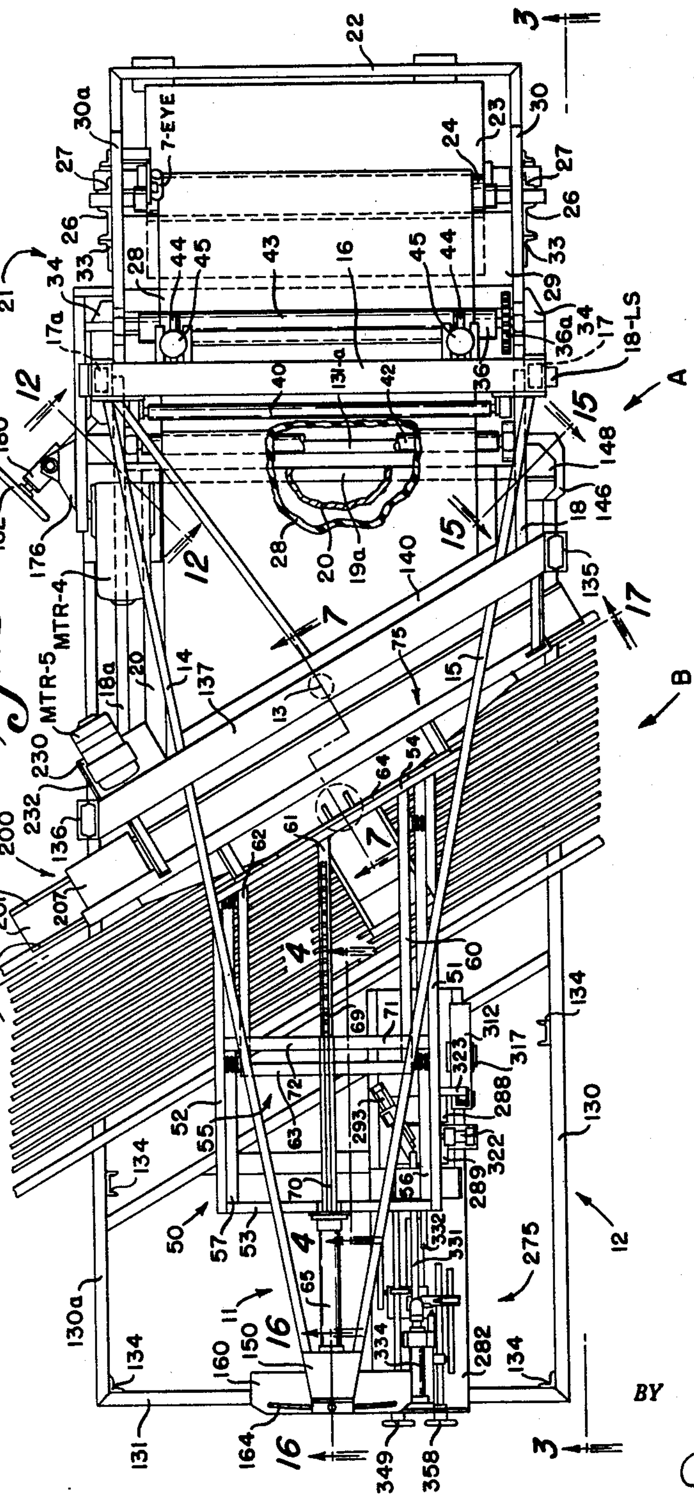

Fig. 2

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Fig. 3

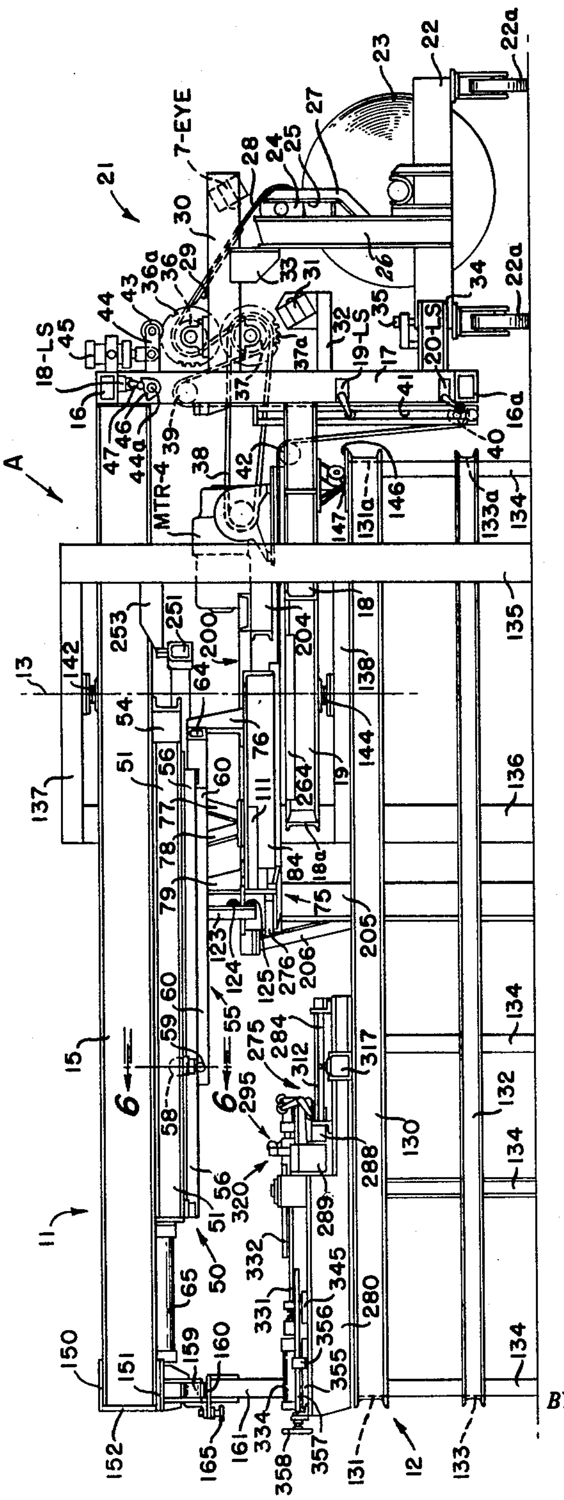

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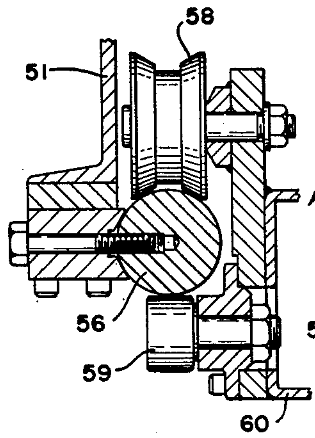
Fig. 6



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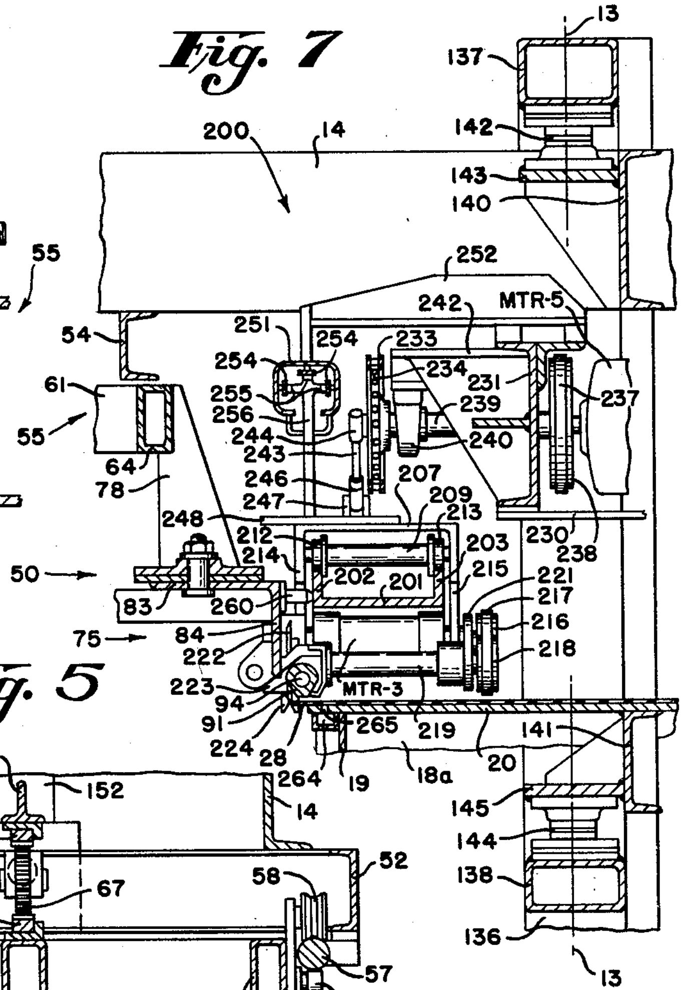

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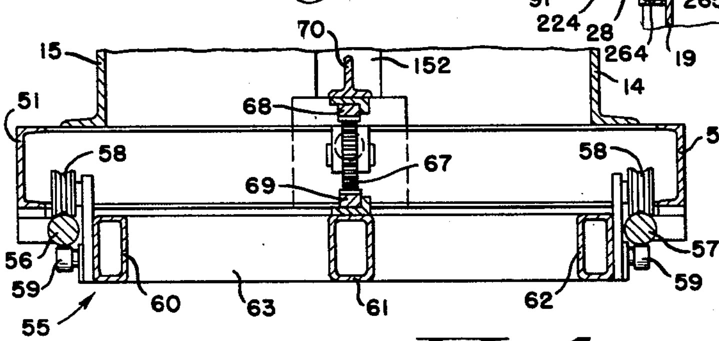

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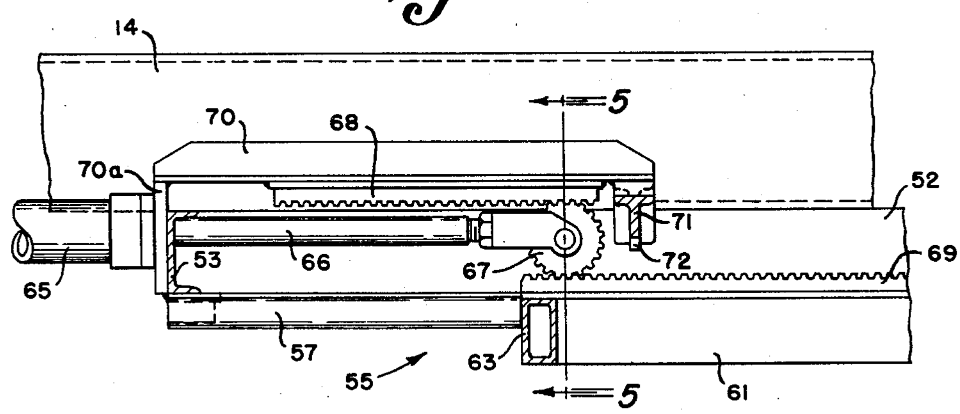

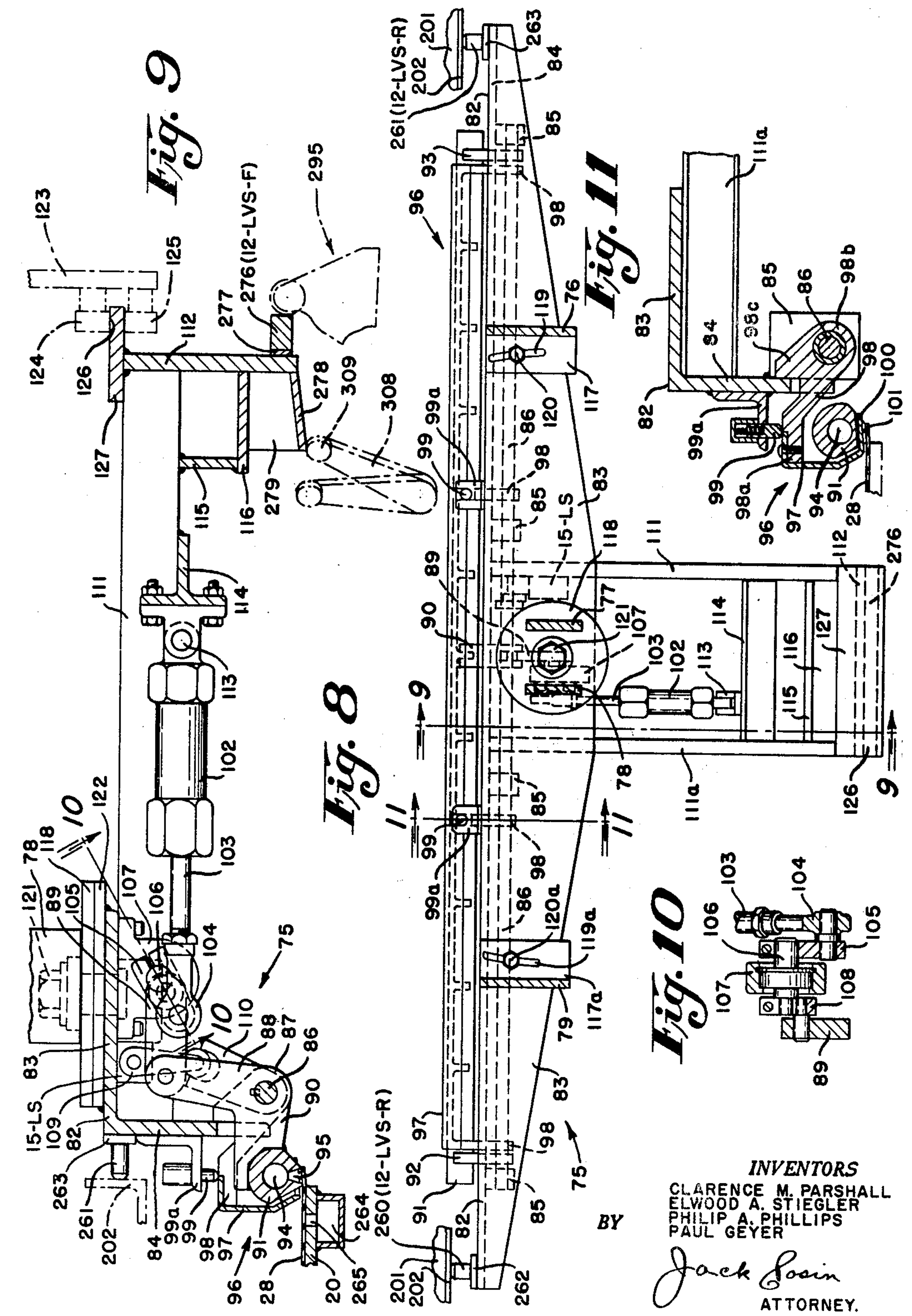

Fig. 8

Fig. 9

Fig. 10

Fig. 11

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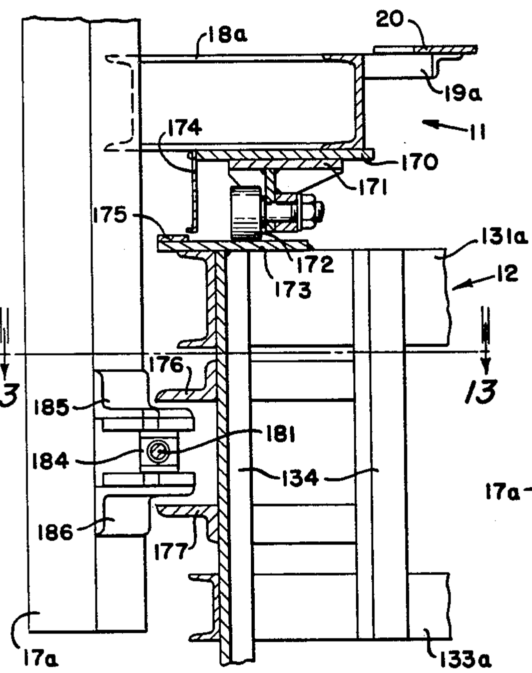
Fig. 12



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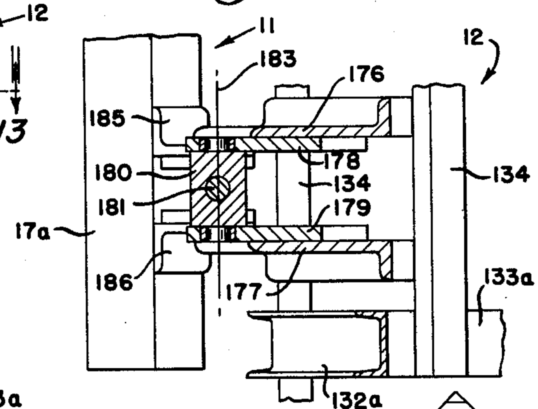

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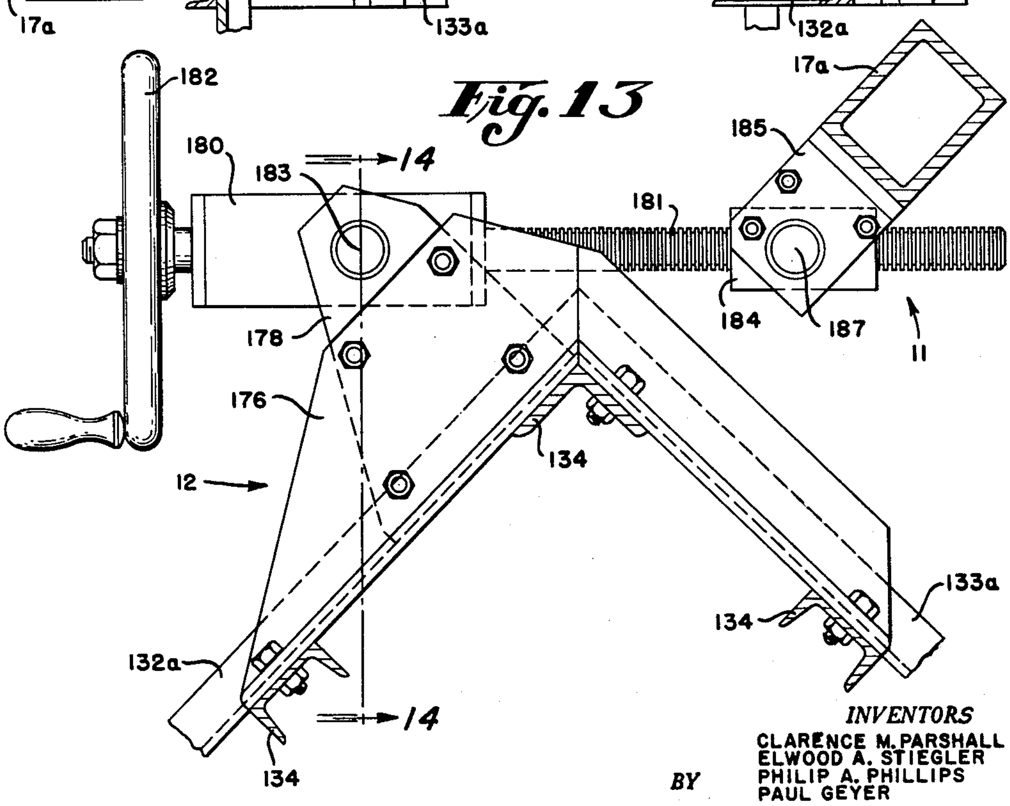

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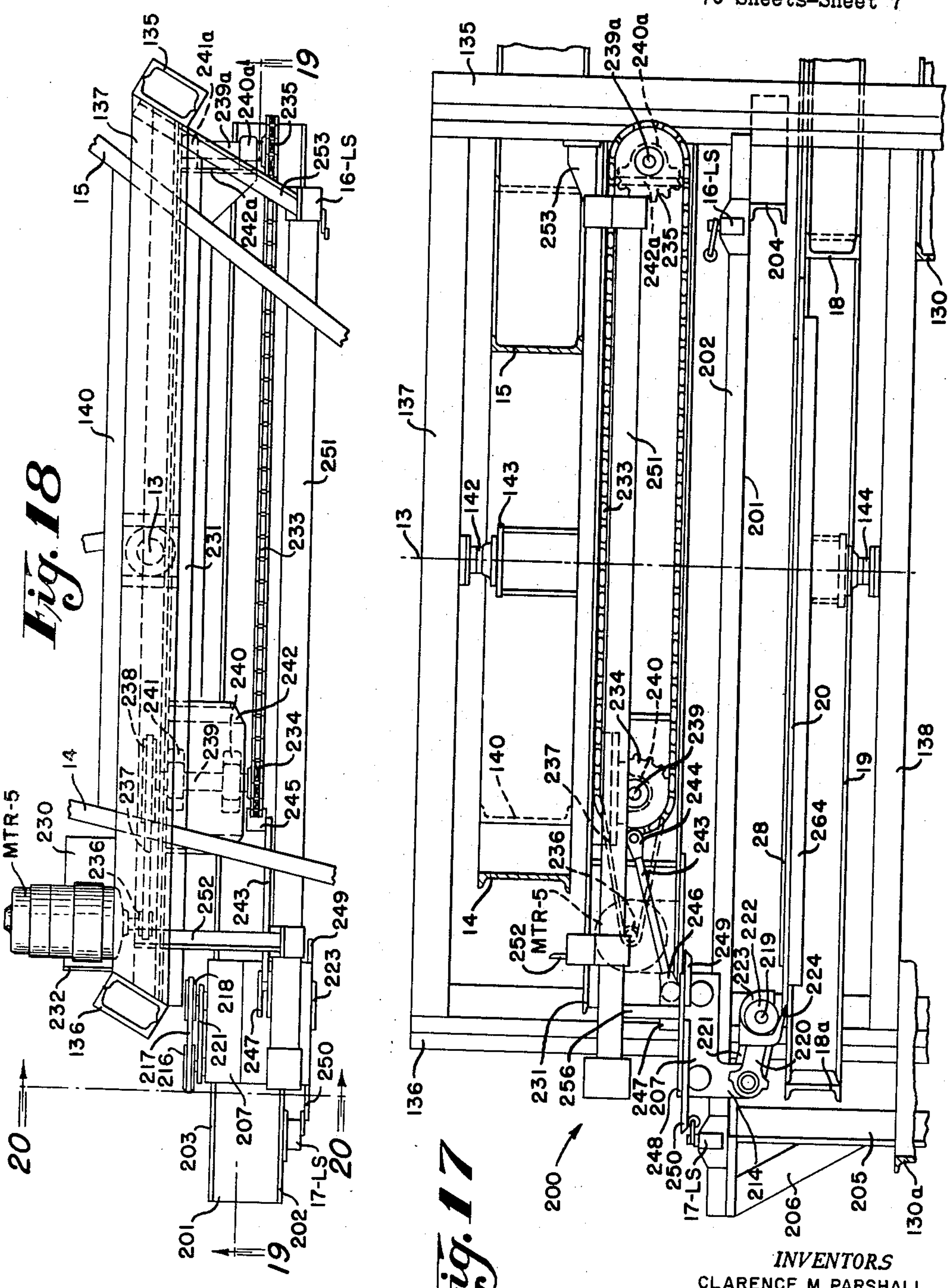

Fig. 18

Fig. 17

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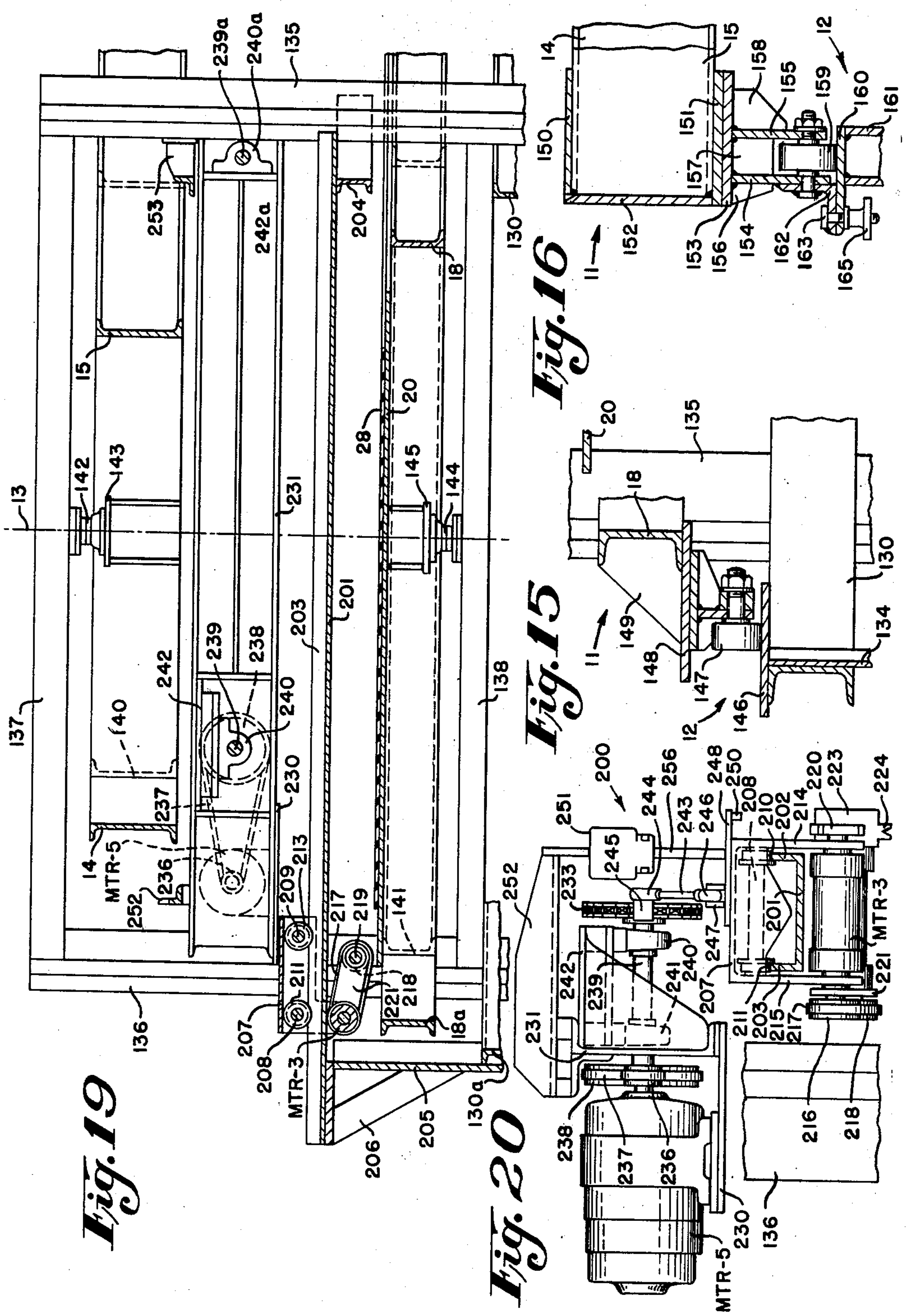

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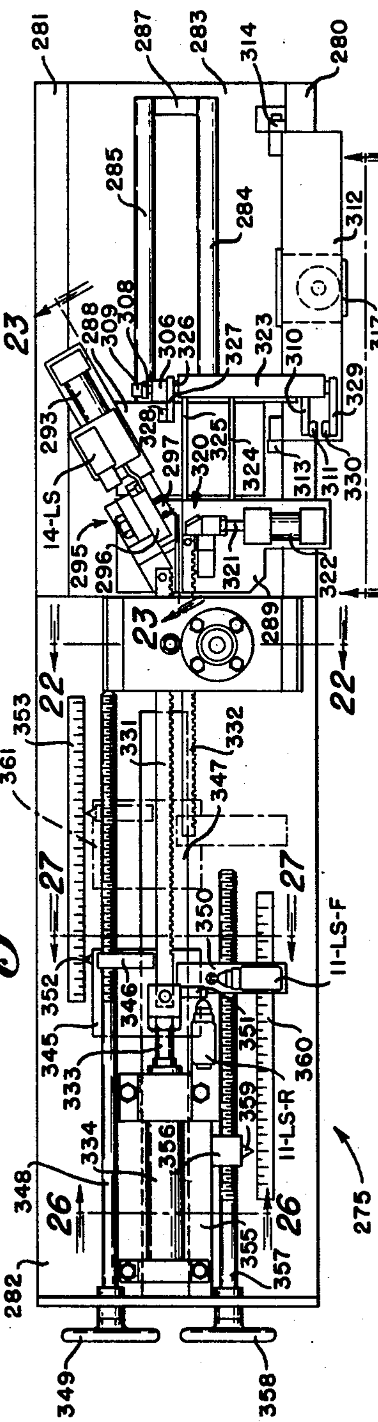

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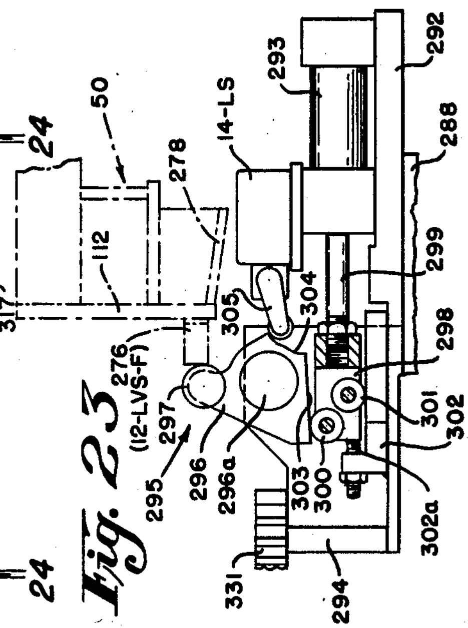

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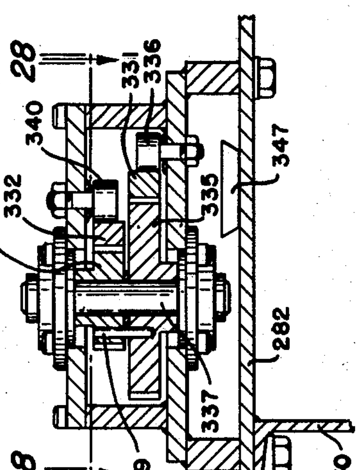

Fig. 22

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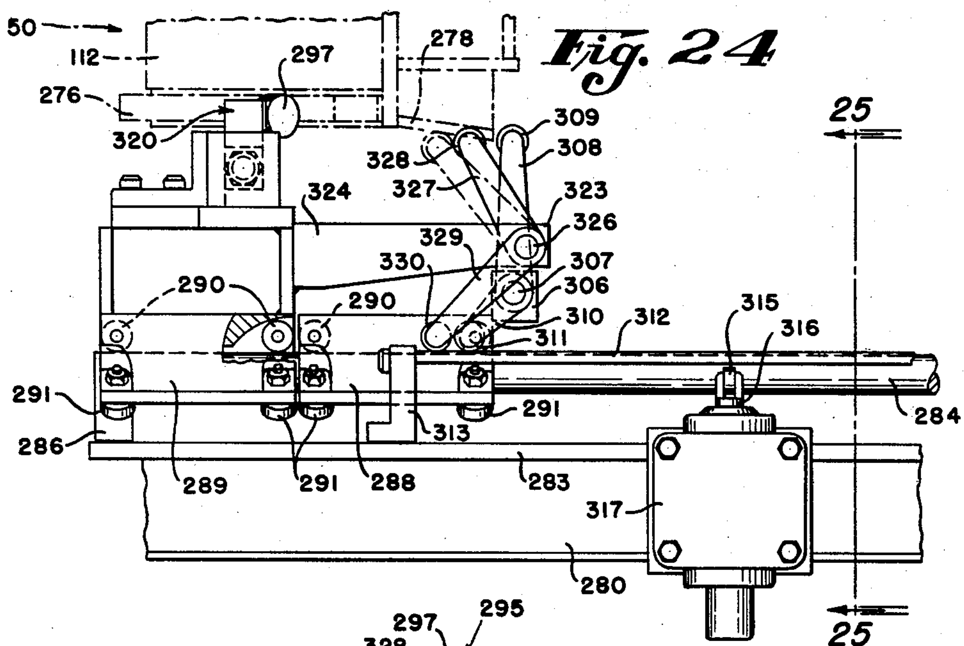
Fig. 24



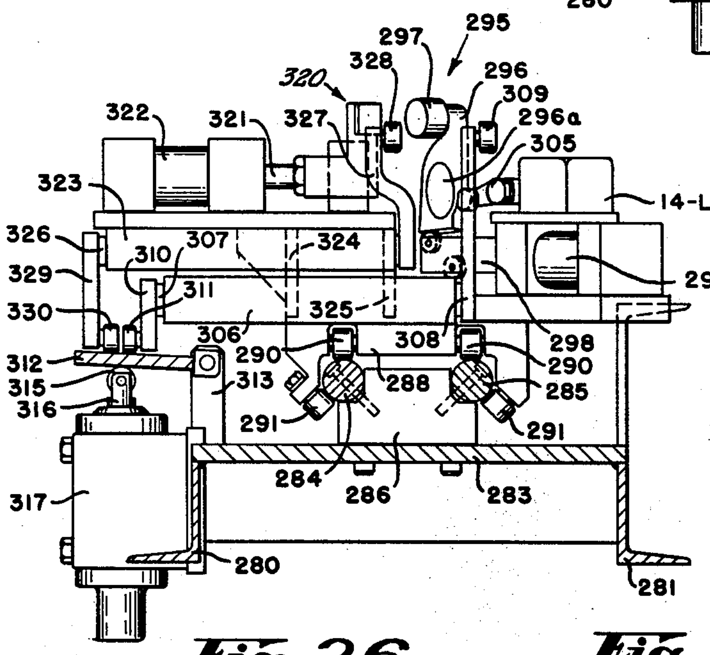
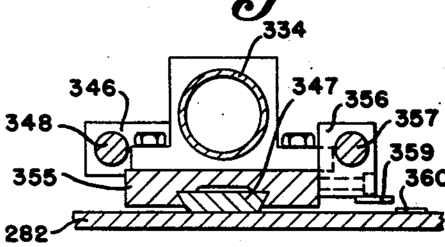


Fig. 25

Fig. 26



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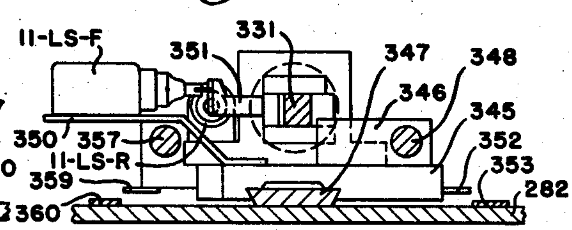

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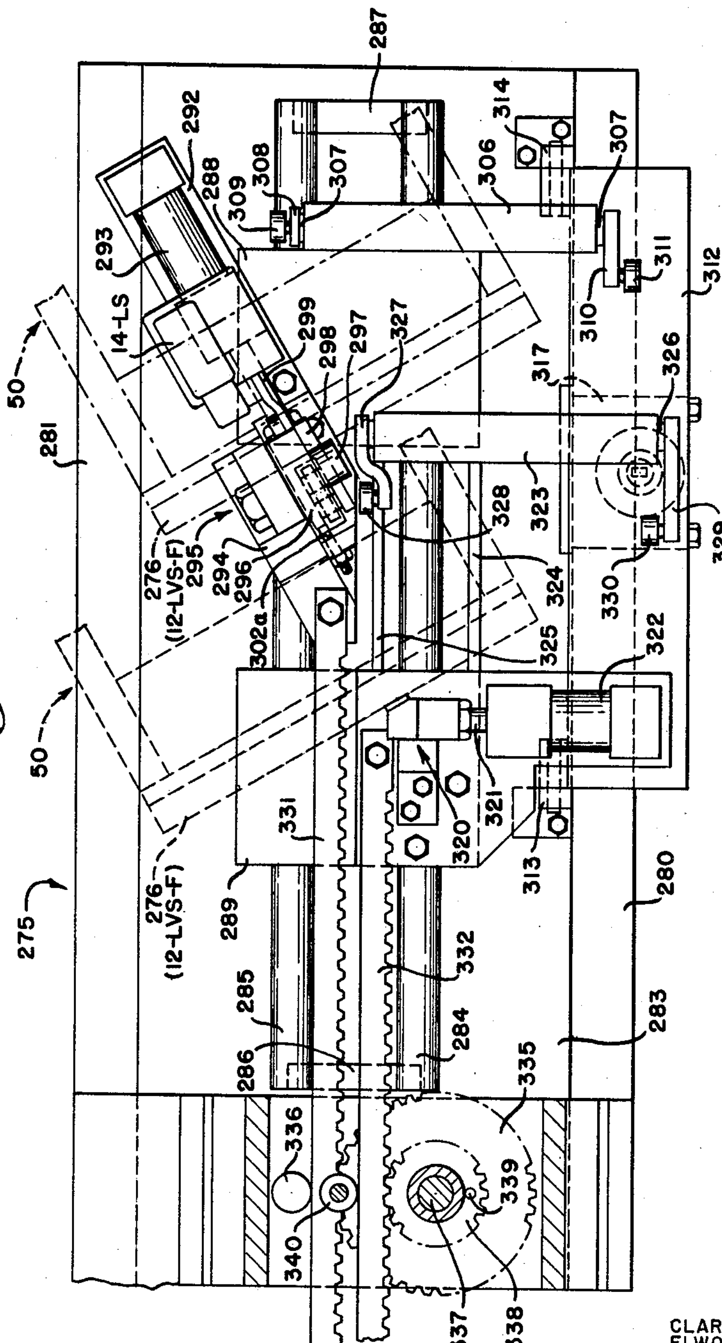
Fig. 28



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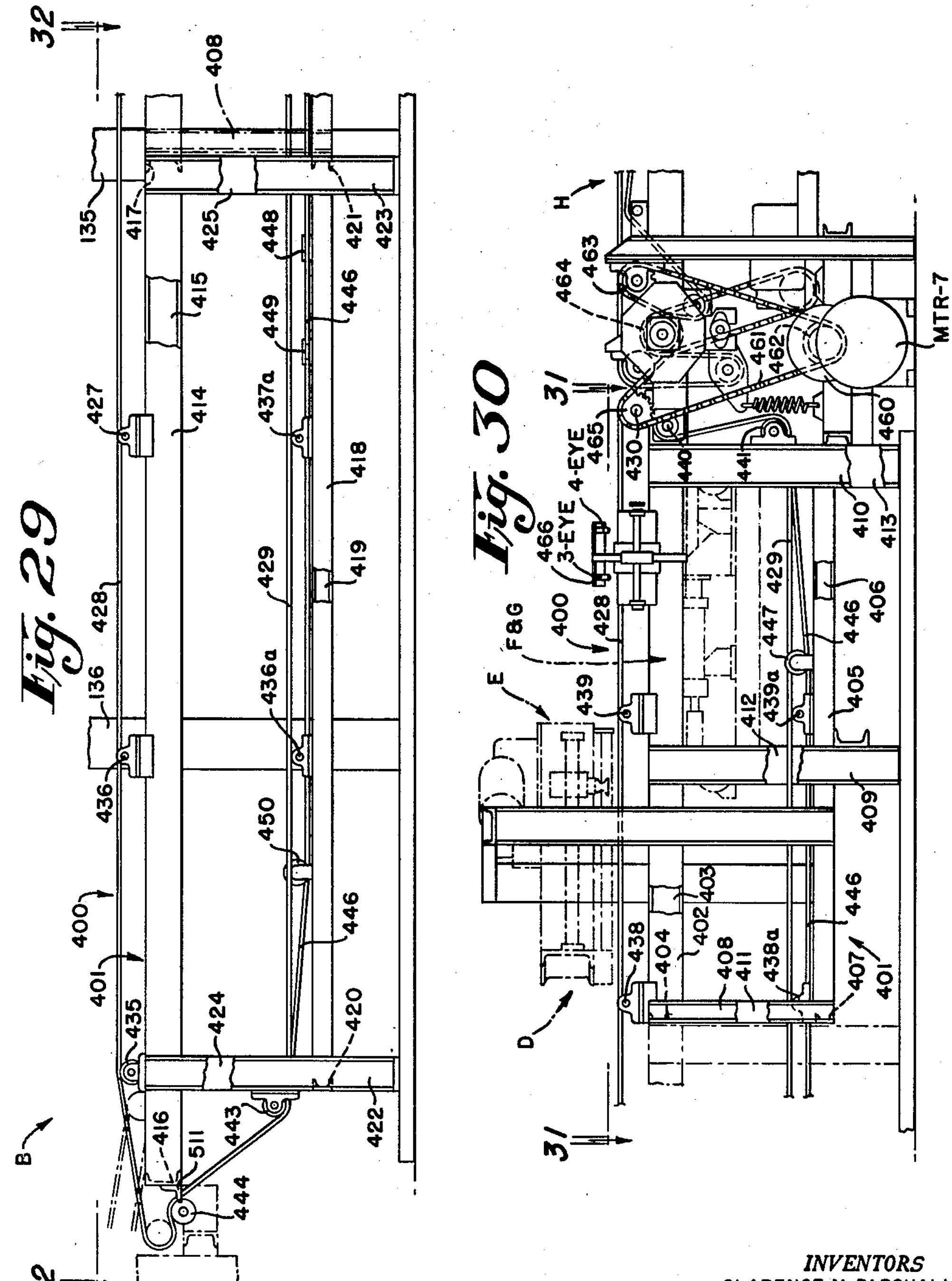

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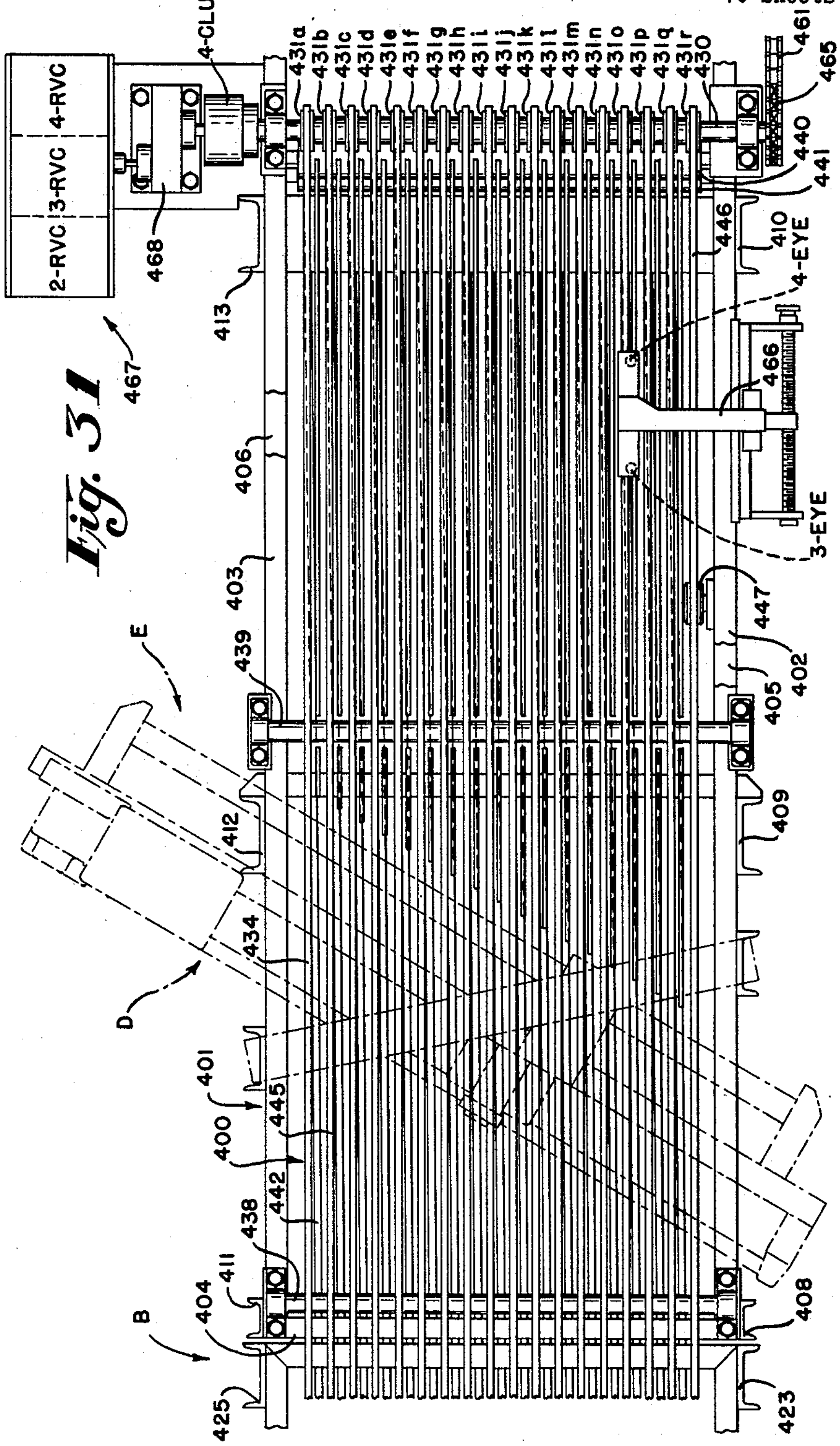

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Fig. 31

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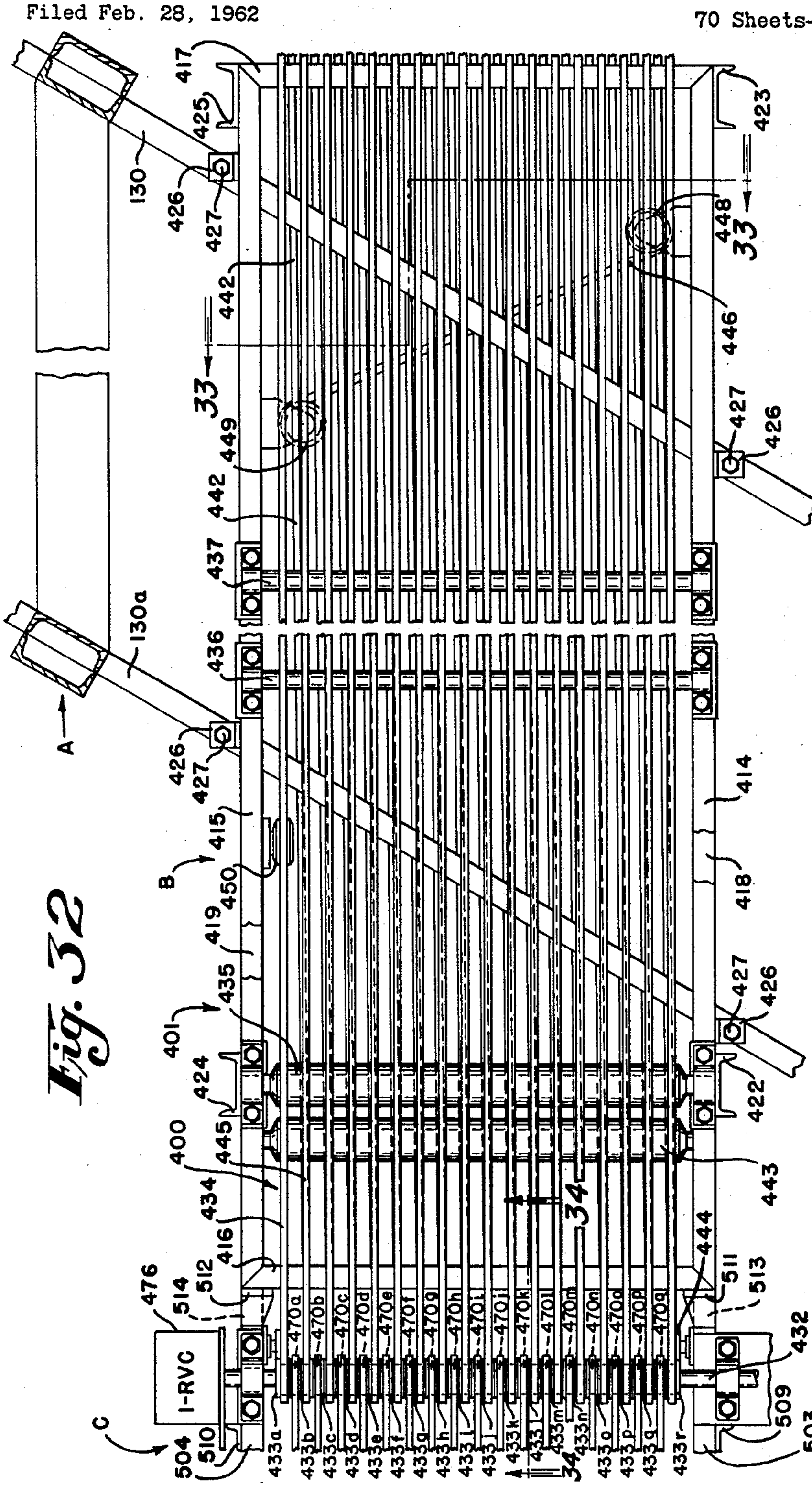

Fig. 32

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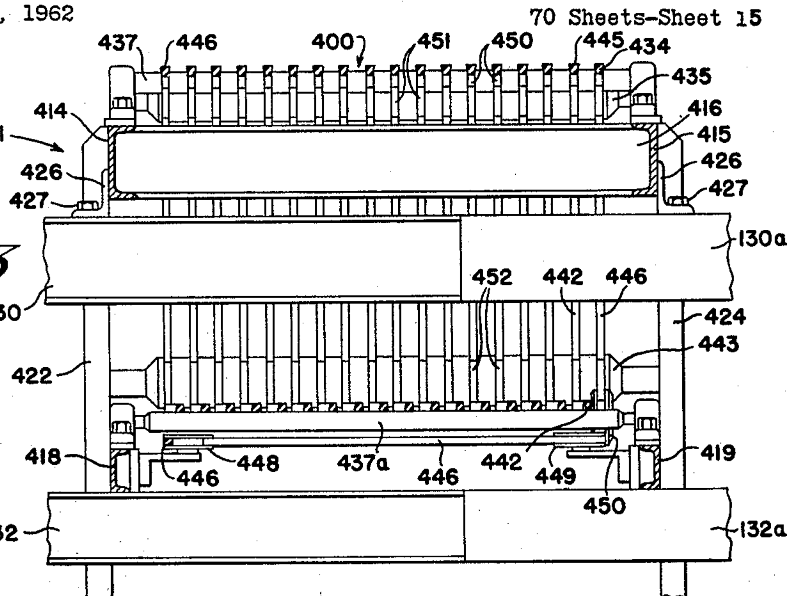

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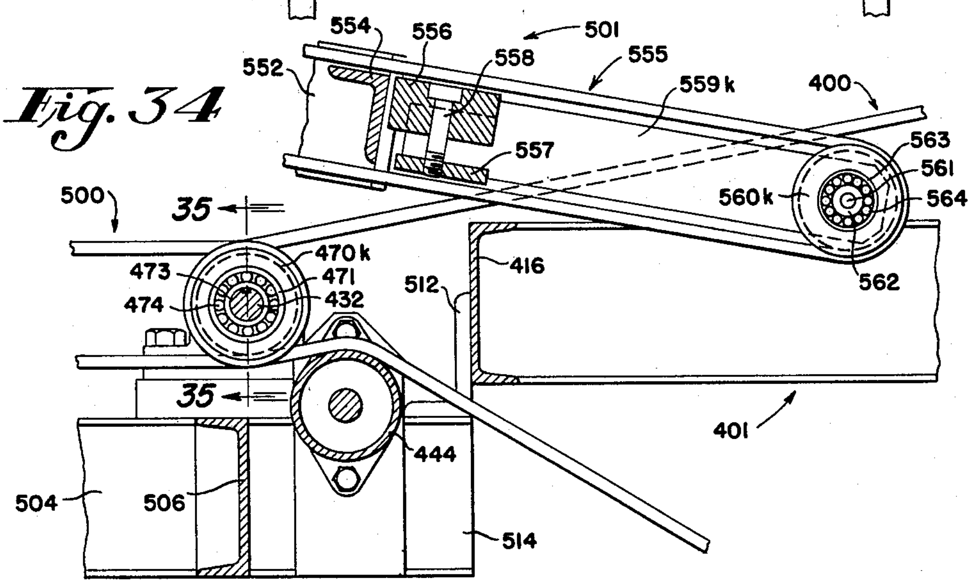

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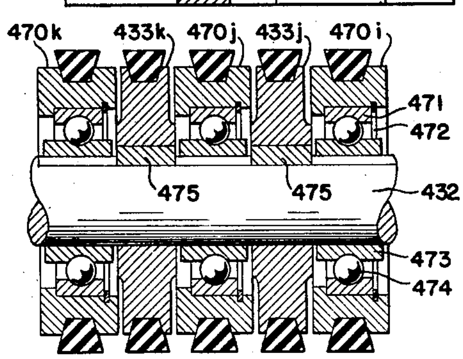

Fig. 35

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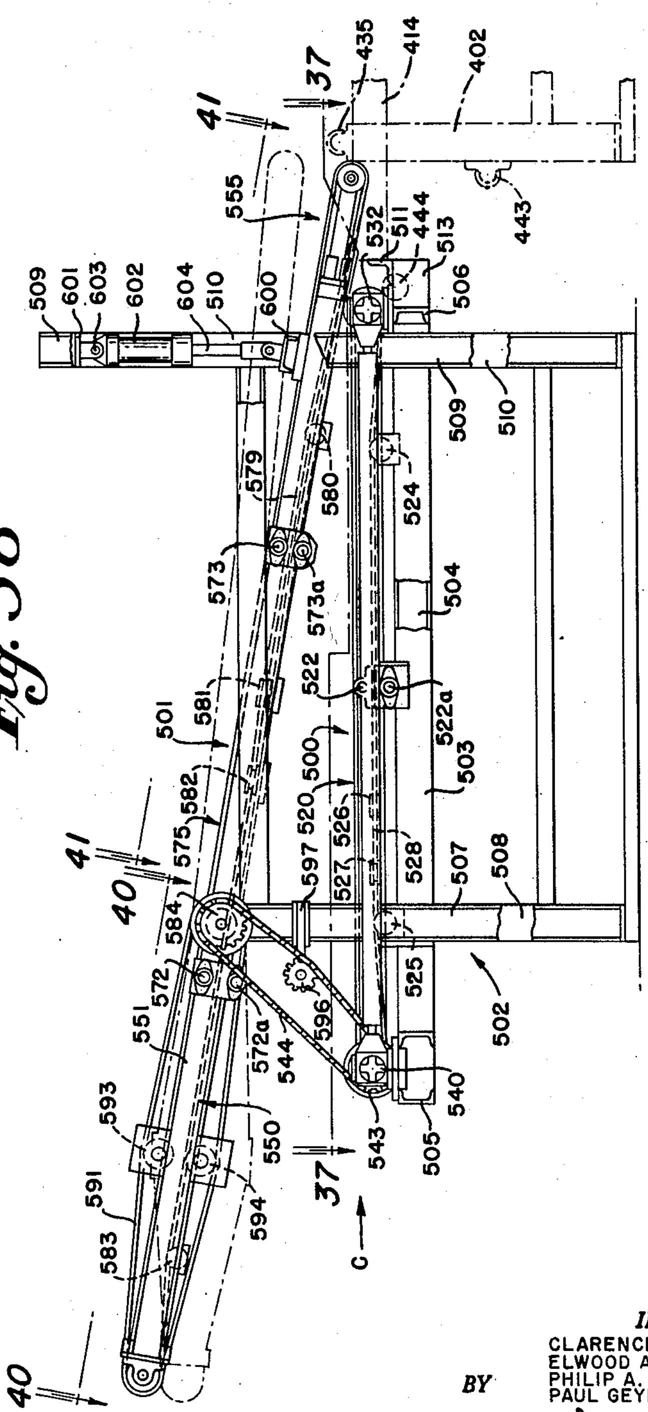
Fig. 36



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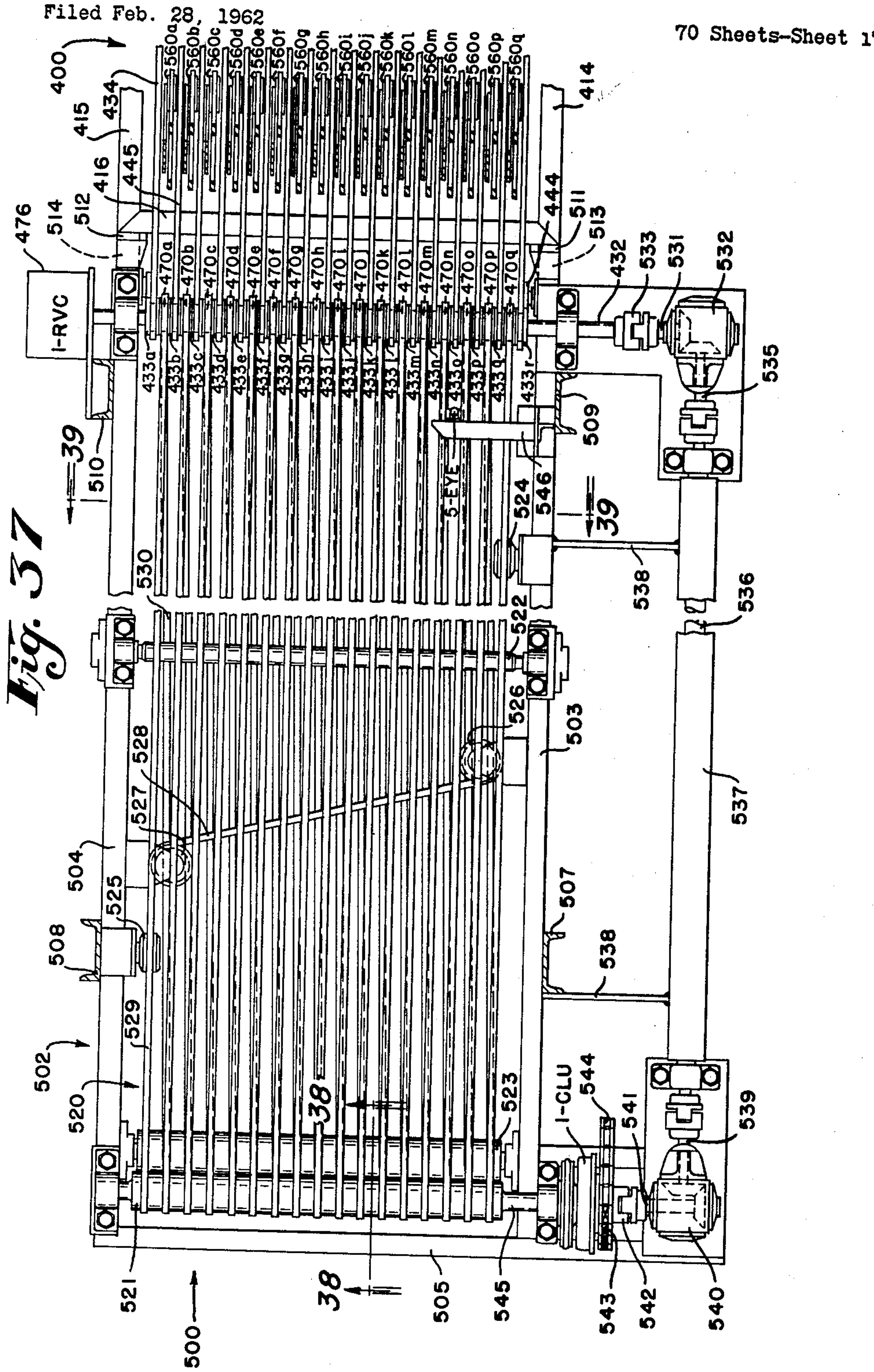

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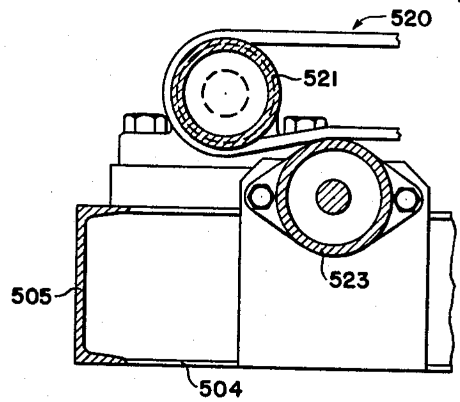
Fig. 38



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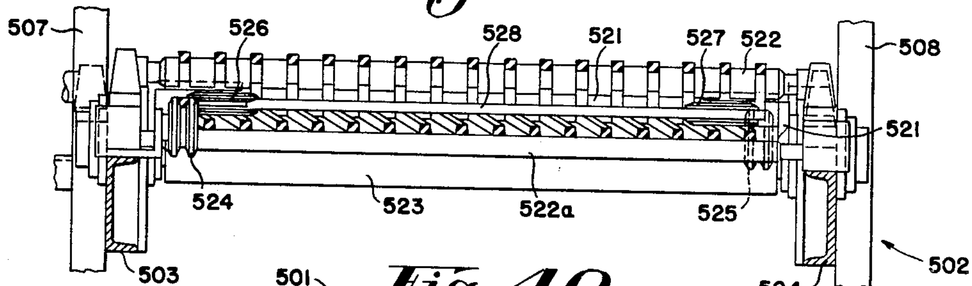

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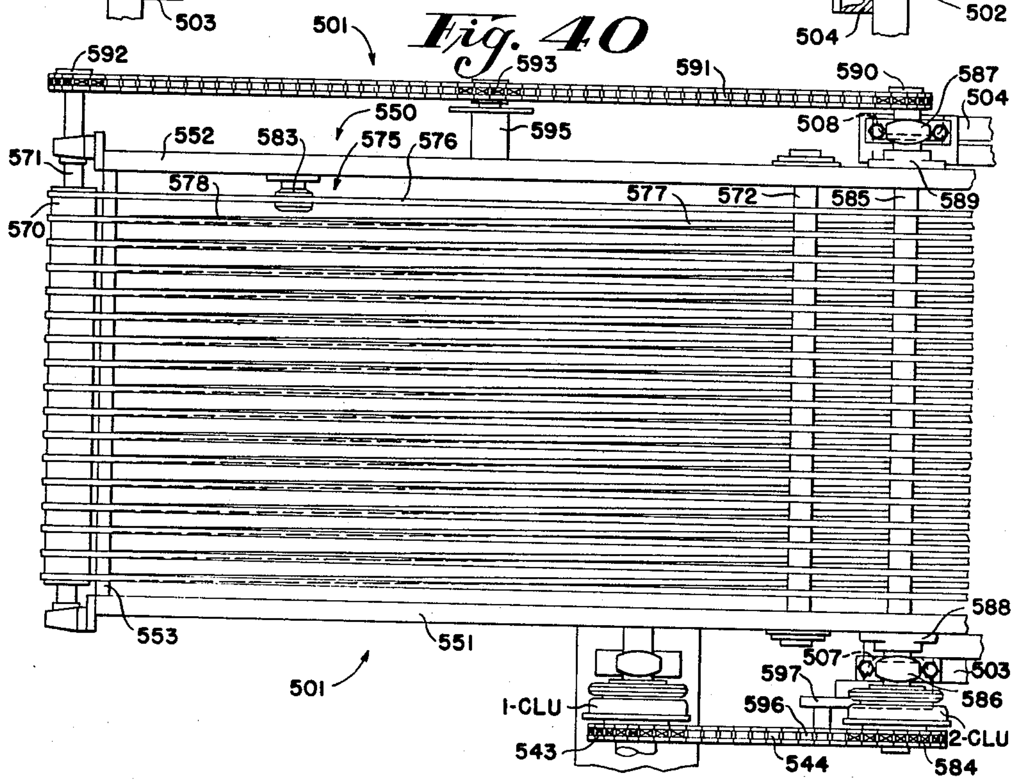

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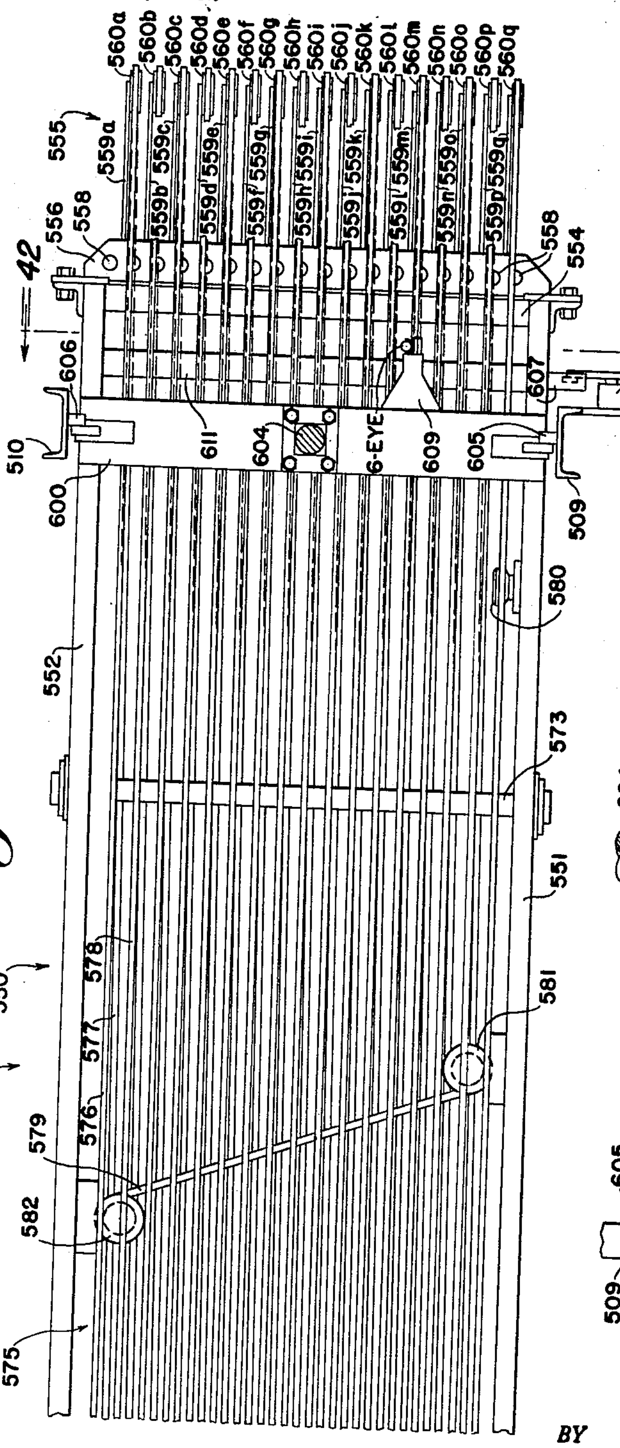

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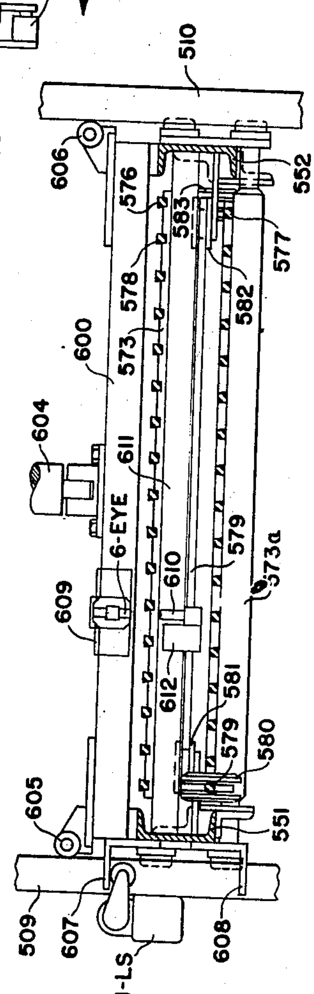

Fig. 42

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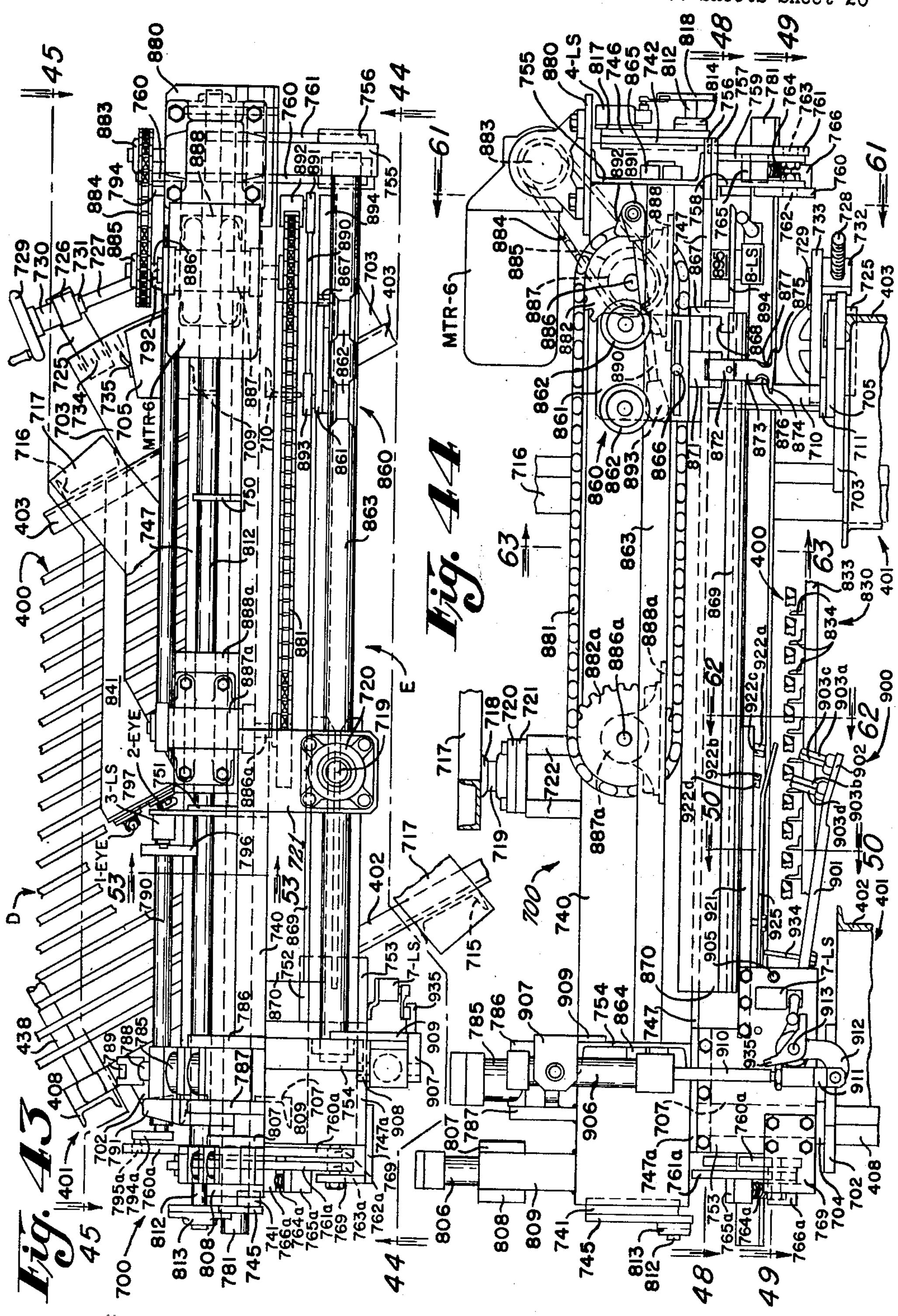

Fig. 43

Fig. 44

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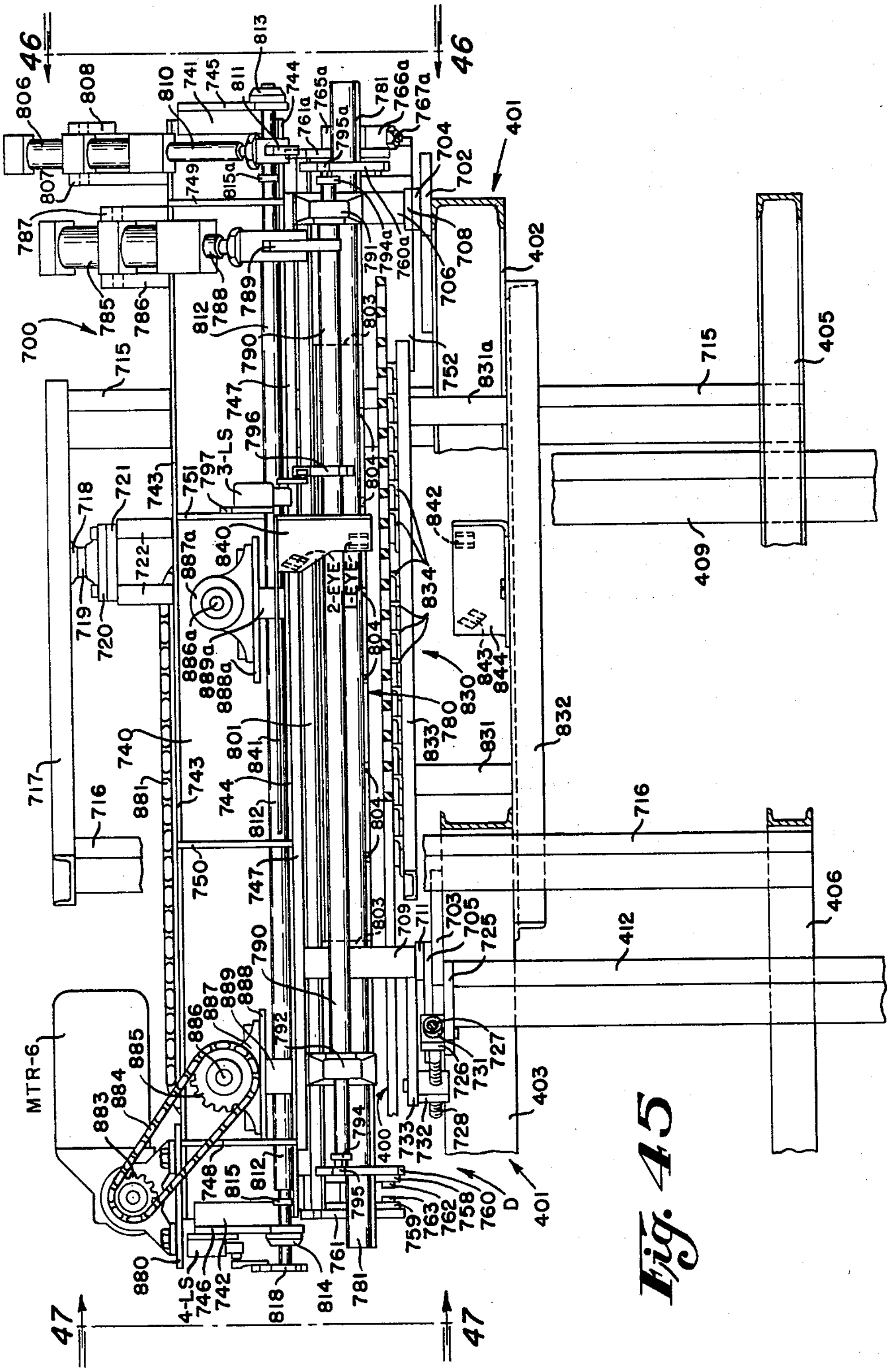

Fig. 45

Fig. 46

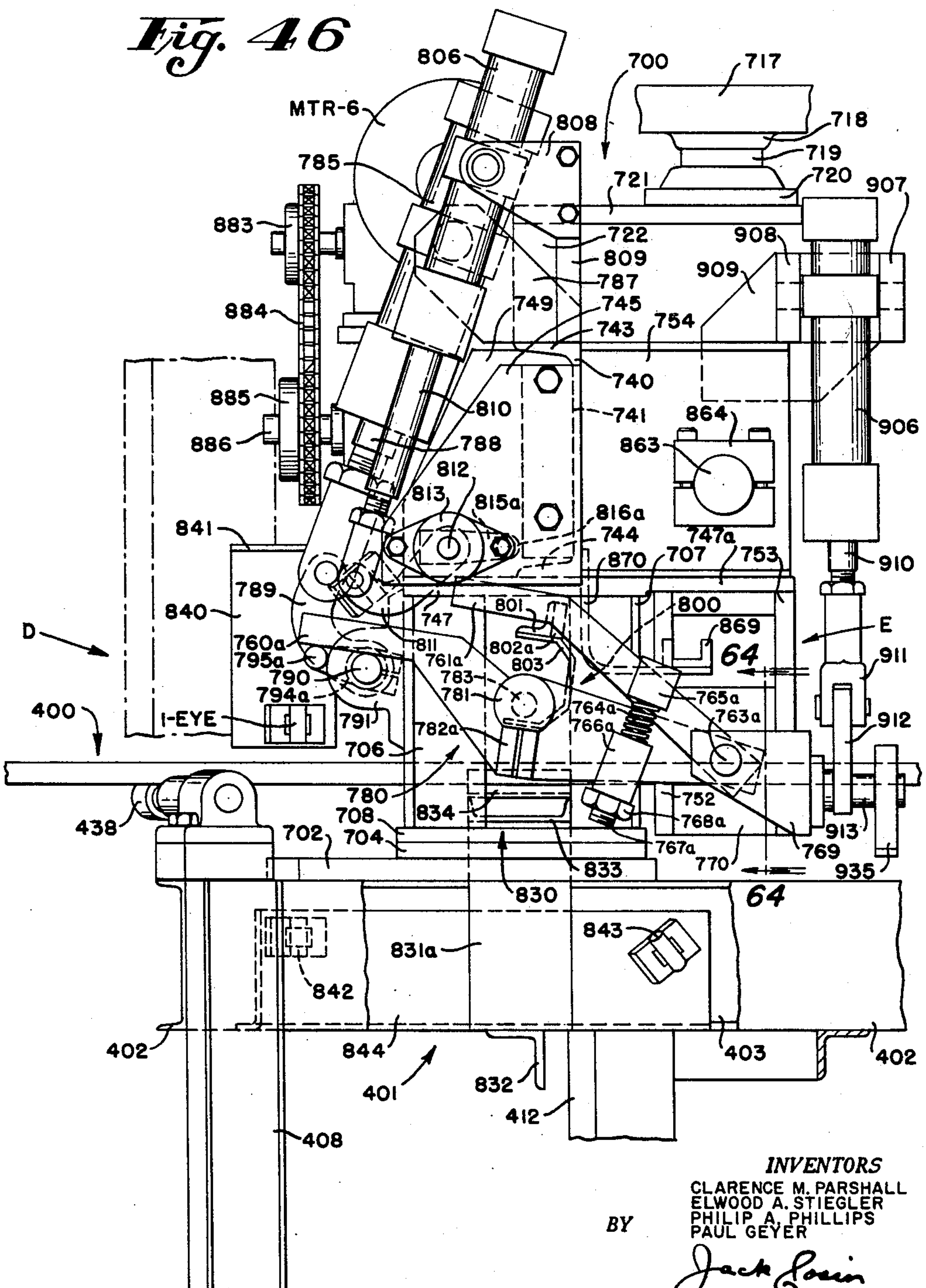

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Fig. 47

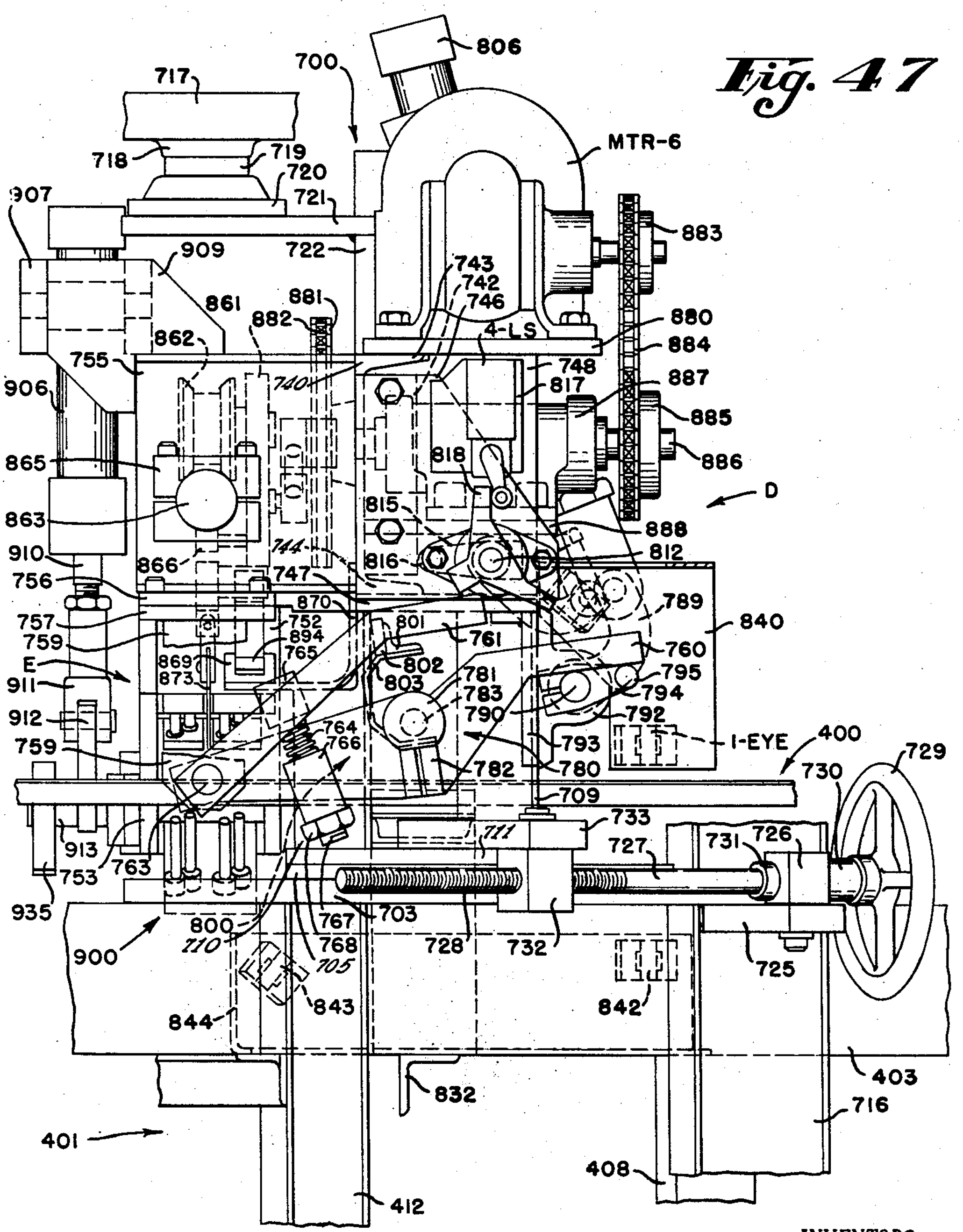

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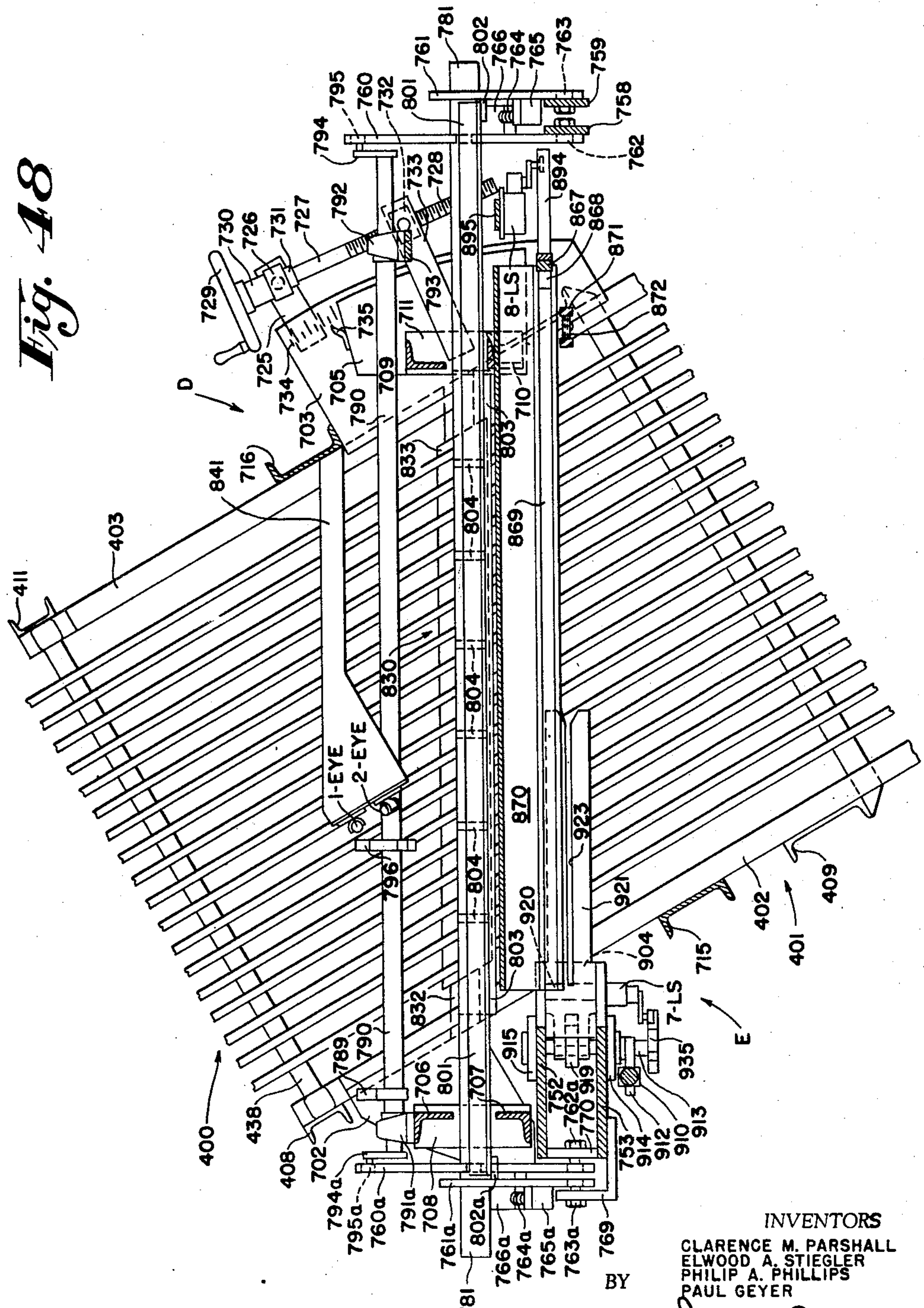
Fig. 18



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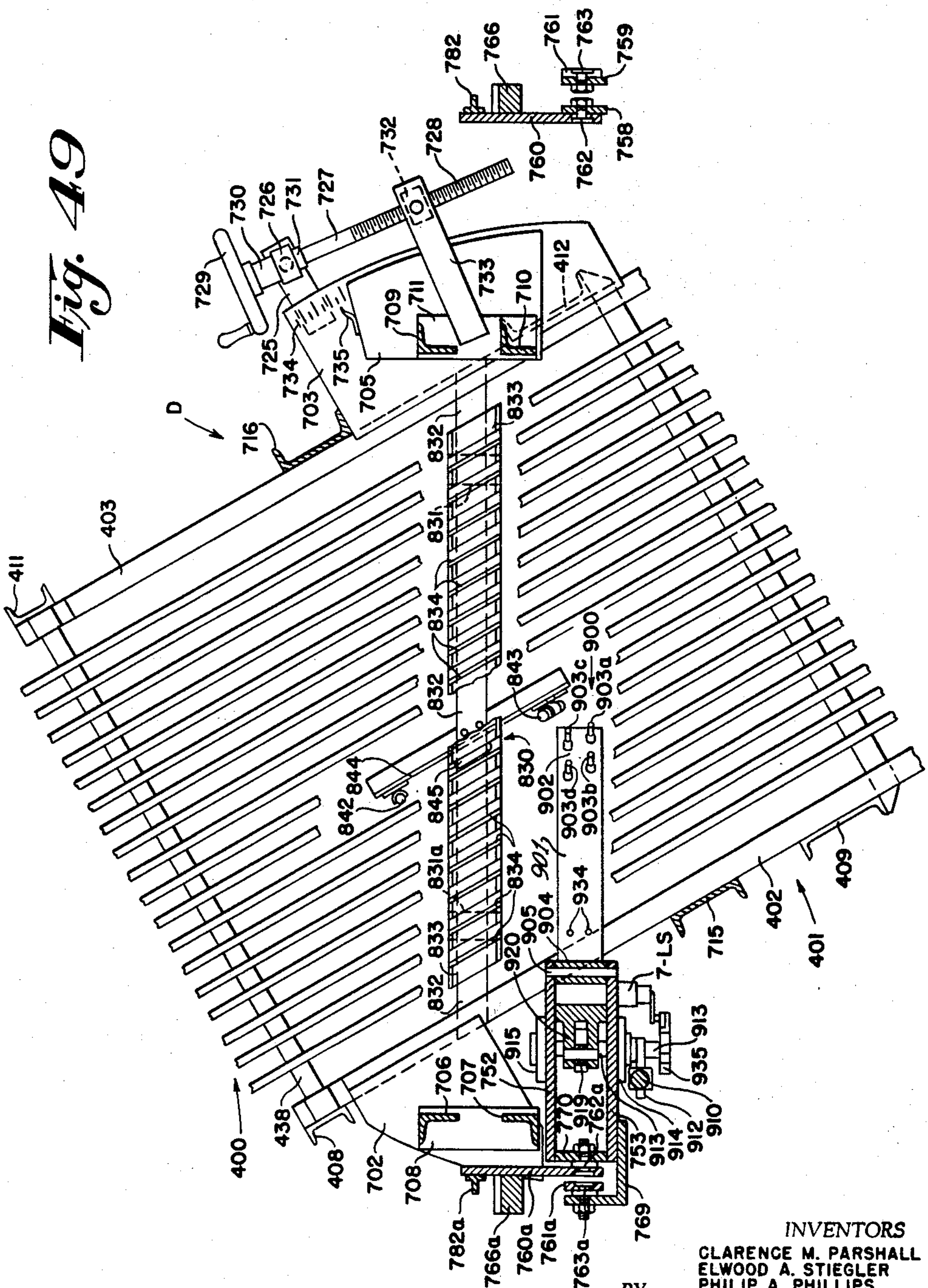

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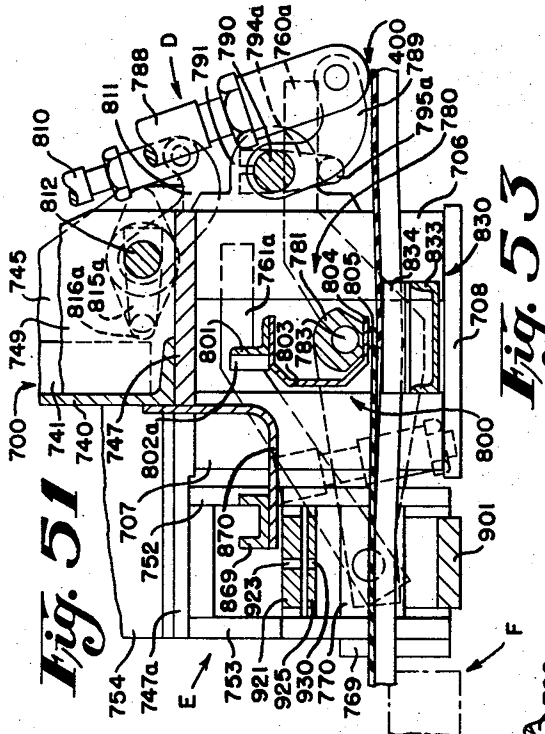

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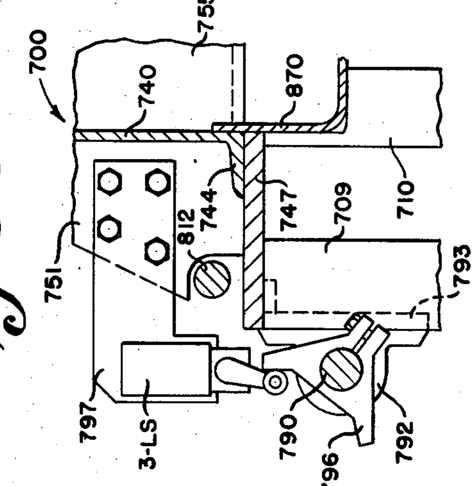

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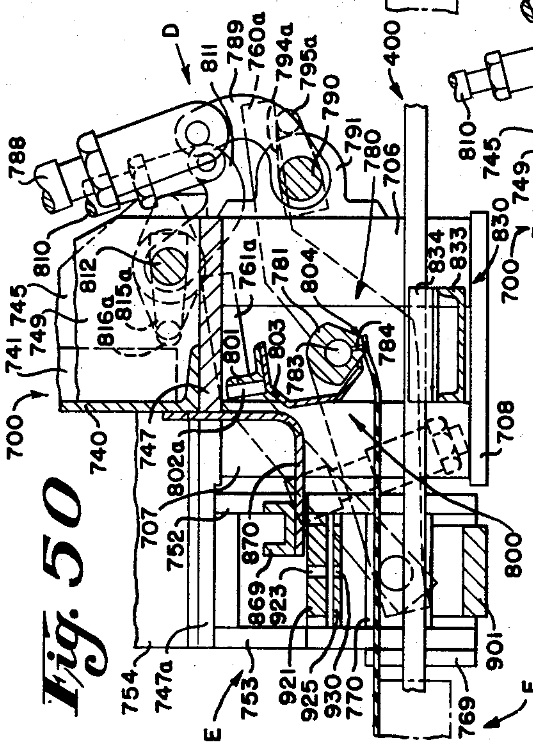

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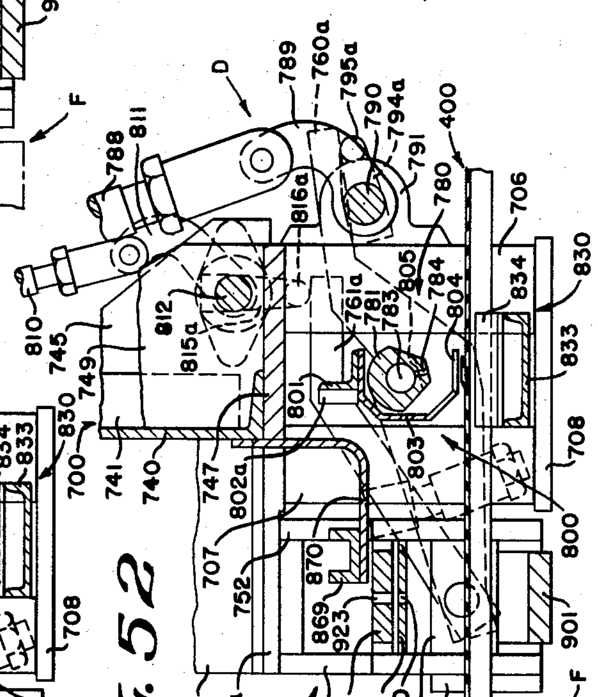

Fig. 52

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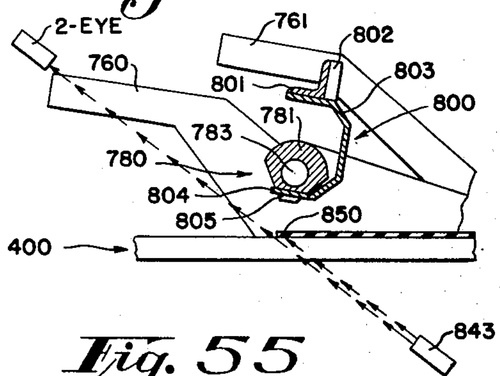
Fig. 54



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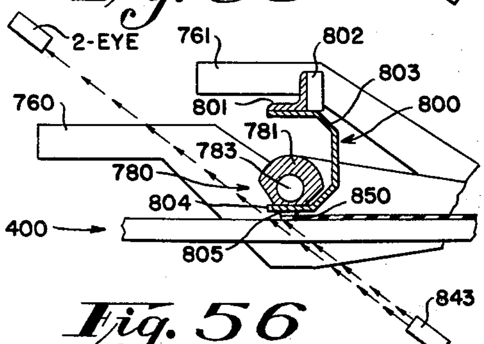

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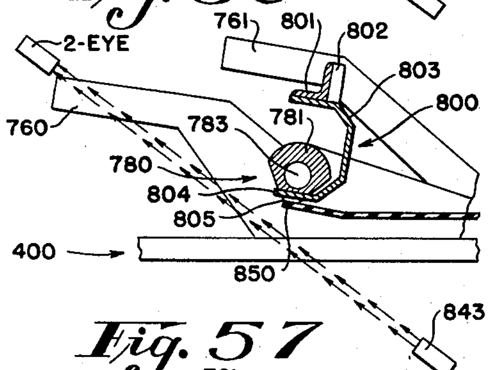

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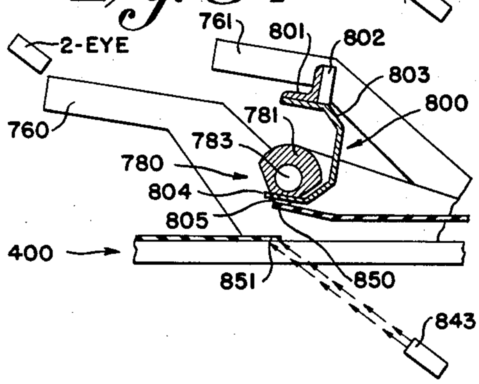

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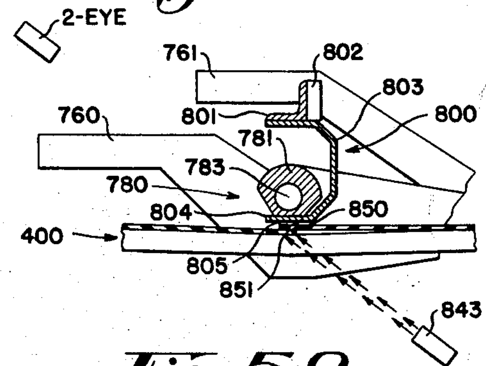

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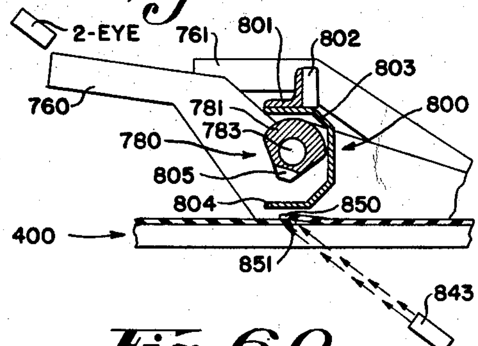

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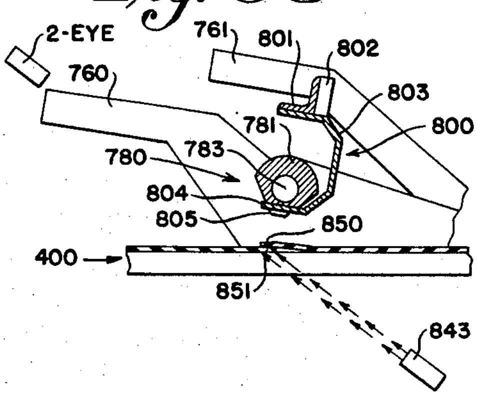

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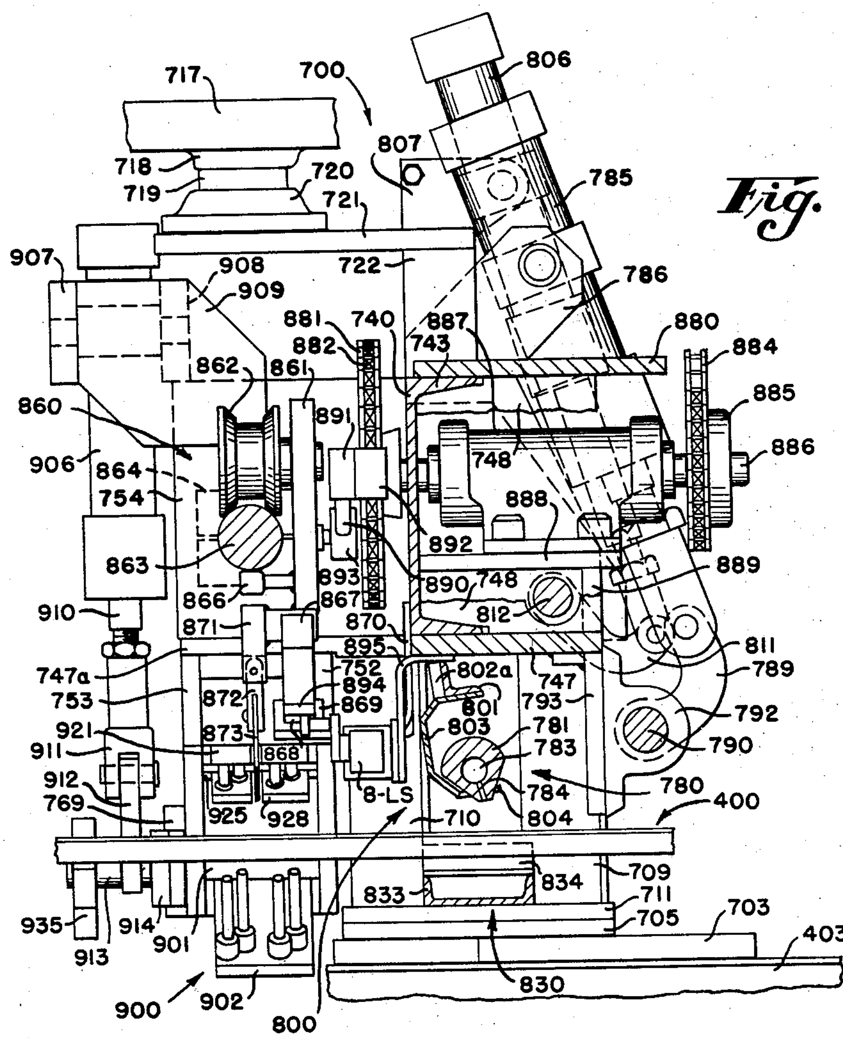

Fig. 61

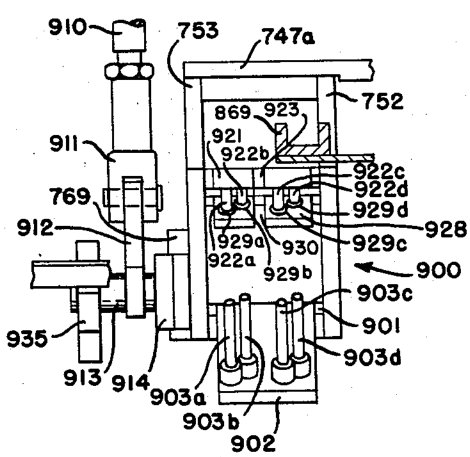

Fig. 62

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PAUL GEYER
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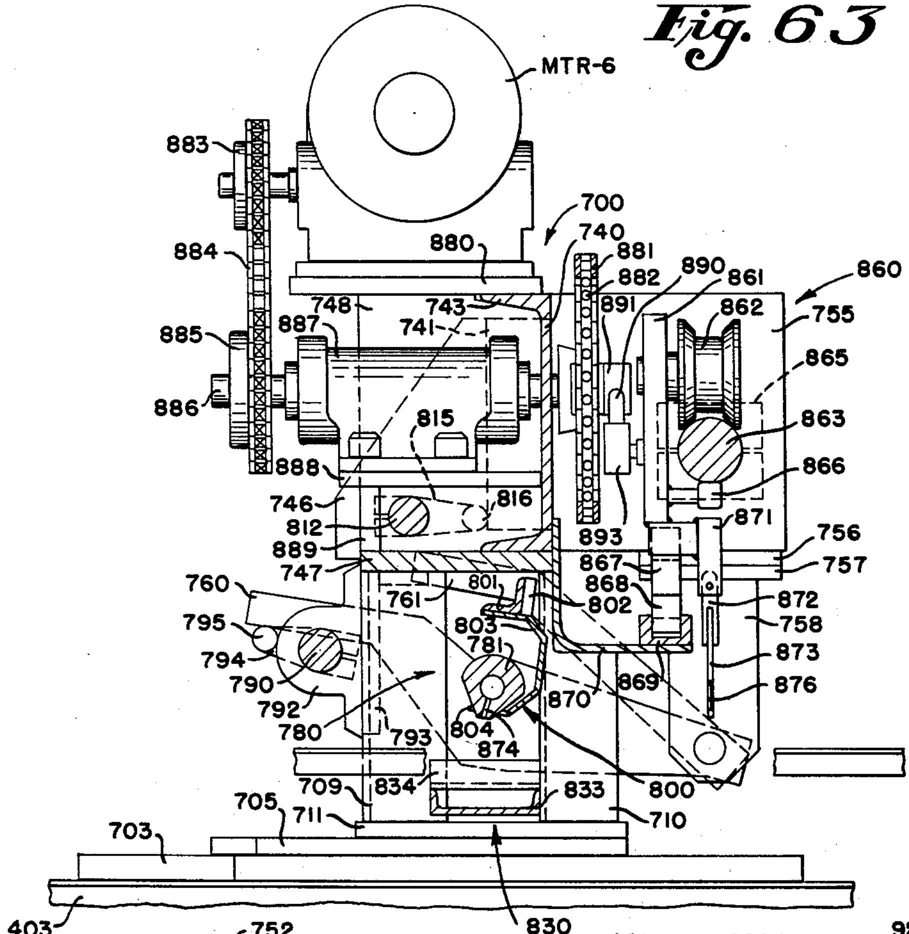
Fig. 63



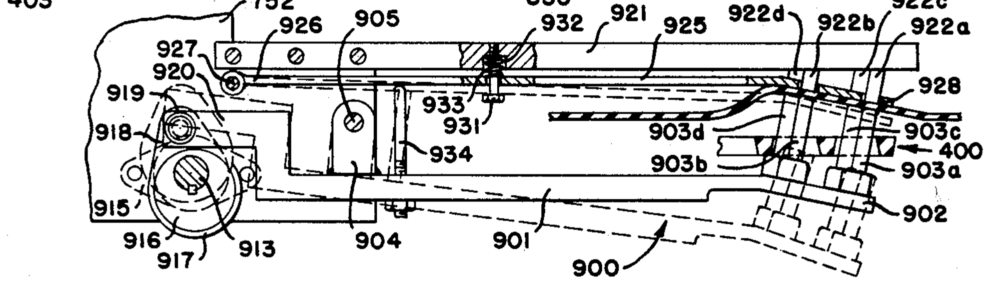


Fig. 64

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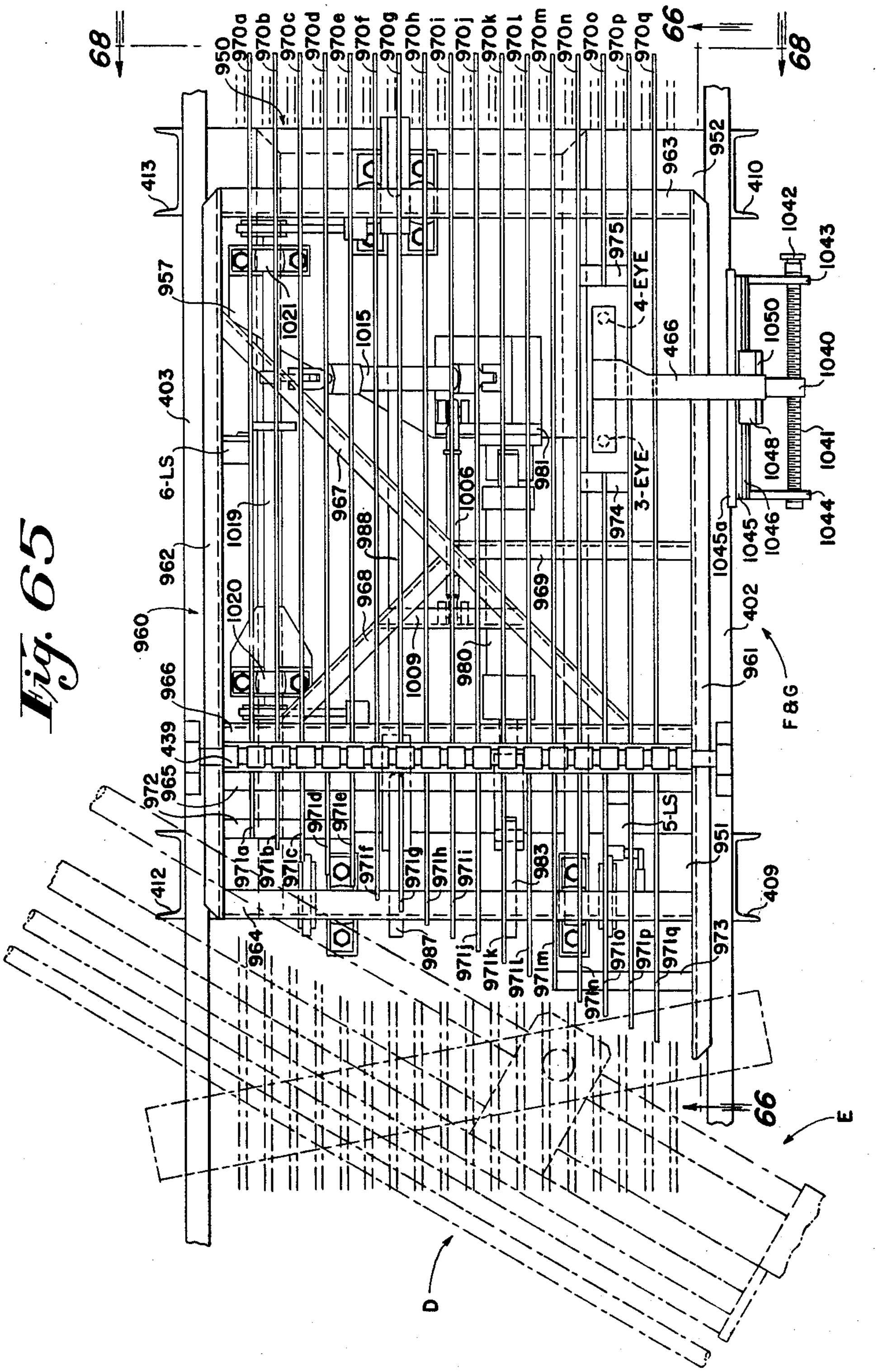
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66
66
950
970a
970b
970c
970d
970e
970f
970g
970h
970i
970j
970k
970l
970m
970n
970o
970p
970q
413
952
410
963
1042
1043
975
4-EYE
957
1021
1015
466
1050
1040
403
6-LS
981
3-EYE
1048
1041
967
1006
974
1044
1046
1045
1045a
1019
988
962
969
1020
968
1009
980
402
961
F&G
960
966
439
965
972
971a
971b
971c
971d
971e
971f
971g
971h
971i
983
5-LS
951
412
409
964
987
971j
971k
971L
971m
971n
971o
971p
971q
973
E
D

Fig. 65

TIRE BUILDING APPARATUS

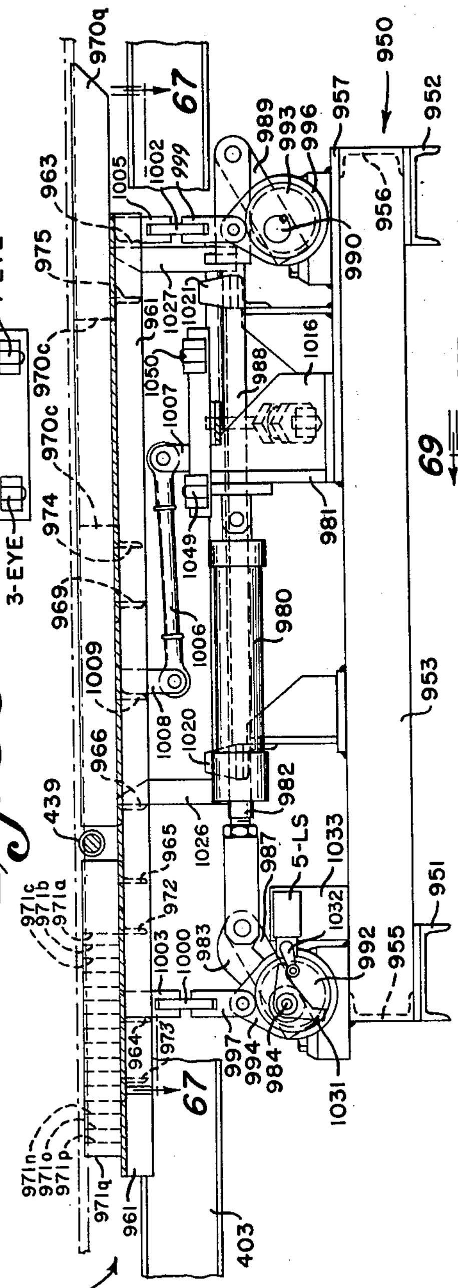

Fig. 66

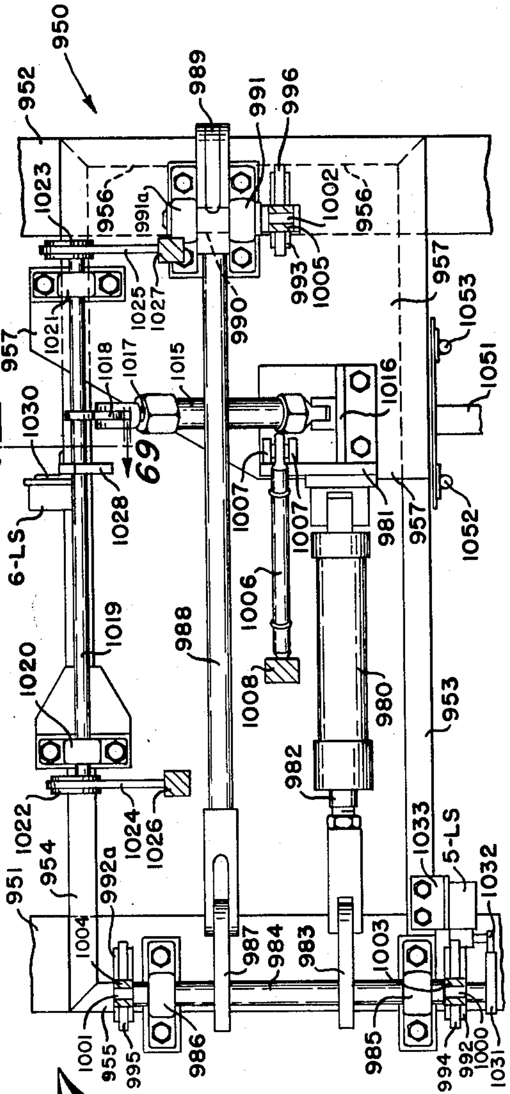

Fig. 67

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Fig. 70

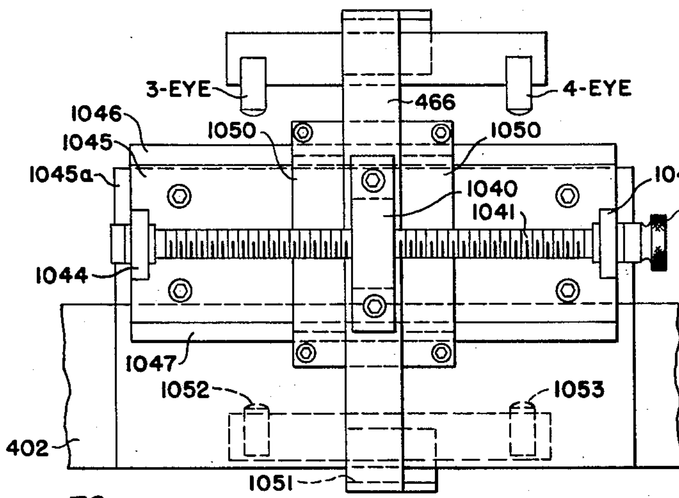


Fig. 69

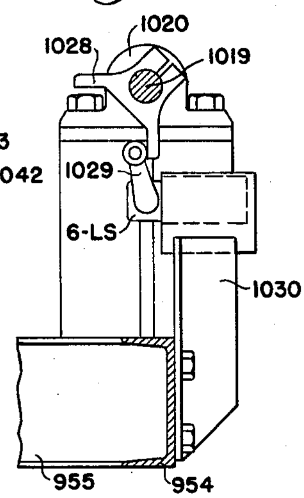


Fig. 68

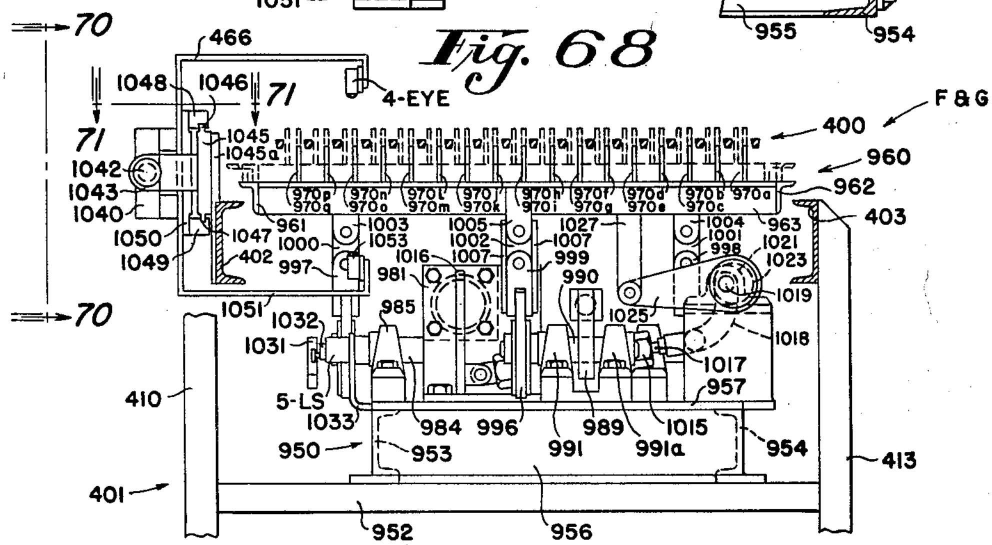
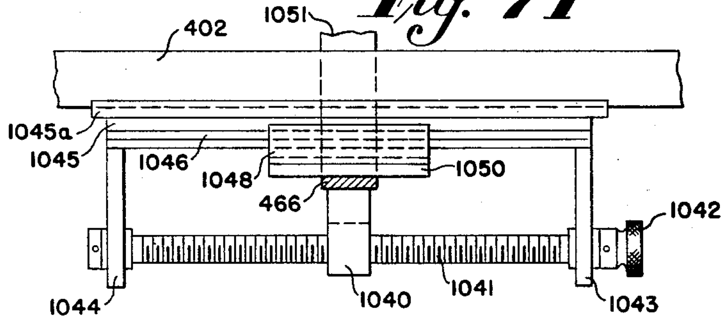


Fig. 71



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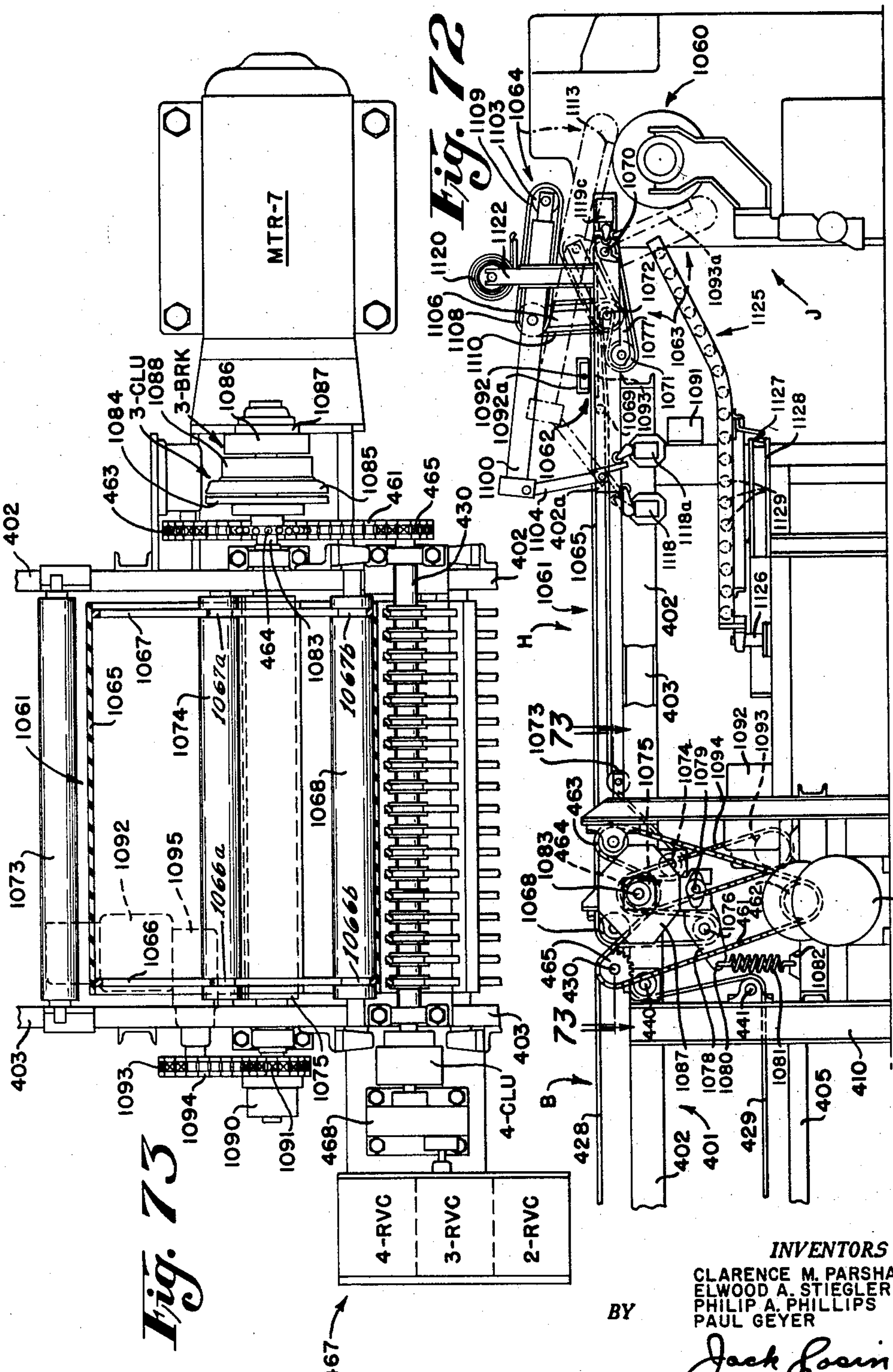

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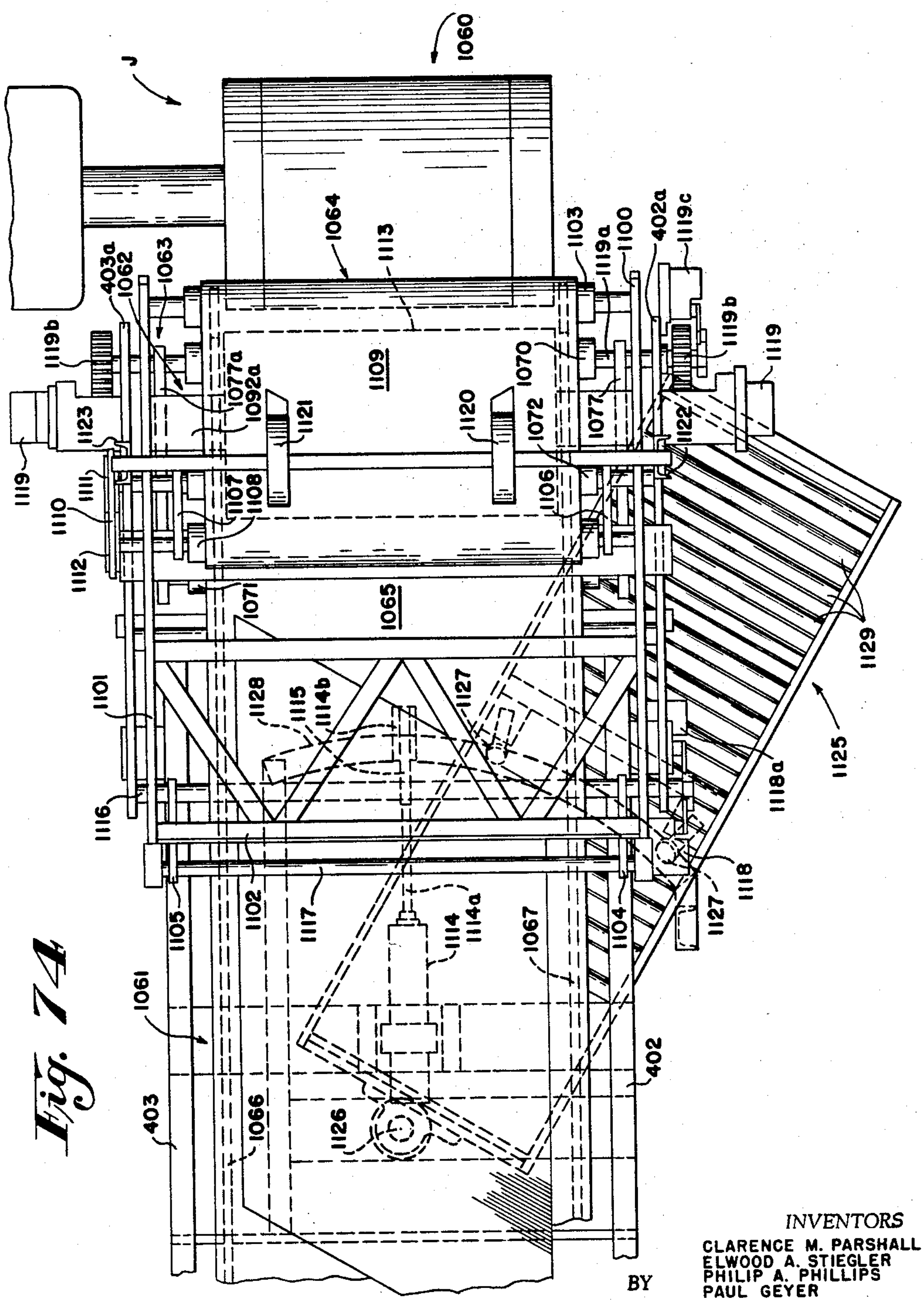

Fig. 74

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Fig. 75

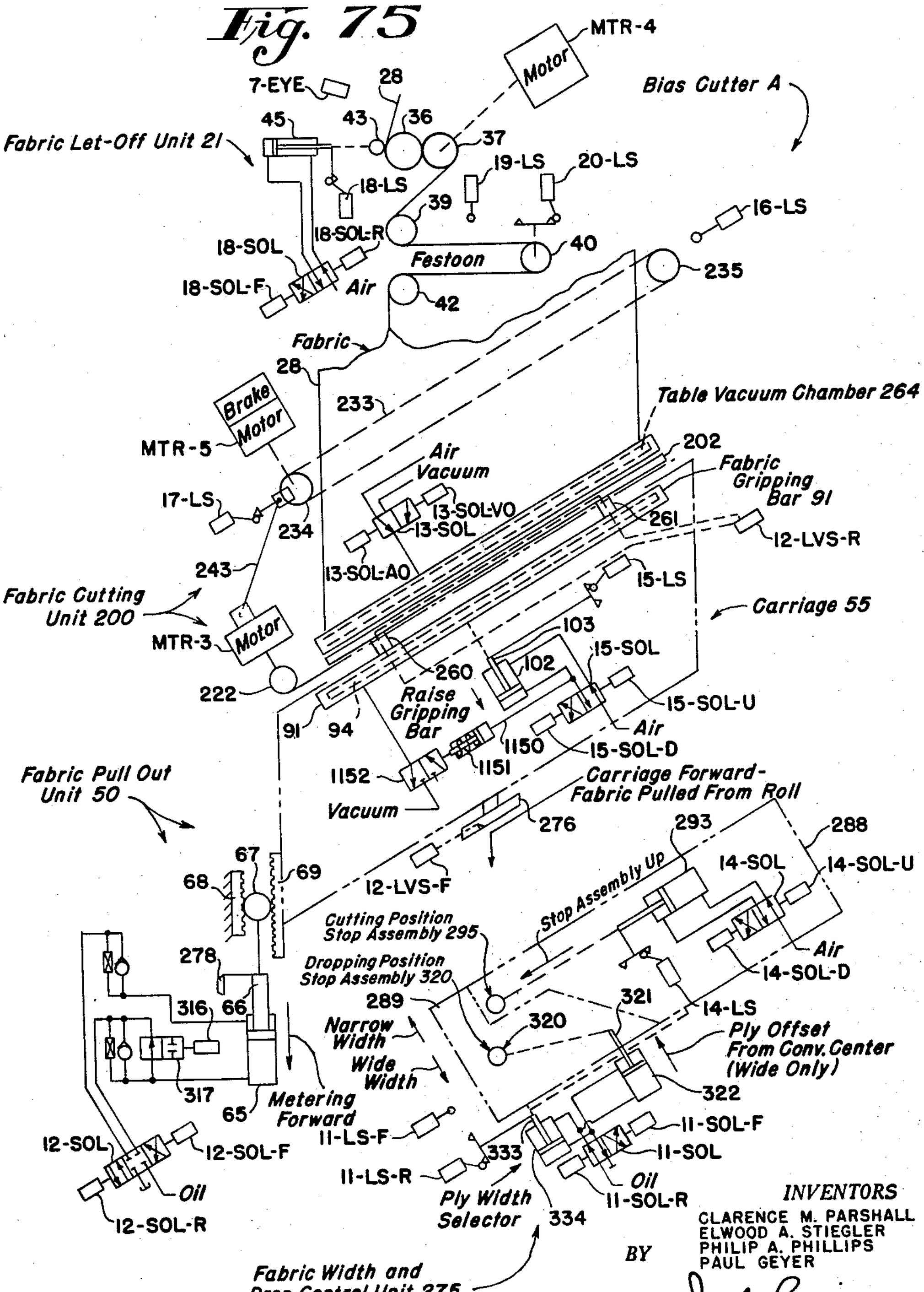

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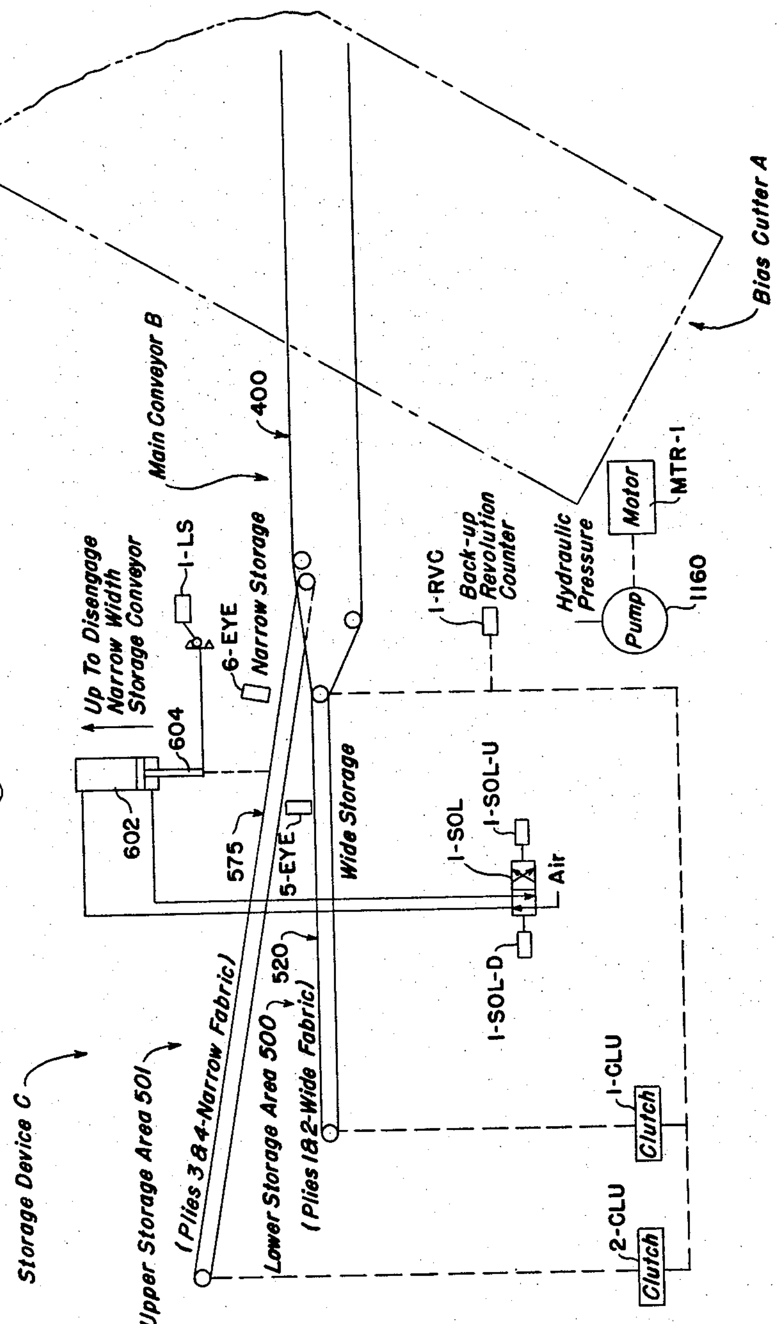
Fig. 76



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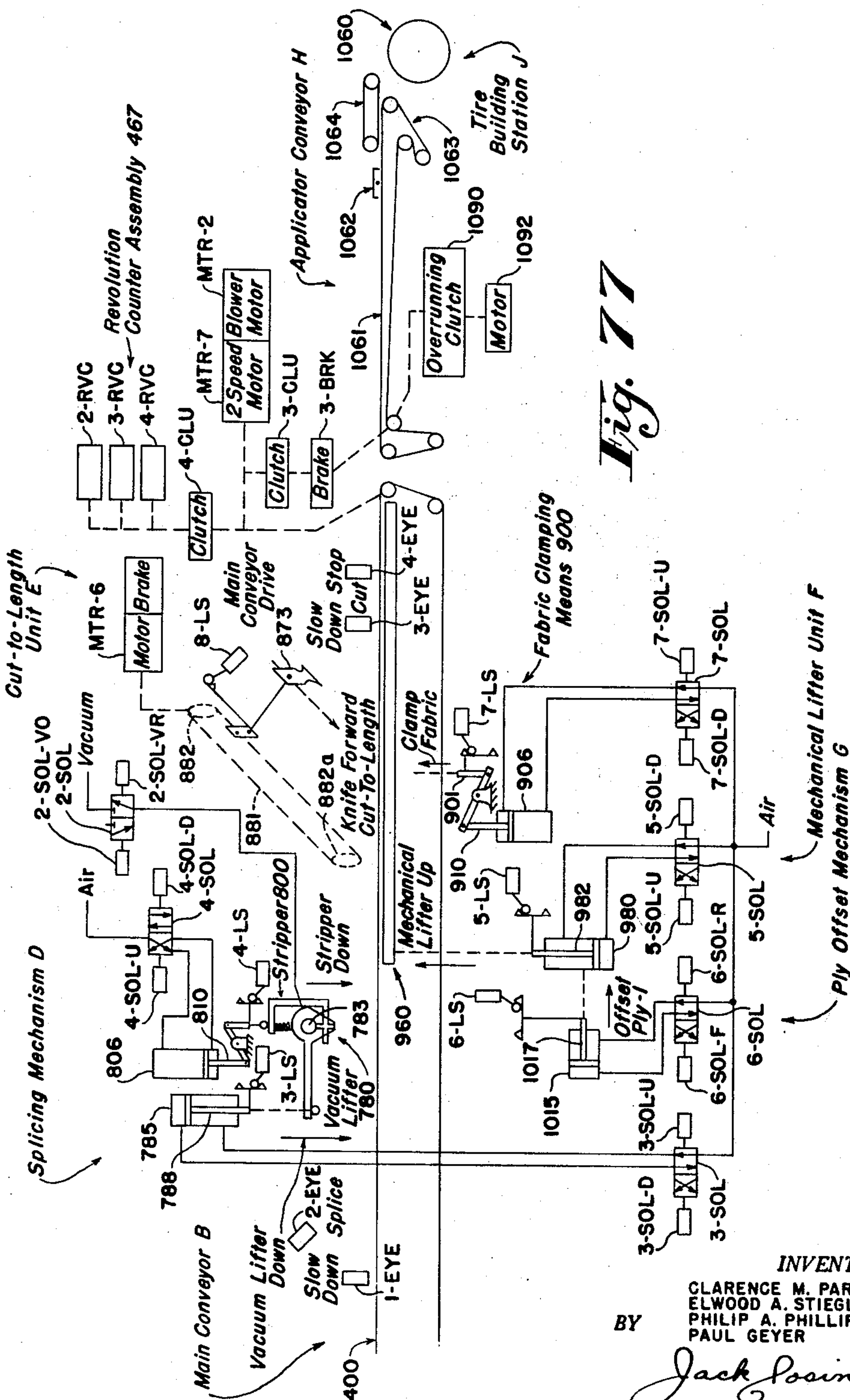

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Fig. 78

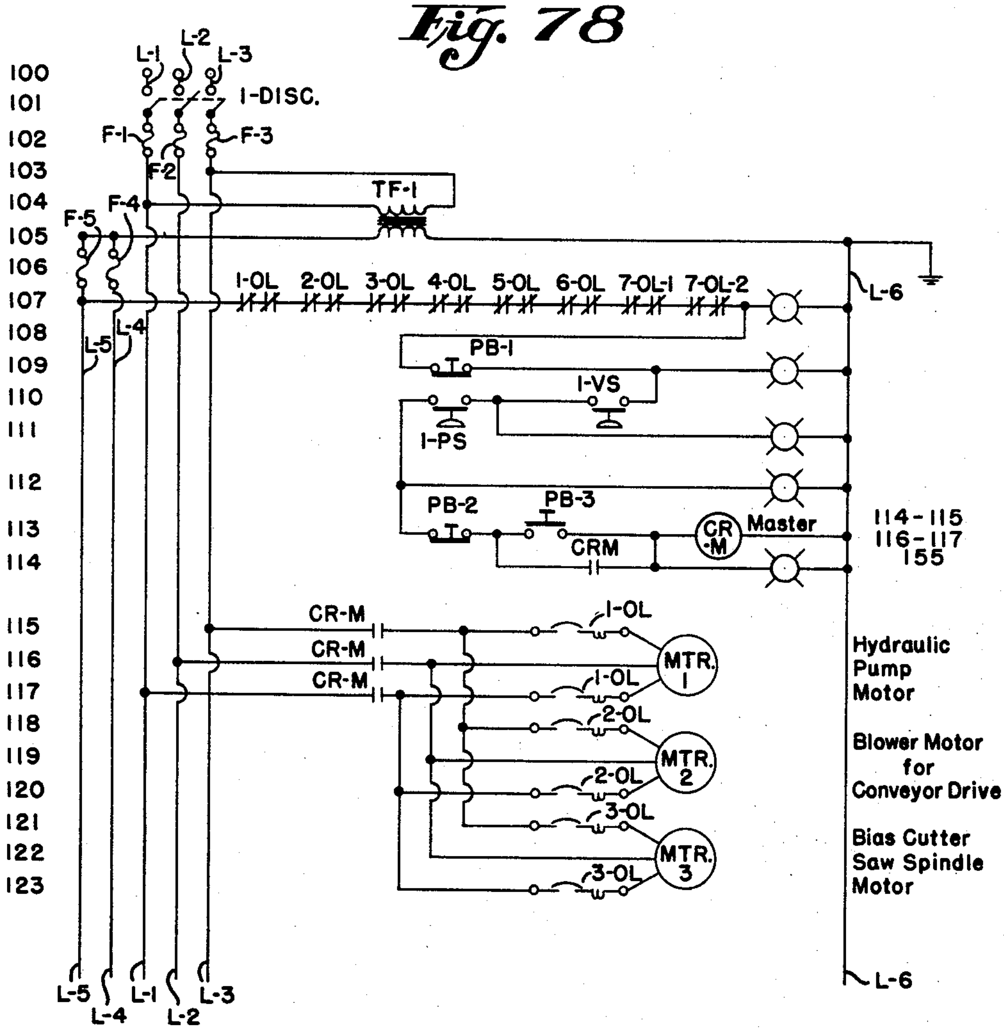

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Fig. 79

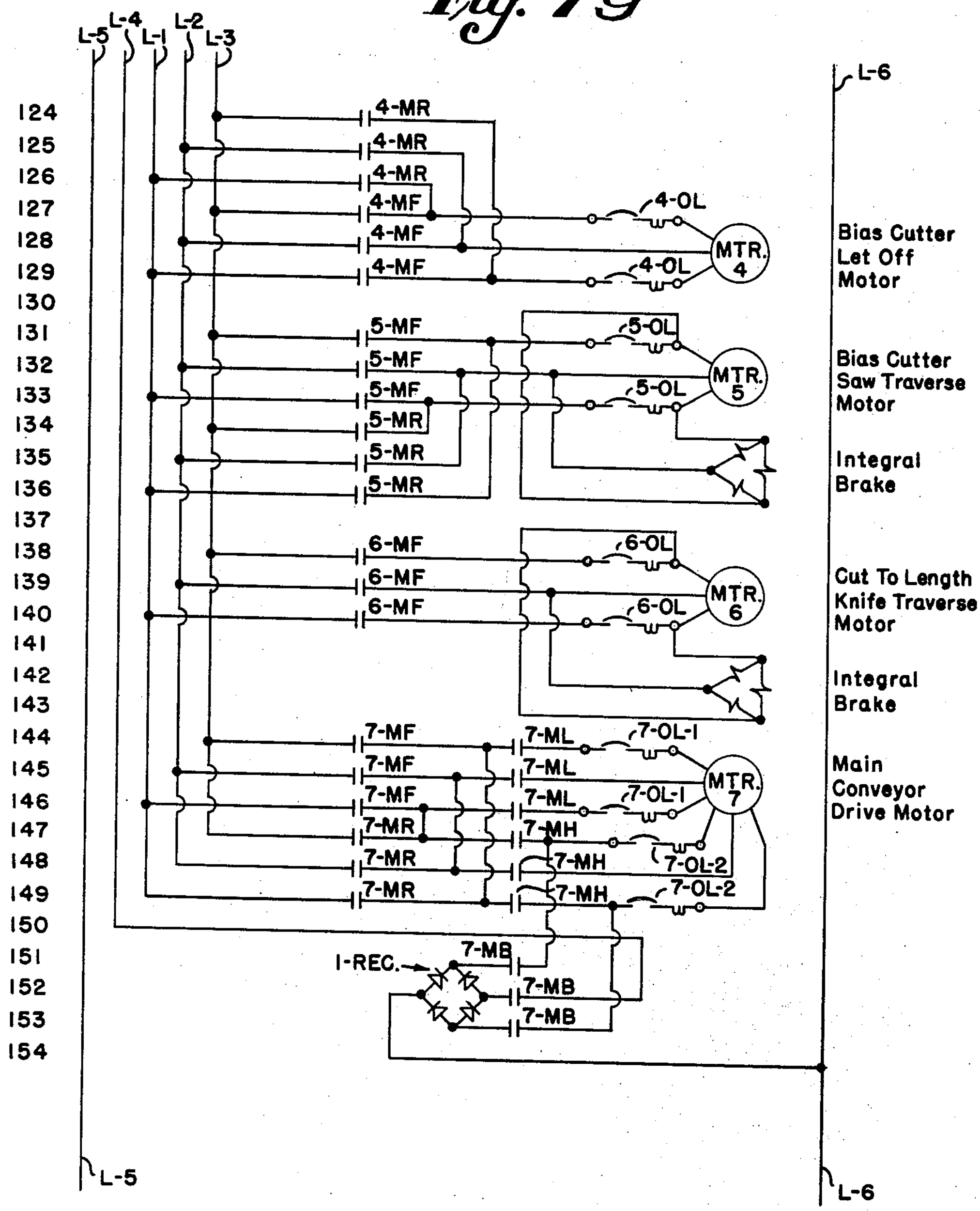

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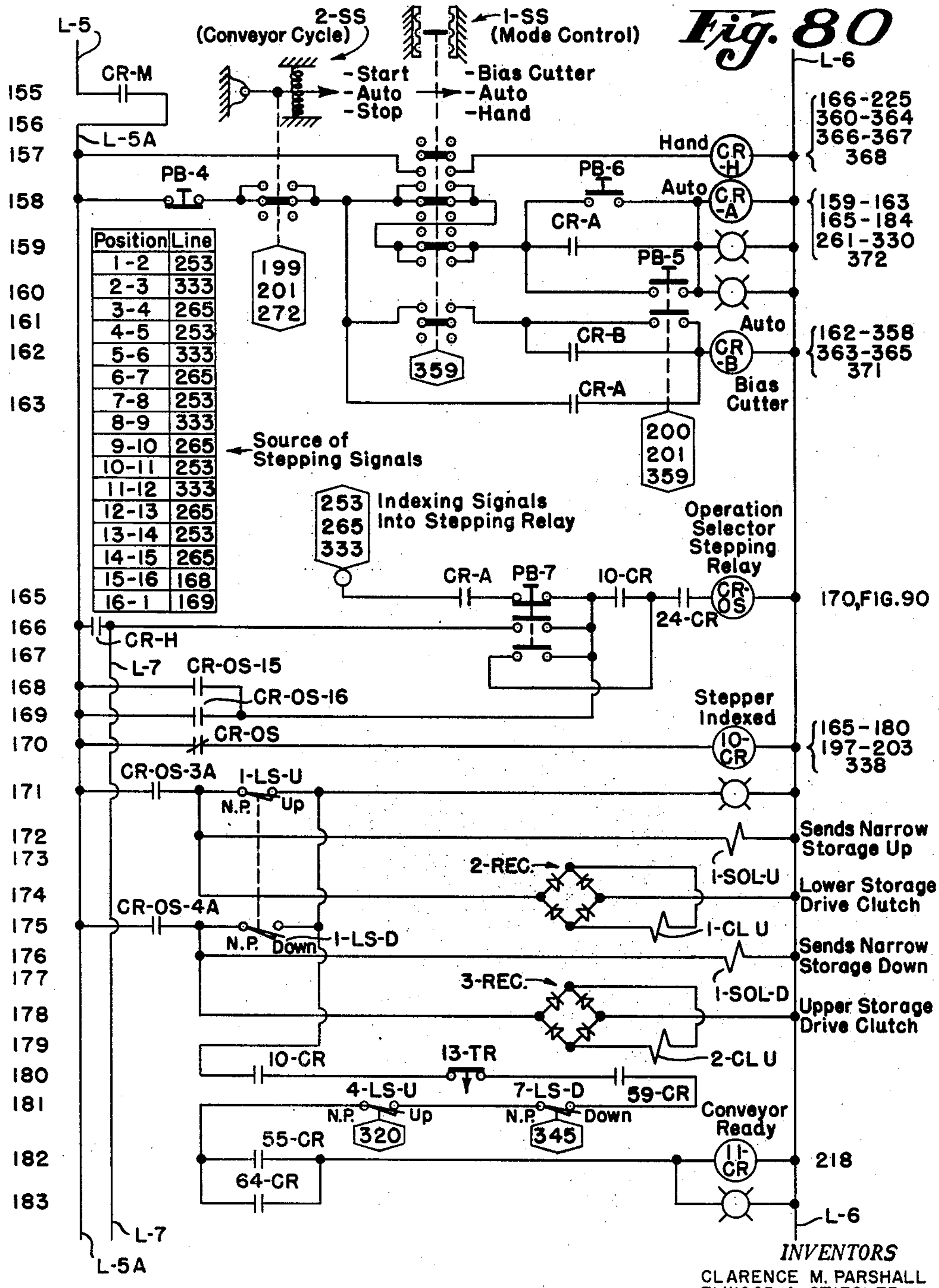
Fig. 80



Position	Line
1-2	253
2-3	333
3-4	265
4-5	253
5-6	333
6-7	265
7-8	253
8-9	333
9-10	265
10-11	253
11-12	333
12-13	265
13-14	253
14-15	265
15-16	168
16-1	169

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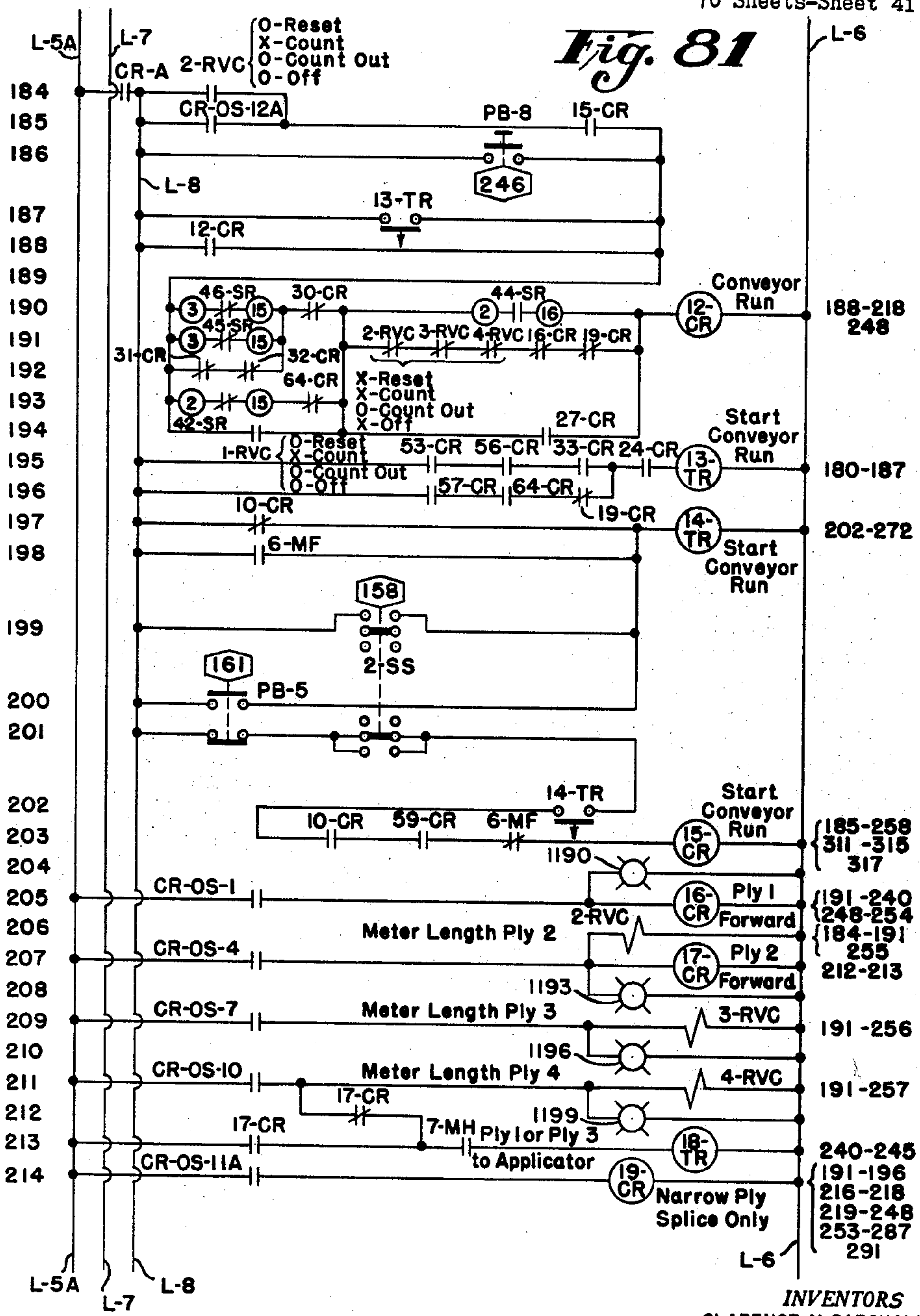
Fig. 81



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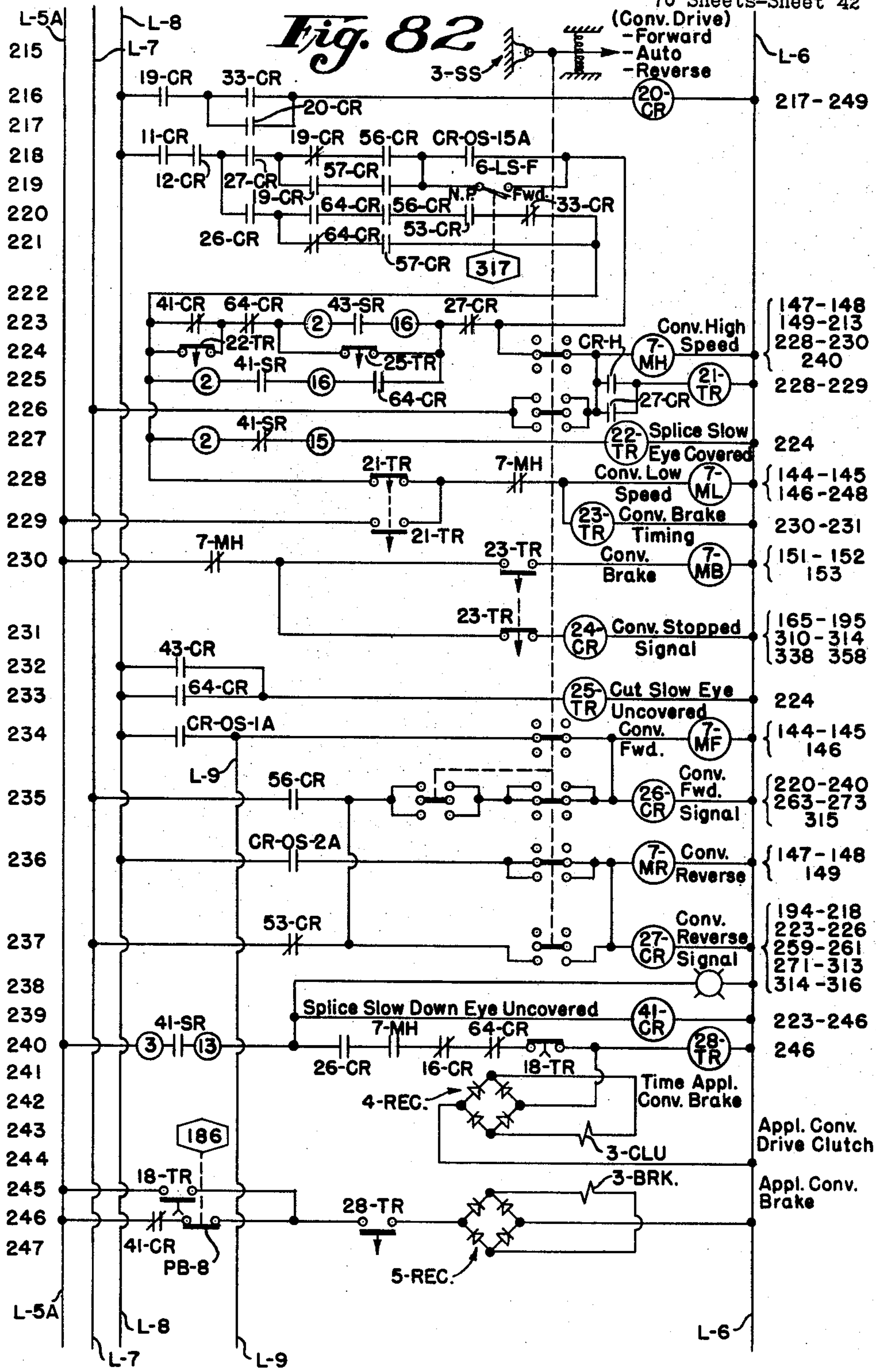

L-5A
L-8
L-7
L-6
L-9
3-SS
(Conv. Drive)
-Forward
-Auto
-Reverse
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
19-CR
33-CR
20-CR
11-CR
12-CR
27-CR
19-CR
56-CR
CR-OS-15A
57-CR
6-LS-F
N.P.
Fwd.
64-CR
53-CR
26-CR
317
41-CR
43-SR
22-TR
41-SR
25-TR
CR-H
Conv. High Speed
7-MH
21-TR
27-CR
22-TR
Splice Slow Eye Covered
15
7-ML
Conv. Low Speed
23-TR
Conv. Brake Timing
Conv. Brake
7-MB
24-CR
Conv. Stopped Signal
43-CR
25-TR
Cut Slow Eye Uncovered
CR-OS-1A
Conv. Fwd.
7-MF
26-CR
Conv. Fwd. Signal
CR-OS-2A
7-MR
Conv. Reverse
27-CR
Conv. Reverse Signal
Splice Slow Down Eye Uncovered
41-CR
28-TR
16-CR
18-TR
Time Appl. Conv. Brake
4-REC.
3-CLU
Appl. Conv. Drive Clutch
186
3-BRK.
Appl. Conv. Brake
41-CR
PB-8
5-REC.
217-249
147-148
149-213
228-230
240
228-229
224
144-145
146-248
230-231
151-152
153
165-195
310-314
338 358
144-145
146
220-240
263-273
315
147-148
149
194-218
223-226
259-261
271-313
314-316
223-246
246

Fig. 82

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TIRE BUILDING APPARATUS

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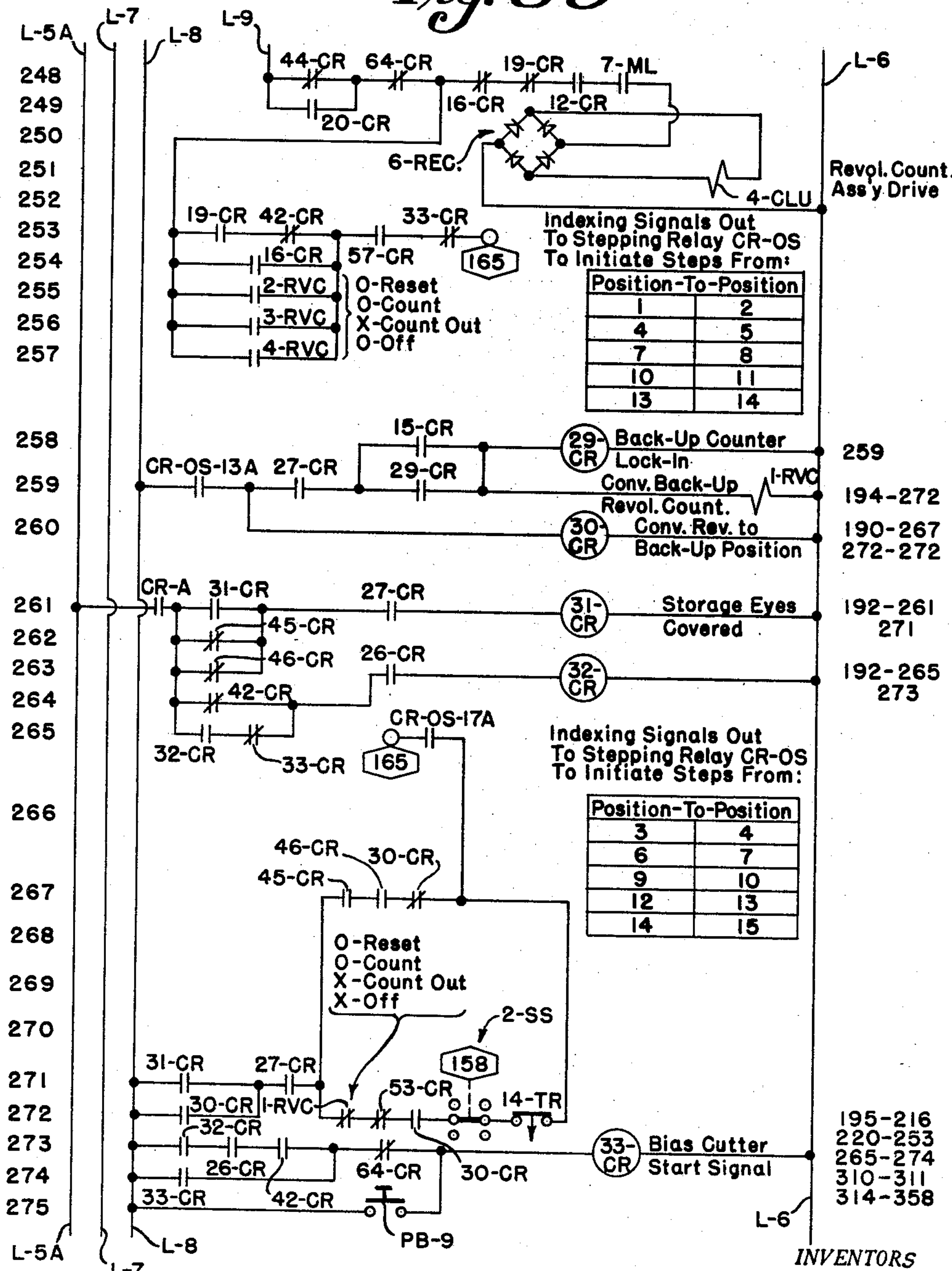
Fig. 83



Position-To-Position	
1	2
4	5
7	8
10	11
13	14

Position-To-Position	
3	4
6	7
9	10
12	13
14	15

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Fig. 84

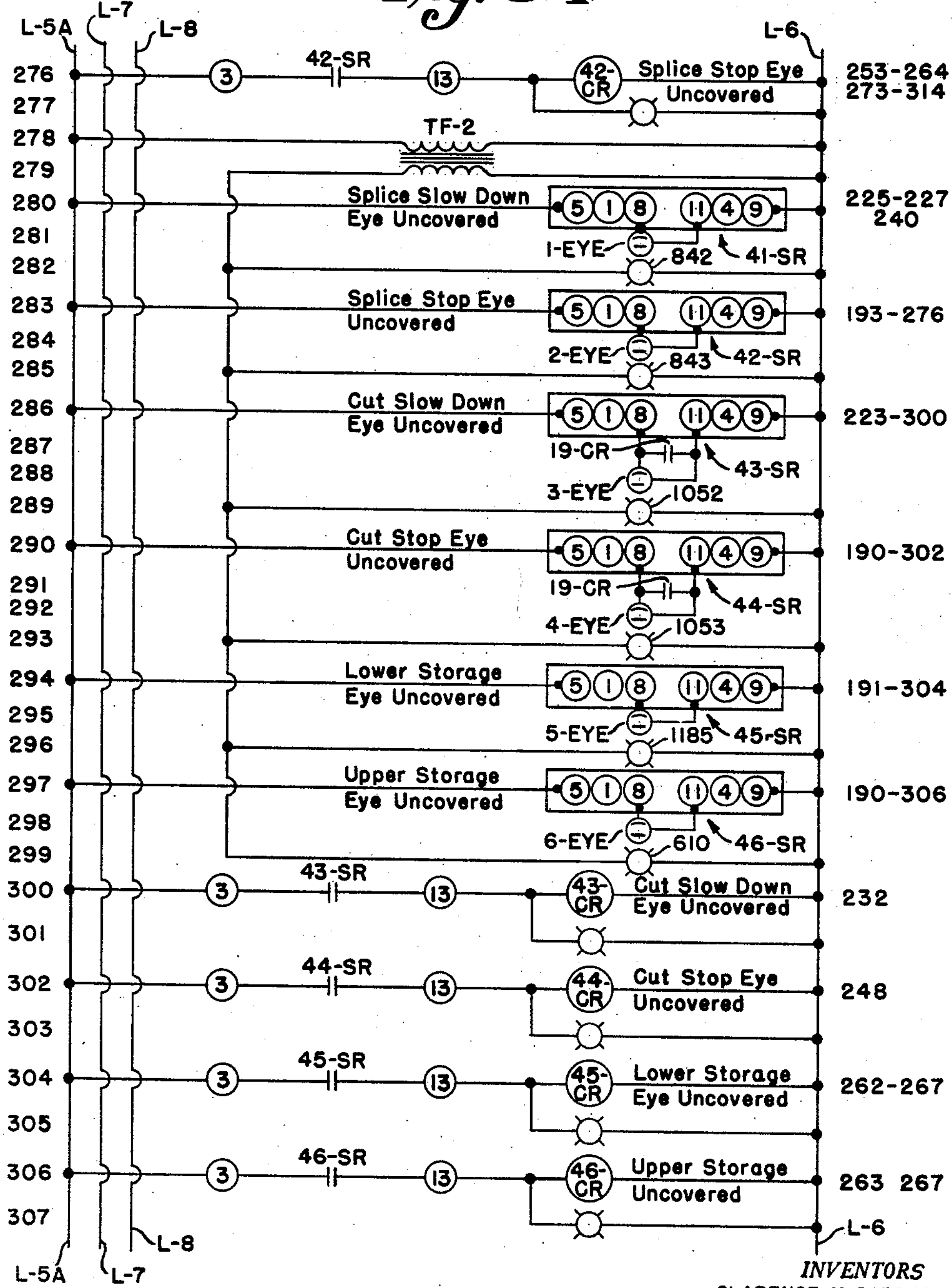

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Fig. 85

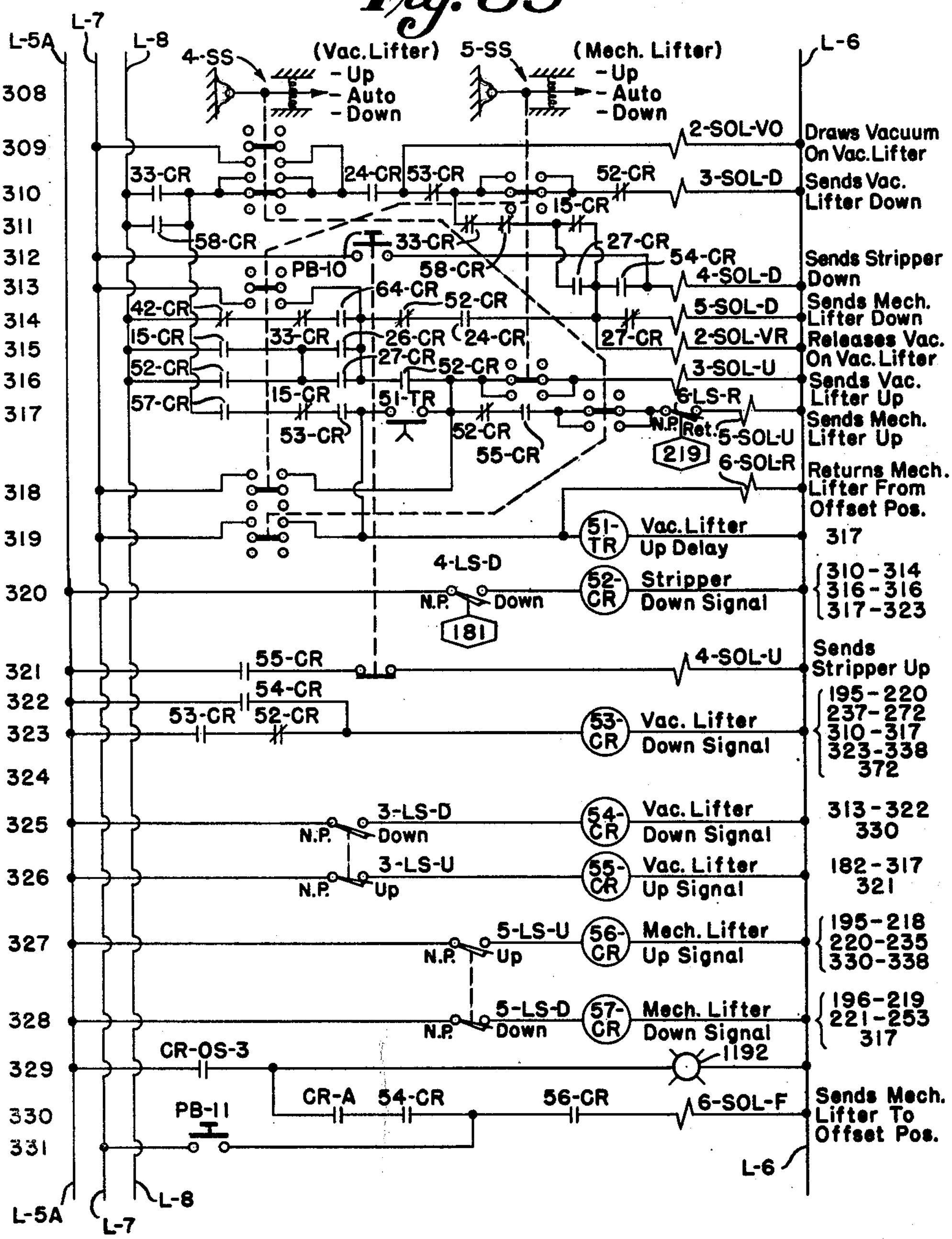

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Fig. 86

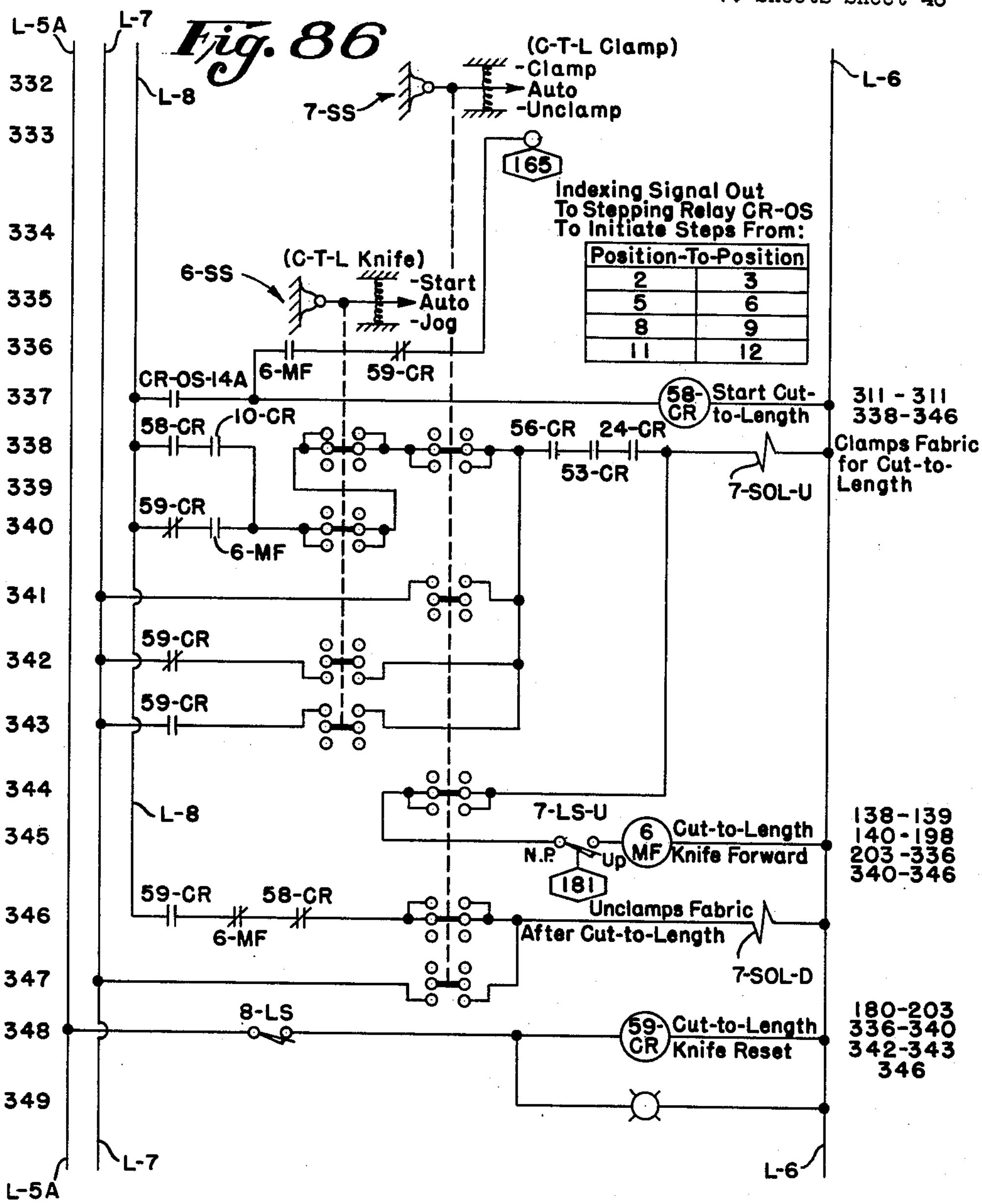

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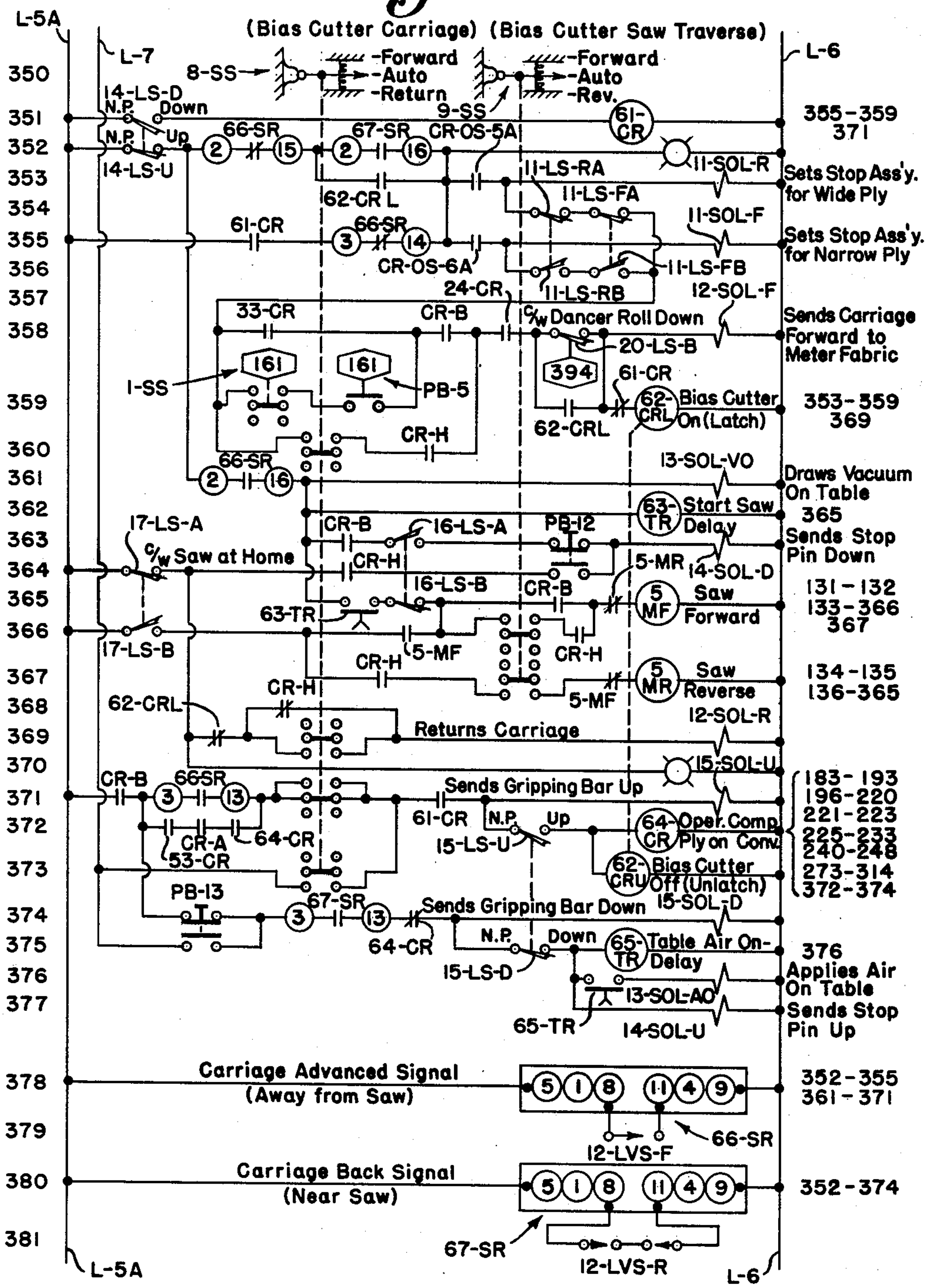
Fig. 87


(Bias Cutter Carriage) (Bias Cutter Saw Traverse)
L-5A
L-7
L-6
8-SS
-Forward
-Auto
-Return
-Forward
-Auto
-Rev.
9-SS
14-LS-D
Down
Up
14-LS-U
Sets Stop Ass'y. for Wide Ply
Sets Stop Ass'y. for Narrow Ply
Sends Carriage Forward to Meter Fabric
Bias Cutter On (Latch)
13-SOL-VO
Draws Vacuum On Table
Start Saw Delay
Sends Stop Pin Down
Saw Forward
Saw Reverse
12-SOL-R
Returns Carriage
Sends Gripping Bar Up
Oper. Comp Ply on Conv.
Bias Cutter Off (Unlatch)
Sends Gripping Bar Down
Table Air On-Delay
Applies Air On Table
Sends Stop Pin Up
14-SOL-U
Carriage Advanced Signal (Away from Saw)
12-LVS-F
Carriage Back Signal (Near Saw)
12-LVS-R
67-SR
66-SR
355-359 371
353-359 369
365
131-132 133-366 367
134-135 136-365
183-193 196-220 221-223 225-233 240-248 273-314 372-374
376
352-355 361-371
352-374

TIRE BUILDING APPARATUS

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Fig. 88

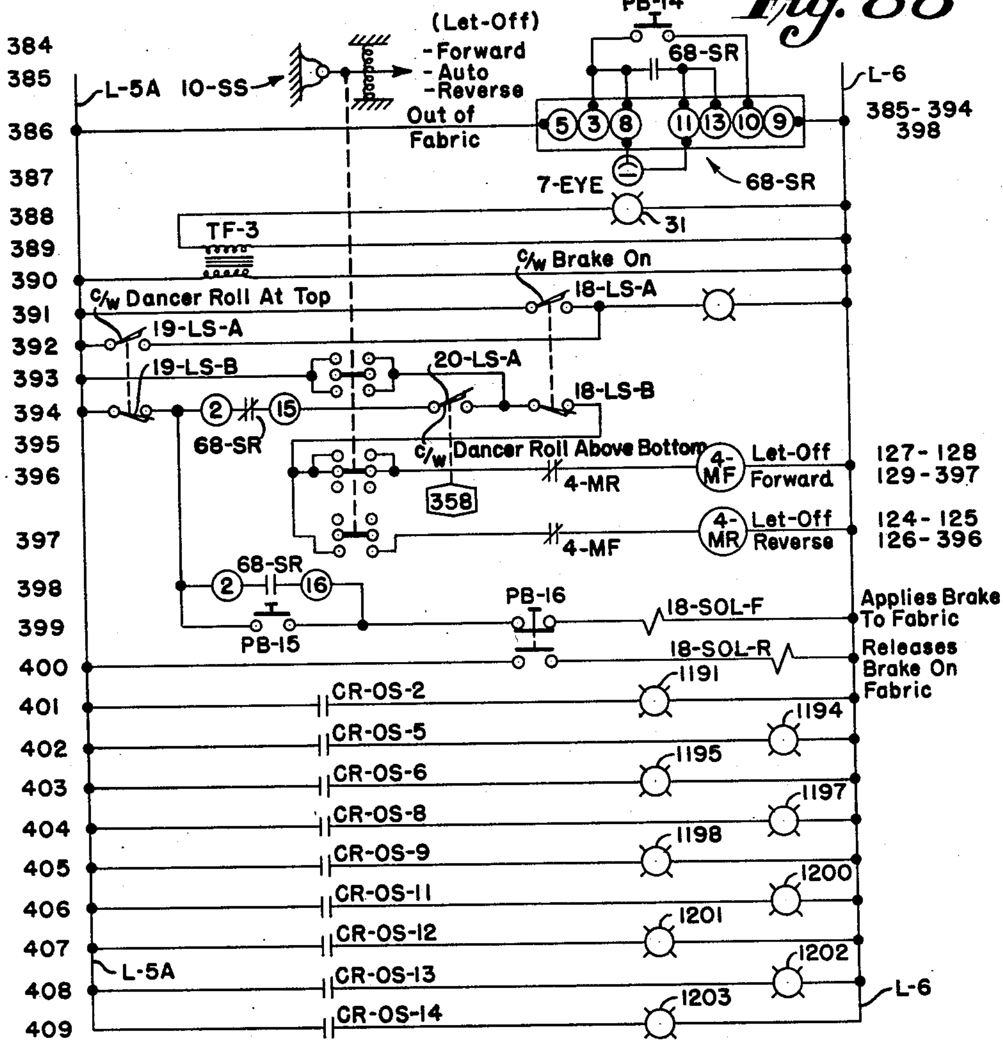
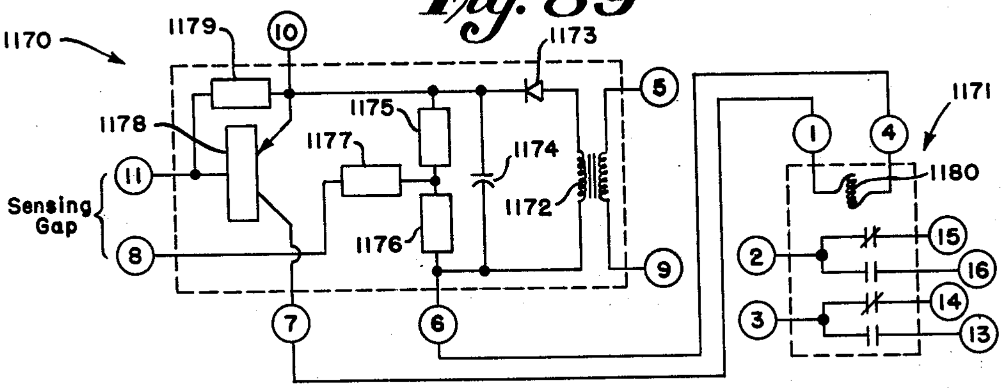


Fig. 89



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TIRE BUILDING APPARATUS

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ELECTRICAL LAYOUT LINE NUMBERS — Line	DESCRIPTION OF OPERATION — Position / Contact	1 CONV. FWD. Ply-1	2 CUT-TO-LENGTH Ply-1	3 CONV. REV. Ply-1 residue to back position	4 CONV. FWD. Ply-2 (Transfer ply-1)	5 CUT-TO-LENGTH Ply-2	6 CONV. REV. Ply-2 residue to storage	7 CONV. FWD. Ply-3 (Apply ply-2)	8 CUT-TO-LENGTH Ply-3	9 CONV. REV. Ply-3 residue to back position	10 CONV. FWD. Ply-4 (Transfer ply-3)	11 CUT-TO-LENGTH Ply-4	12 CONV. REV. Ply-4 residue to back position	13 CONV. FWD. Narrow splice (Apply ply-4)	14 CONV. REV. Narrow fabric to storage	15 IDLE	16 IDLE	
205	1	X																
401	2		X															
329	3			X														
207	4				X													
402	5					X												
403	6						X											
209	7							X										
404	8								X									
405	9									X								
211	10										X							
406	11											X						
407	12												X					
408	13													X				
409	14														X			
168	15															X		
169	16																X	
234	1A	X			X			X			X			X				CONVEYOR FORWARD
236	2A			X			X			X			X		X			CONVEYOR REVERSE
171	3A	X	X	X	X	X	X											STORAGE CONVEYOR UP
175	4A							X	X	X	X	X	X	X	X	X		STORAGE CONVEYOR DOWN
353	5A	X	X	X	X	X	X											BIAS-CUTTER WIDE PLY
355	6A							X	X	X	X	X	X	X	X	X	X	BIAS-CUTTER NARROW PLY
	7A																	SPARE
	8A																	SPARE
	9A																	SPARE
	10A																	SPARE
214	11A													X	X			NARROW PLY SPLICE ONLY
185	12A	X		X			X			X	X		X		X			CONVEYOR START
259	13A			X						X			X					CONVEYOR REVERSE To back position
337	14A		X			X			X			X						CUT-TO-LENGTH
218	15A	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	MECHANICAL LIFTER Offset by-pass
	16A																	SPARE
265	17A			X			X			X			X		X			INDEX ANTI-REPEAT AFTER REVERSE
	18A																	SPARE
	19A																	SPARE

Fig. 90

CR-OS

Relay position - contact condition Chart for Operation Selector Stepping relay

(X = closed contact)

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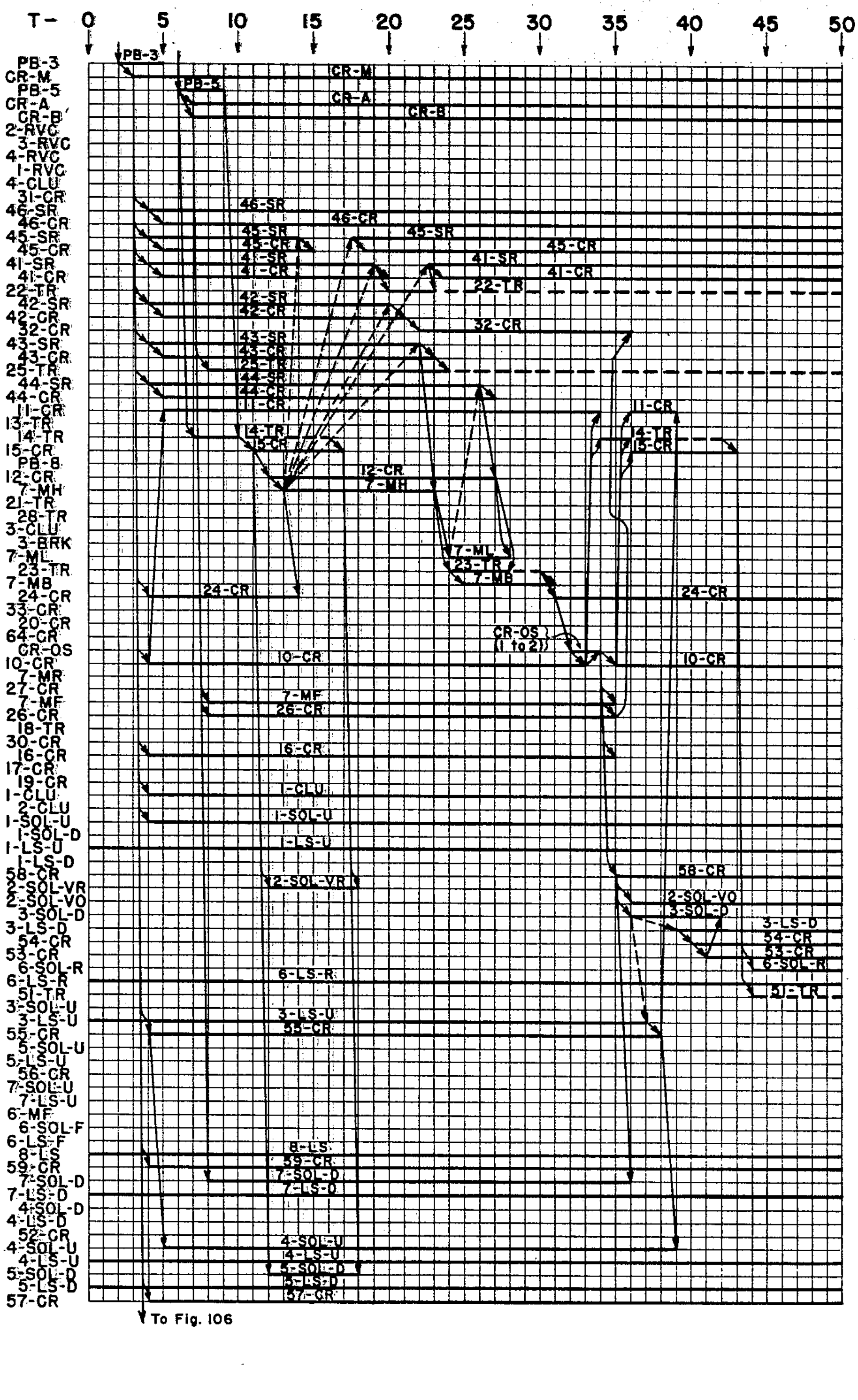
Fig. 91


T-
0
5
10
15
20
25
30
35
40
45
50
PB-3
CR-M
PB-5
CR-A
CR-B
2-RVC
3-RVC
4-RVC
1-RVC
4-CLU
31-CR
46-SR
46-CR
45-SR
45-CR
41-SR
41-CR
22-TR
42-SR
42-CR
32-CR
43-SR
43-CR
25-TR
44-SR
44-CR
11-CR
13-TR
14-TR
15-CR
PB-8
12-CR
7-MH
21-TR
28-TR
3-CLU
3-BRK
7-ML
23-TR
7-MB
24-CR
33-CR
20-CR
64-CR
CR-OS
10-CR
7-MR
27-CR
7-MF
26-CR
18-TR
30-CR
16-CR
17-CR
19-CR
1-CLU
2-CLU
1-SOL-U
1-SOL-D
1-LS-U
1-LS-D
58-CR
2-SOL-VR
2-SOL-VO
3-SOL-D
3-LS-D
54-CR
53-CR
6-SOL-R
6-LS-R
51-TR
3-SOL-U
3-LS-U
55-CR
5-SOL-U
5-LS-U
56-CR
7-SOL-U
7-LS-U
6-MF
6-SOL-F
6-LS-F
8-LS
59-CR
7-SOL-D
7-LS-D
4-SOL-D
4-LS-D
52-CR
4-SOL-U
4-LS-U
5-SOL-D
5-LS-D
57-CR
CR-OS (1 to 2)
To Fig. 106

TIRE BUILDING APPARATUS

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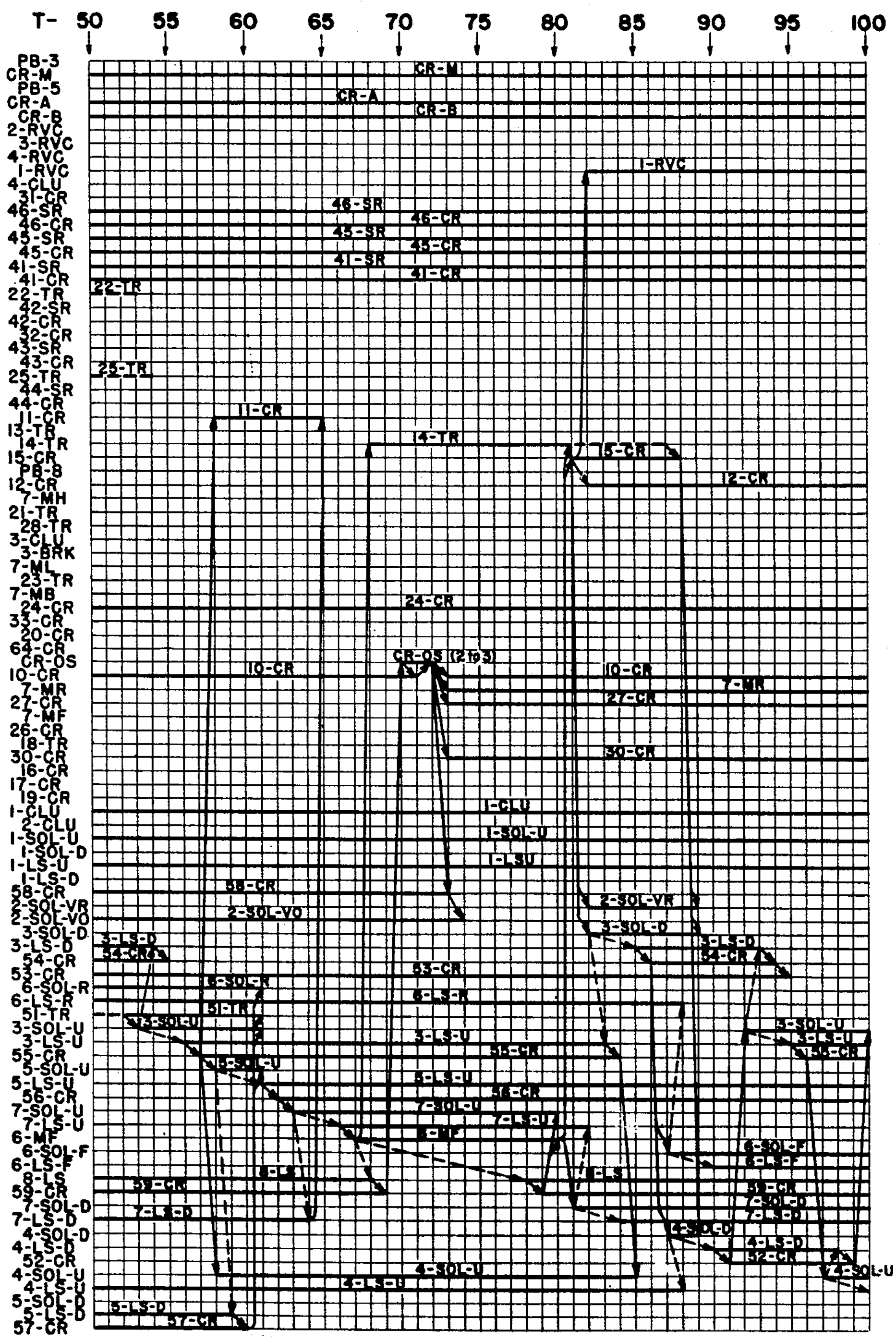
Fig. 92



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TIRE BUILDING APPARATUS

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Fig. 93

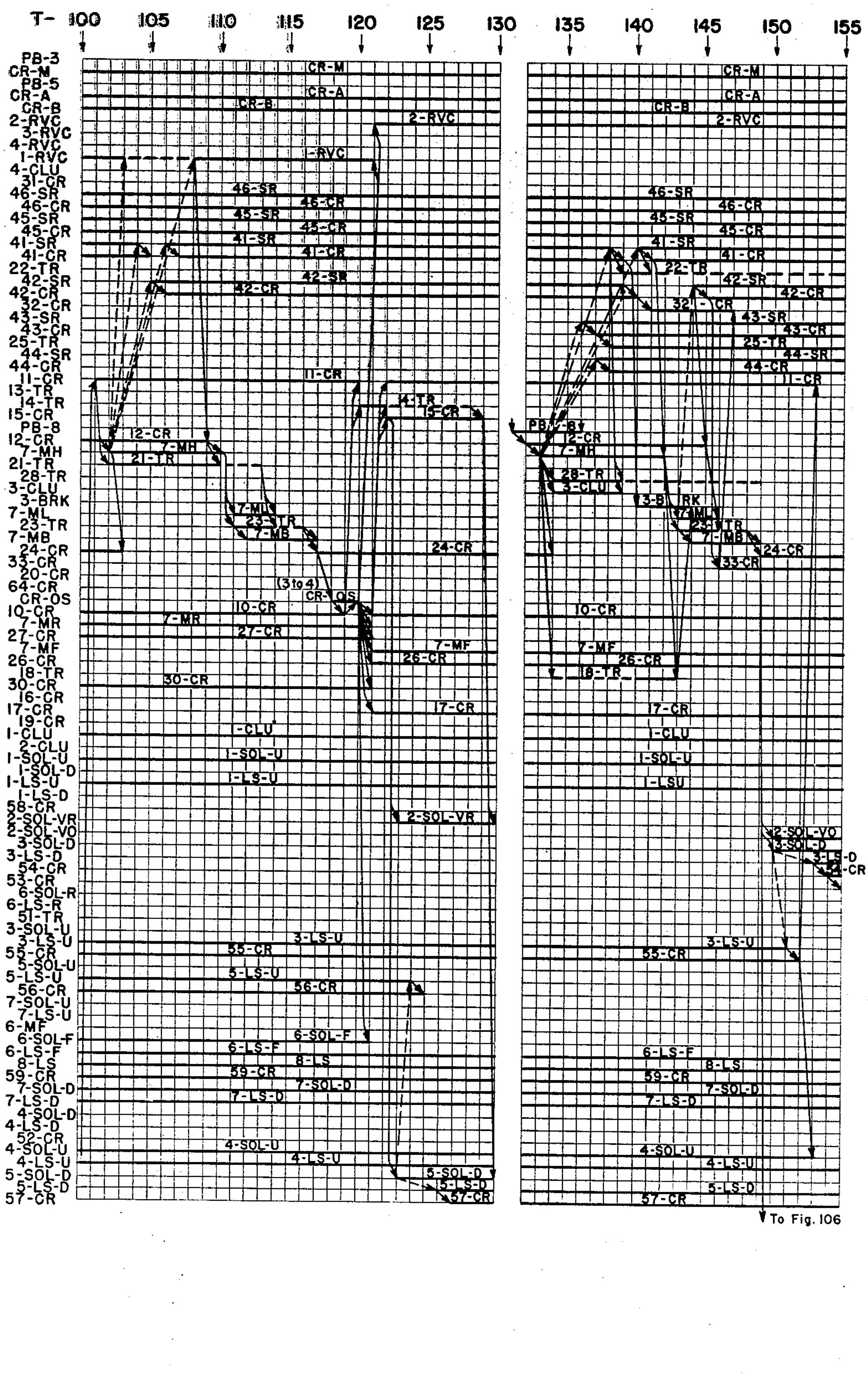
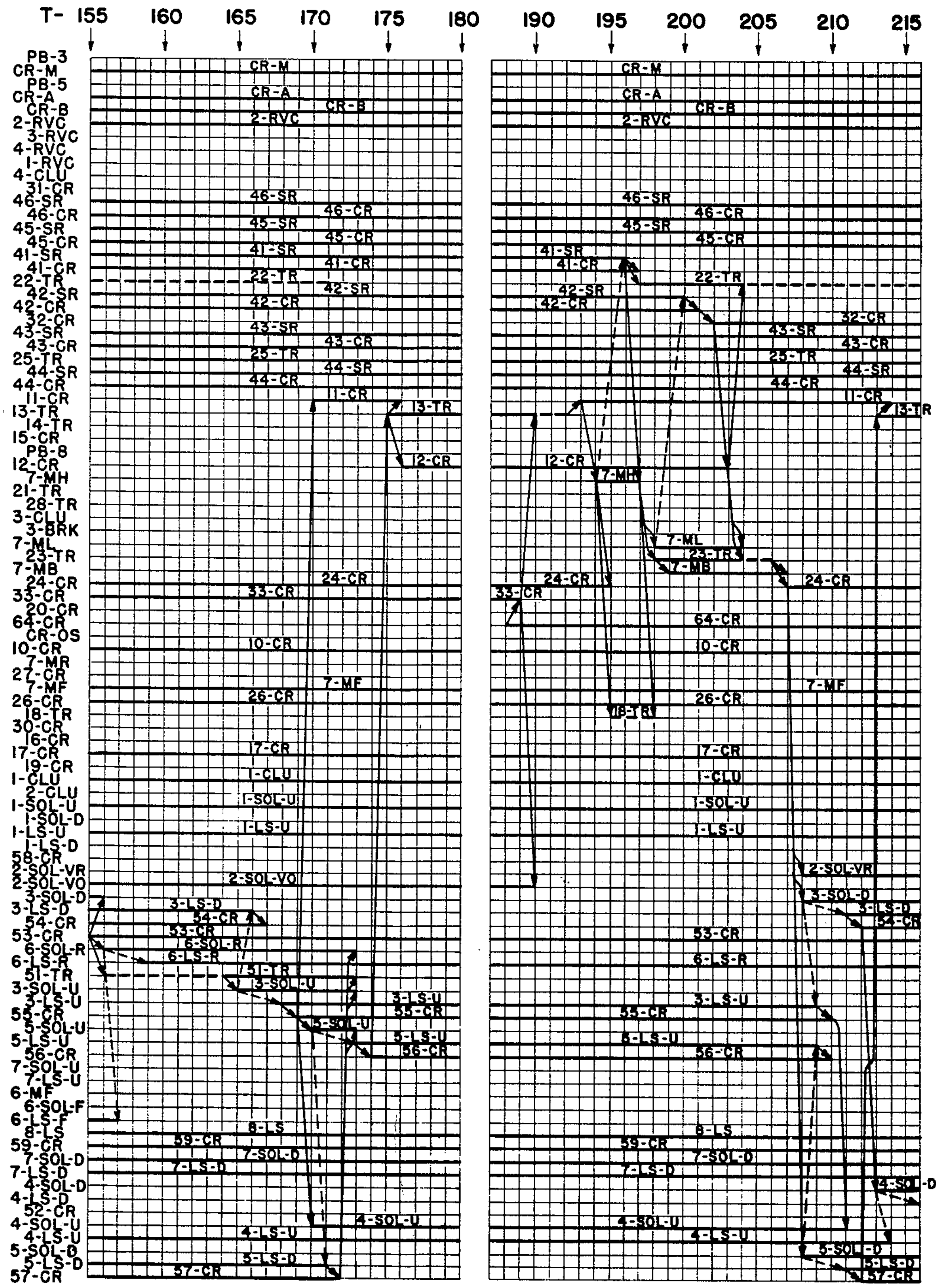


Fig. 94



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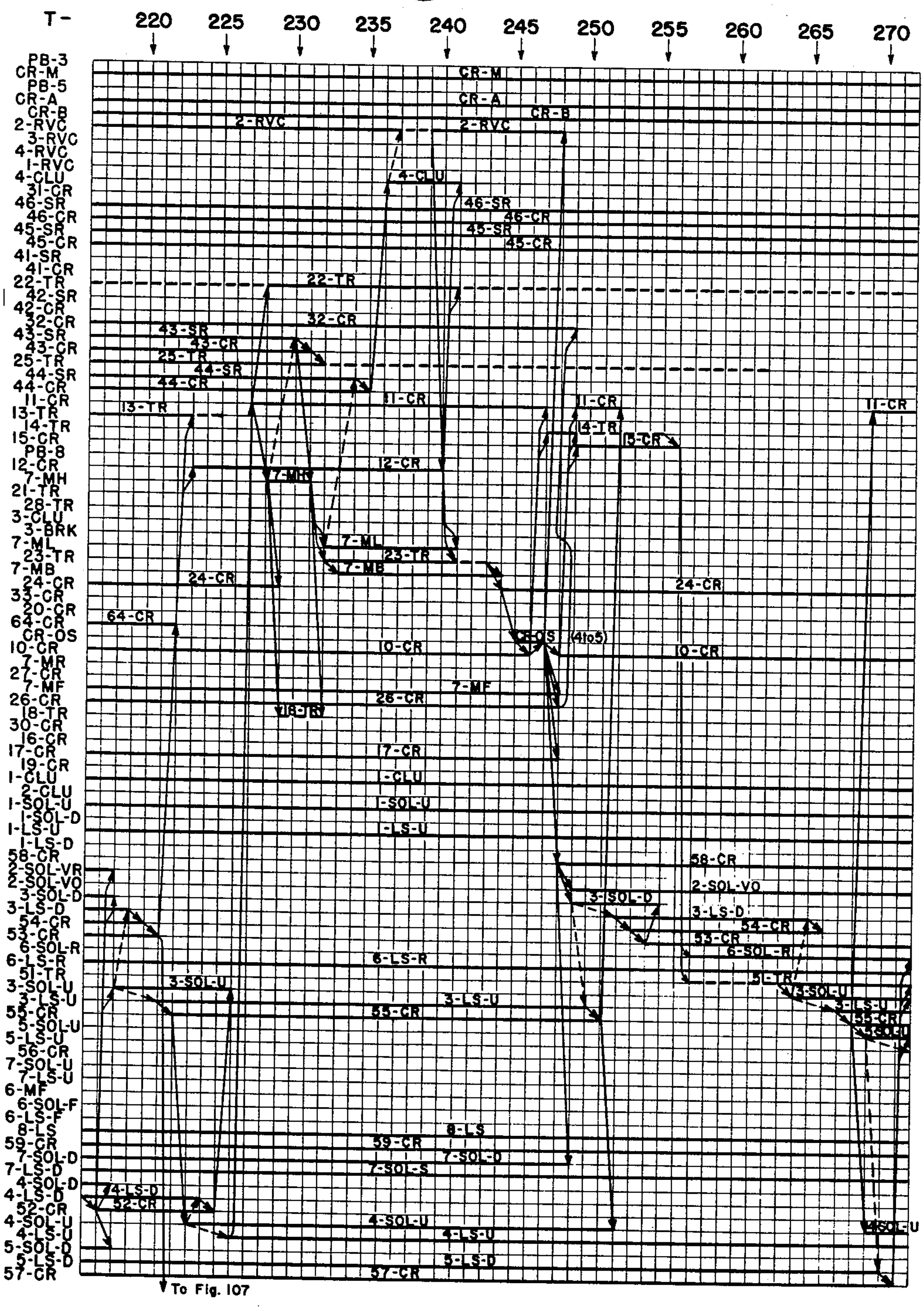

Fig. 95

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Fig. 96

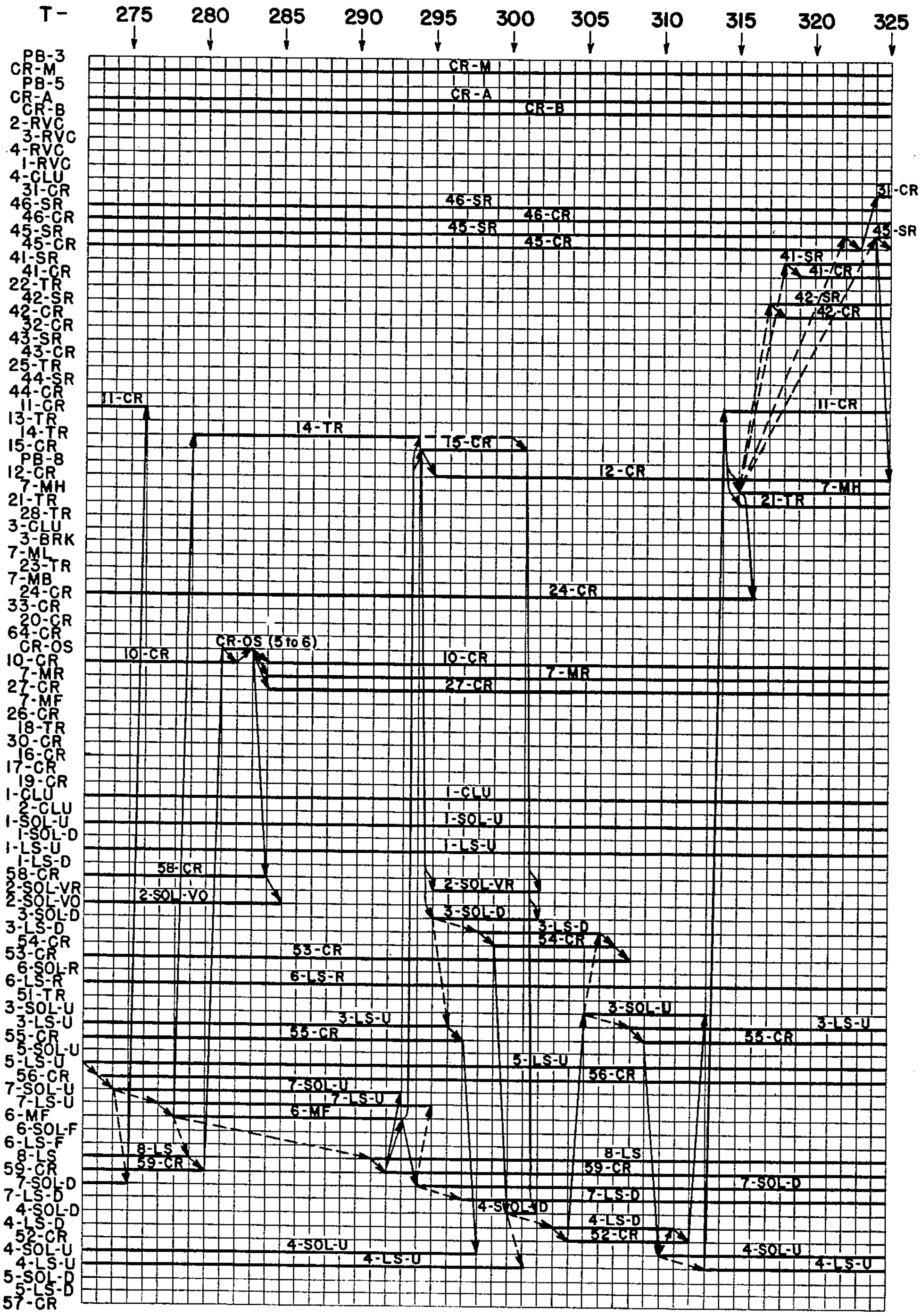
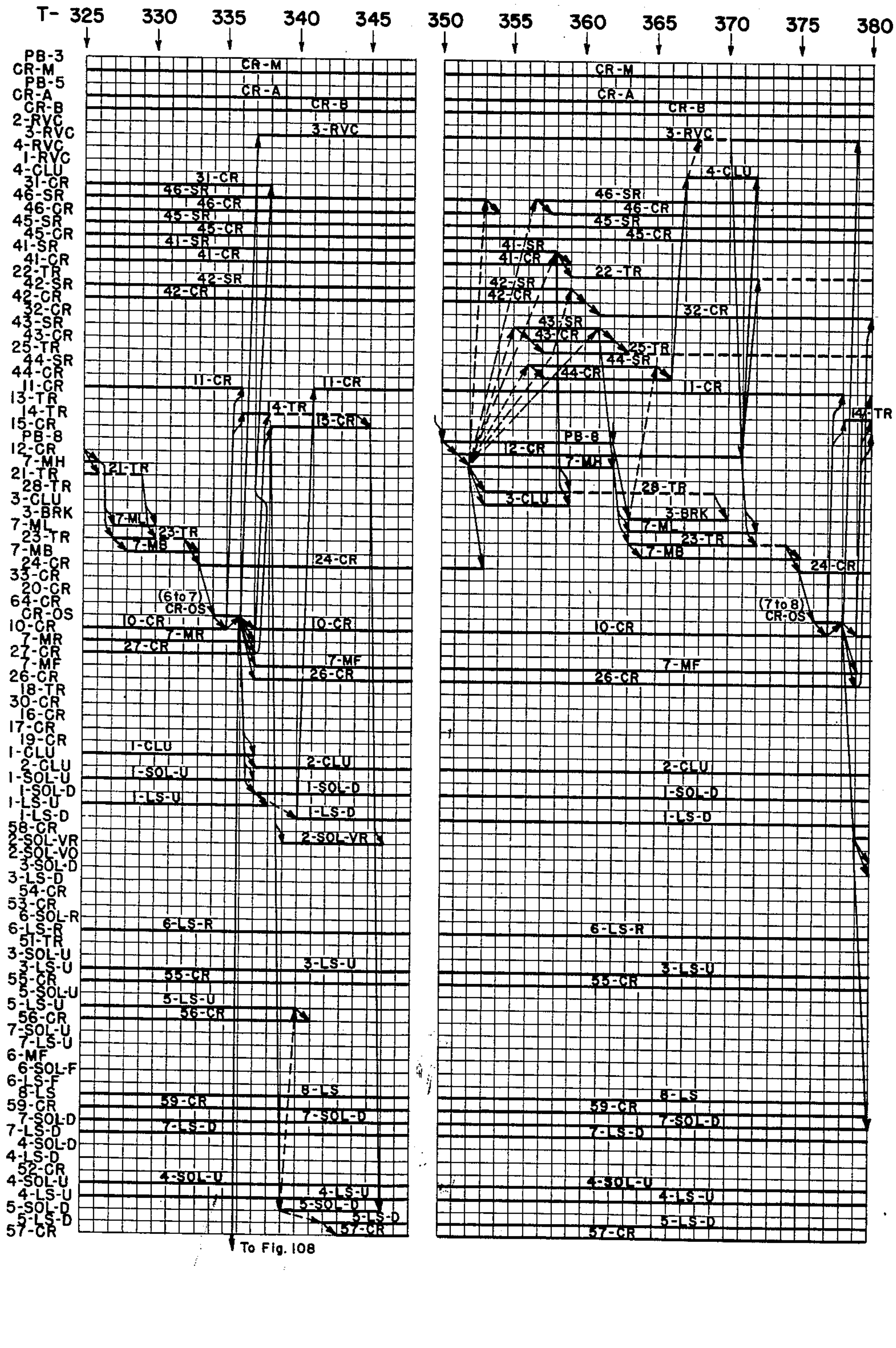


Fig. 97


T- 325
330
335
340
345
350
355
360
365
370
375
380
PB-3
CR-M
PB-5
CR-A
CR-B
2-RVC
3-RVC
4-RVC
1-RVC
4-CLU
31-CR
46-SR
46-CR
45-SR
45-CR
41-SR
41-CR
22-TR
42-SR
42-CR
32-CR
43-SR
43-CR
25-TR
44-SR
44-CR
11-CR
13-TR
14-TR
15-CR
PB-8
12-CR
7-MH
21-TR
28-TR
3-CLU
3-BRK
7-ML
23-TR
7-MB
24-CR
33-CR
20-CR
64-CR
CR-OS
10-CR
7-MR
27-CR
7-MF
26-CR
18-TR
30-CR
16-CR
17-CR
19-CR
1-CLU
2-CLU
1-SOL-U
1-SOL-D
1-LS-U
1-LS-D
58-CR
2-SOL-VR
2-SOL-VO
3-SOL-D
3-LS-D
54-CR
53-CR
6-SOL-R
6-LS-R
51-TR
3-SOL-U
3-LS-U
55-CR
5-SOL-U
5-LS-U
56-CR
7-SOL-U
7-LS-U
6-MF
6-SOL-F
6-LS-F
8-LS
59-CR
7-SOL-D
7-LS-D
4-SOL-D
4-LS-D
52-CR
4-SOL-U
4-LS-U
5-SOL-D
5-LS-D
57-CR
(6 to 7) CR-OS
(7 to 8) CR-OS
To Fig. 108

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TIRE BUILDING APPARATUS

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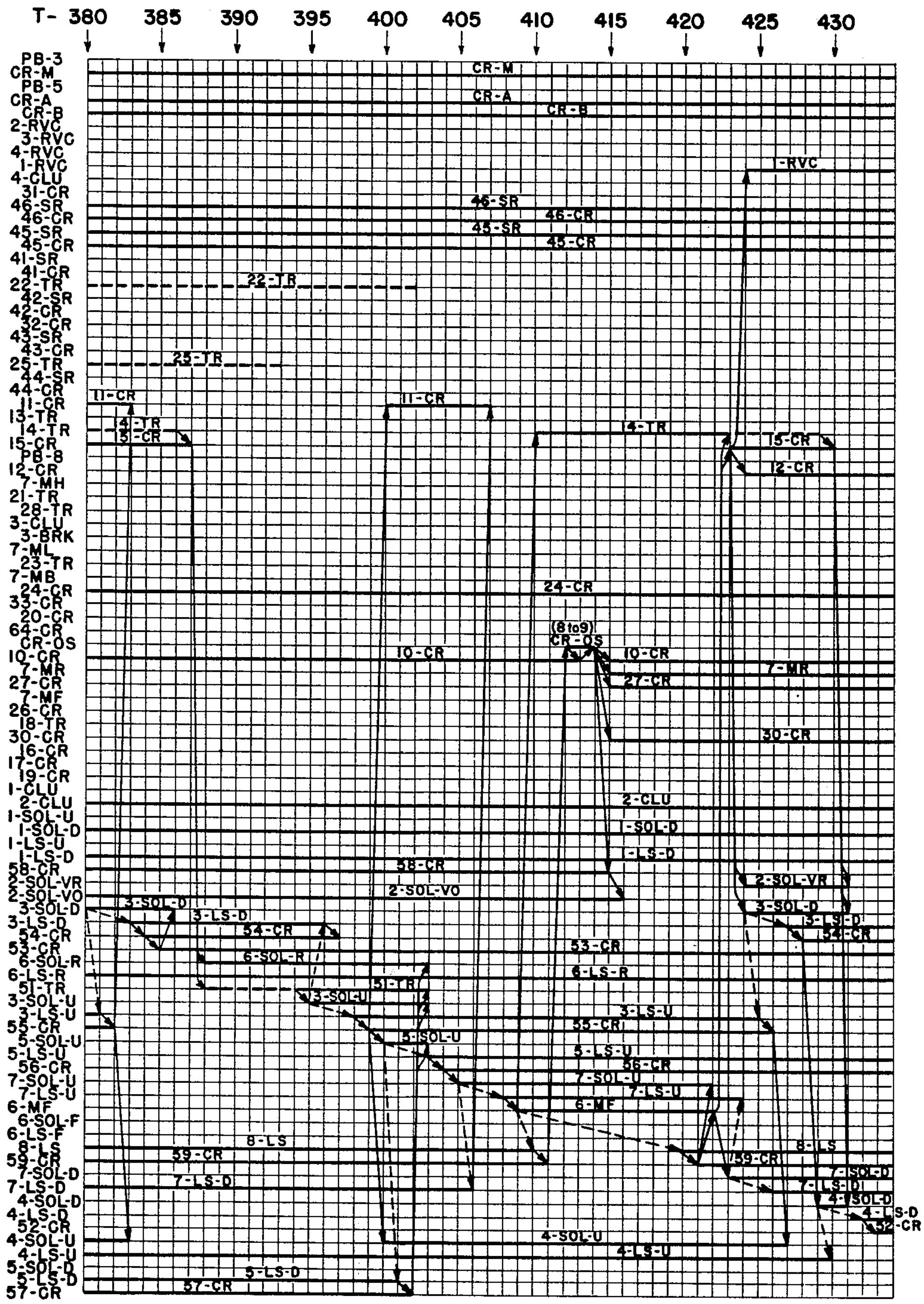
Fig. 98



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TIRE BUILDING APPARATUS

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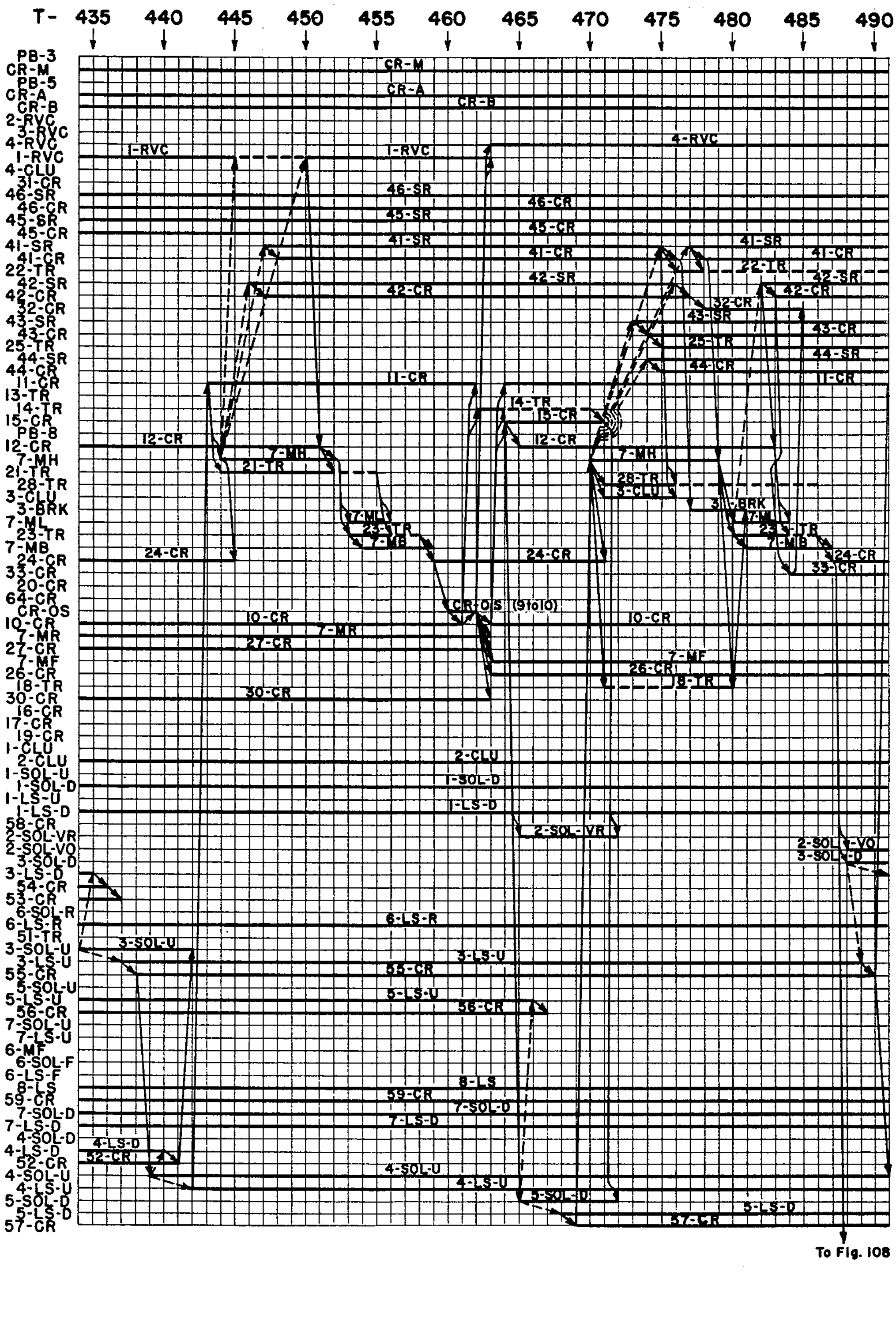
Fig. 99



TIRE BUILDING APPARATUS

Filed Feb. 28, 1962

Fig. 100

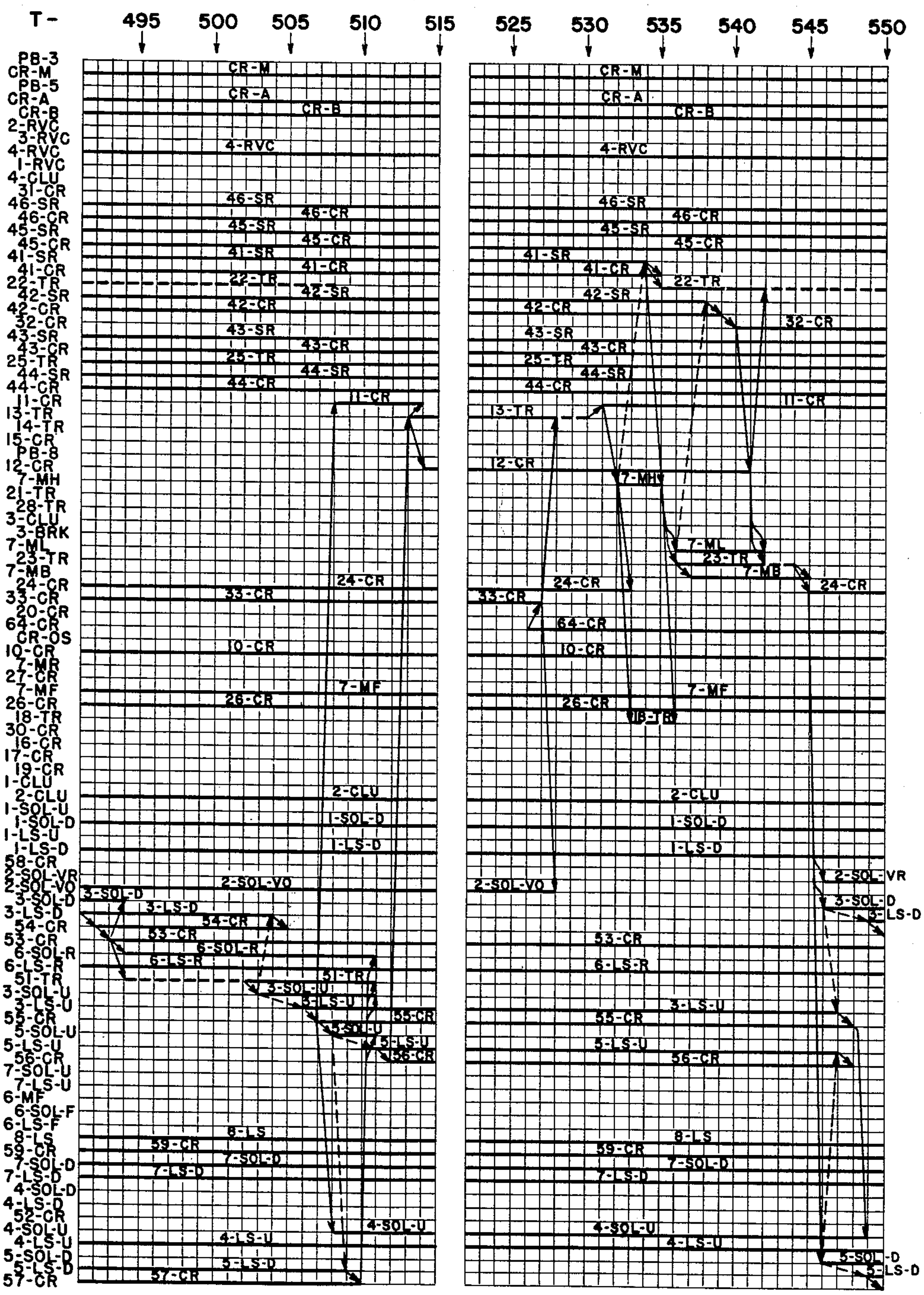


Fig. 101

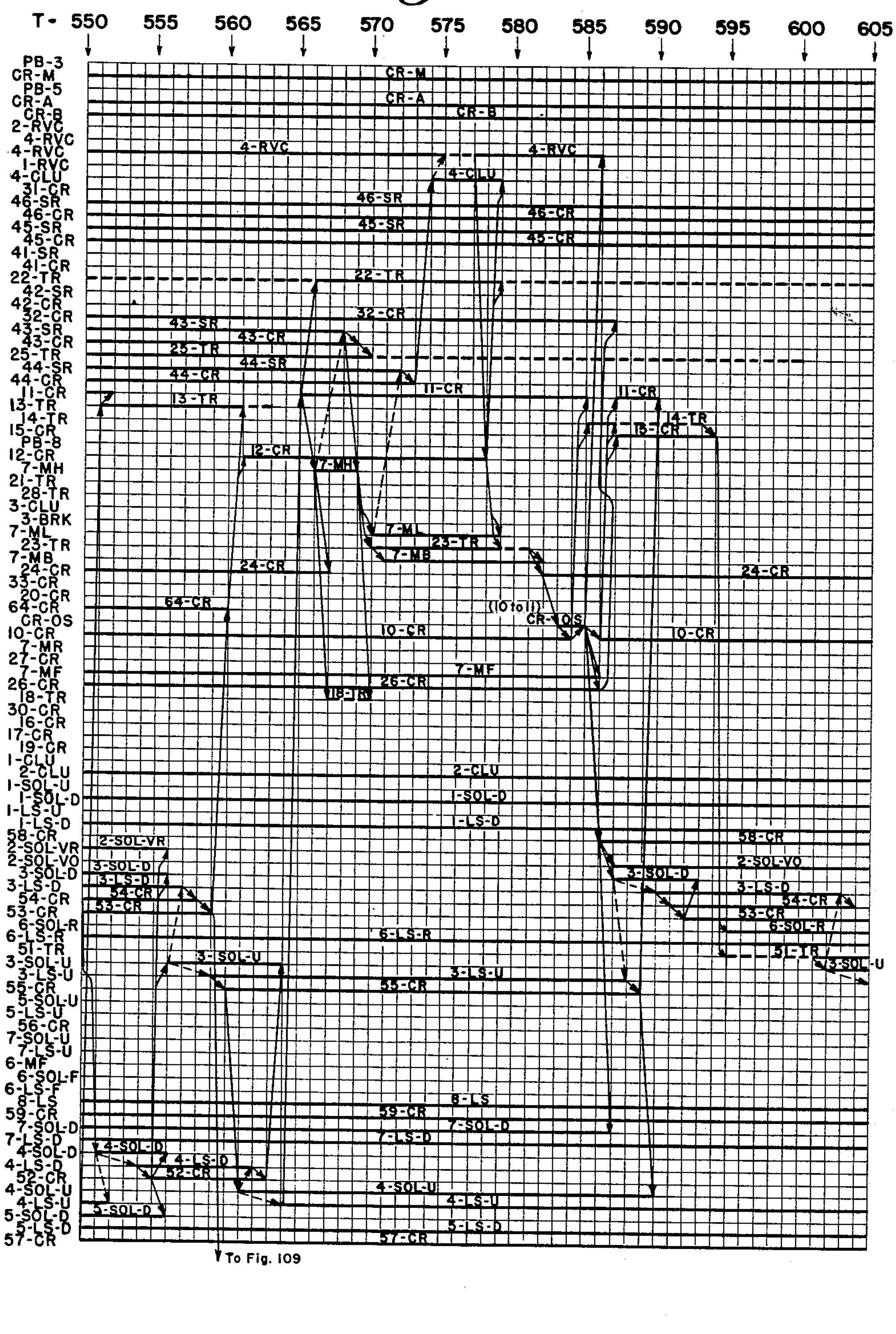

T- 550 555 560 565 570 575 580 585 590 595 600 605
PB-3
CR-M
PB-5
CR-A
CR-B
2-RVC
4-RVC
4-RVC
1-RVC
4-CLU
31-CR
46-SR
46-CR
45-SR
45-CR
41-SR
41-CR
22-TR
42-SR
42-CR
32-CR
43-SR
43-CR
25-TR
44-SR
44-CR
11-CR
13-TR
14-TR
15-CR
PB-8
12-CR
7-MH
21-TR
28-TR
3-CLU
3-BRK
7-ML
23-TR
7-MB
24-CR
33-CR
20-CR
64-CR
CR-OS
10-CR
7-MR
27-CR
7-MF
26-CR
18-TR
30-CR
16-CR
17-CR
19-CR
1-CLU
2-CLU
1-SOL-U
1-SOL-D
1-LS-U
1-LS-D
58-CR
2-SOL-VR
2-SOL-VO
3-SOL-D
3-LS-D
54-CR
53-CR
6-SOL-R
6-LS-R
51-TR
3-SOL-U
3-LS-U
55-CR
5-SOL-U
5-LS-U
56-CR
7-SOL-U
7-LS-U
6-MF
6-SOL-F
6-LS-F
8-LS
59-CR
7-SOL-D
7-LS-D
4-SOL-D
4-LS-D
52-CR
4-SOL-U
4-LS-U
5-SOL-D
5-LS-D
57-CR
(10 to 11)
To Fig. 109

Fig. 102

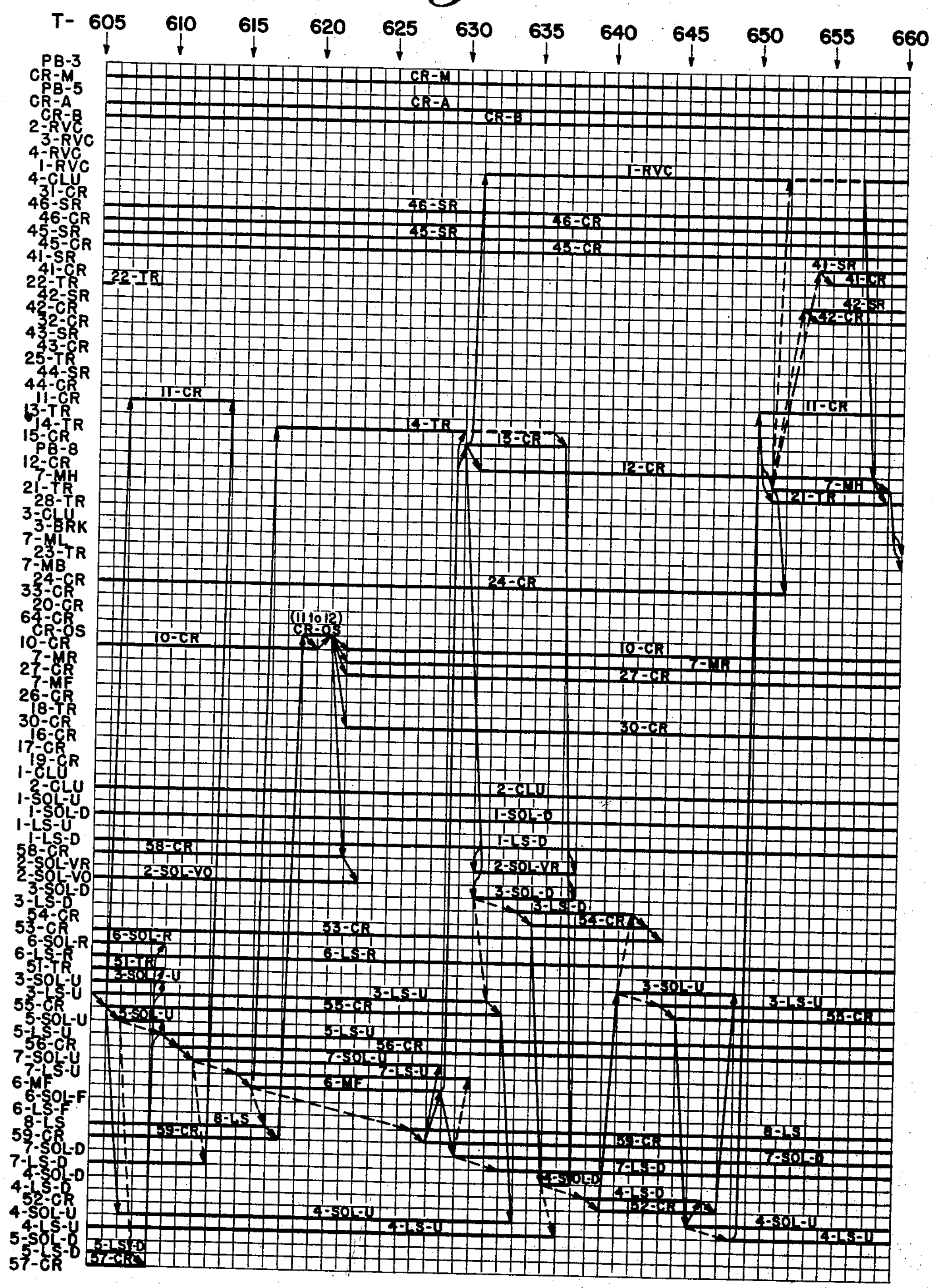

T- 605 610 615 620 625 630 635 640 645 650 655 660
PB-3
CR-M
PB-5
CR-A
CR-B
2-RVC
3-RVC
4-RVC
1-RVC
4-CLU
31-CR
46-SR
46-CR
45-SR
45-CR
41-SR
41-CR
22-TR
42-SR
42-CR
32-CR
43-SR
43-CR
25-TR
44-SR
44-CR
11-CR
13-TR
14-TR
15-CR
PB-8
12-CR
7-MH
21-TR
28-TR
3-CLU
3-BRK
7-ML
23-TR
7-MB
24-CR
33-CR
20-CR
64-CR
CR-OS
10-CR
7-MR
27-CR
7-MF
26-CR
18-TR
30-CR
16-CR
17-CR
19-CR
1-CLU
2-CLU
1-SOL-U
1-SOL-D
1-LS-U
1-LS-D
58-CR
2-SOL-VR
2-SOL-VO
3-SOL-D
3-LS-D
54-CR
53-CR
6-SOL-R
6-LS-R
51-TR
3-SOL-U
3-LS-U
55-CR
5-SOL-U
5-LS-U
56-CR
7-SOL-U
7-LS-U
6-MF
6-SOL-F
6-LS-F
8-LS
59-CR
7-SOL-D
7-LS-D
4-SOL-D
4-LS-D
52-CR
4-SOL-U
4-LS-U
5-SOL-D
5-LS-D
57-CR
(11 to 12)

Fig. 103

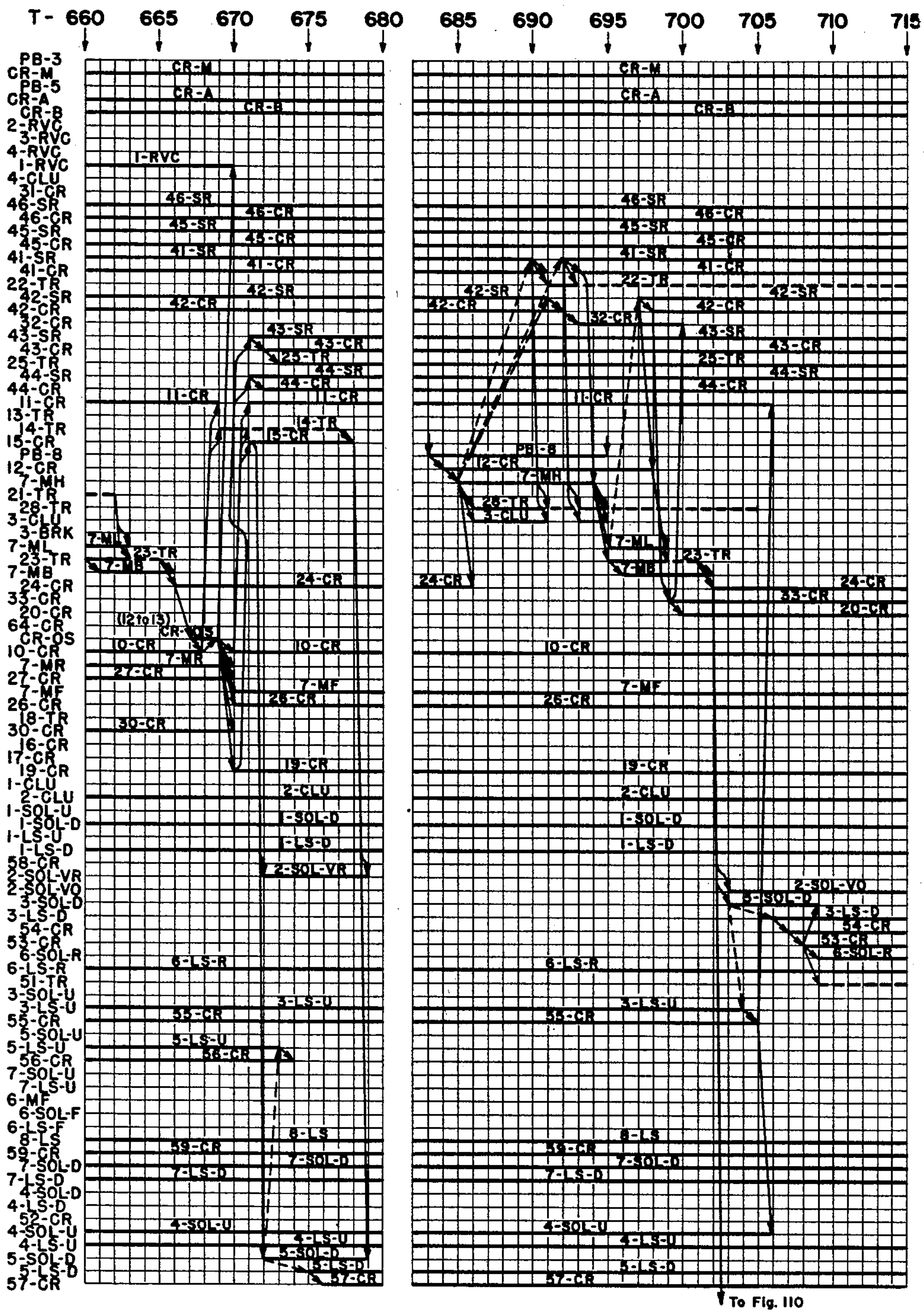

T- 660 665 670 675 680 685 690 695 700 705 710 715
PB-3
CR-M
PB-5
CR-A
CR-B
2-RVC
3-RVC
4-RVC
1-RVC
4-CLU
31-CR
46-SR
46-CR
45-SR
45-CR
41-SR
41-CR
22-TR
42-SR
42-CR
32-CR
43-SR
43-CR
25-TR
44-SR
44-CR
11-CR
13-TR
14-TR
15-CR
PB-8
12-CR
7-MH
21-TR
28-TR
3-CLU
3-BRK
7-ML
23-TR
7-MB
24-CR
33-CR
20-CR
64-CR
CR-OS
10-CR
7-MR
27-CR
7-MF
26-CR
18-TR
30-CR
16-CR
17-CR
19-CR
1-CLU
2-CLU
1-SOL-U
1-SOL-D
1-LS-U
1-LS-D
58-CR
2-SOL-VR
2-SOL-VO
3-SOL-D
3-LS-D
54-CR
53-CR
6-SOL-R
6-LS-R
51-TR
3-SOL-U
3-LS-U
55-CR
5-SOL-U
5-LS-U
56-CR
7-SOL-U
7-LS-U
6-MF
6-SOL-F
6-LS-F
8-LS
59-CR
7-SOL-D
7-LS-D
4-SOL-D
4-LS-D
52-CR
4-SOL-U
4-LS-U
5-SOL-D
5-LS-D
57-CR
(12 to 13)
To Fig. 110

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Fig. 104

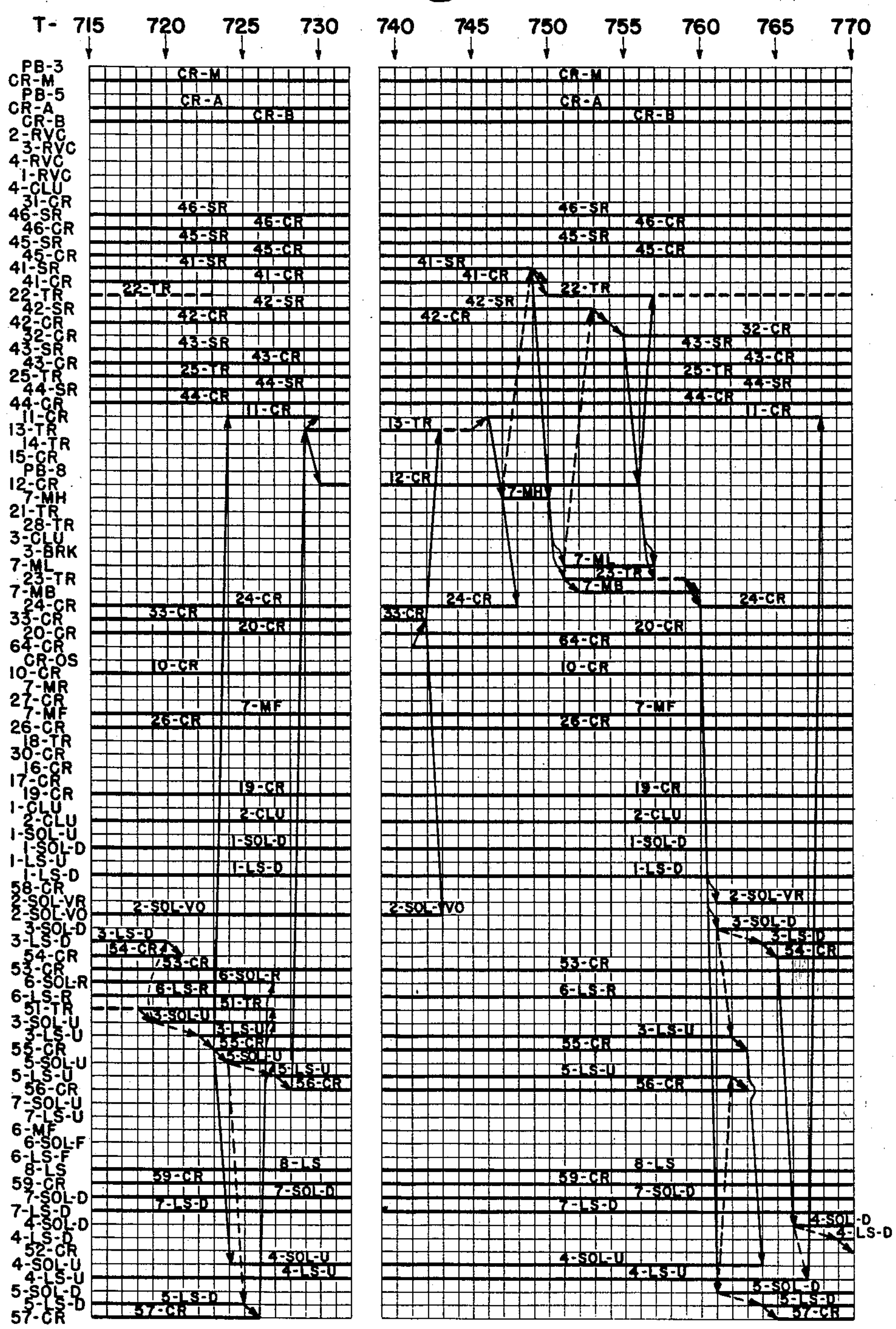

Fig. 105

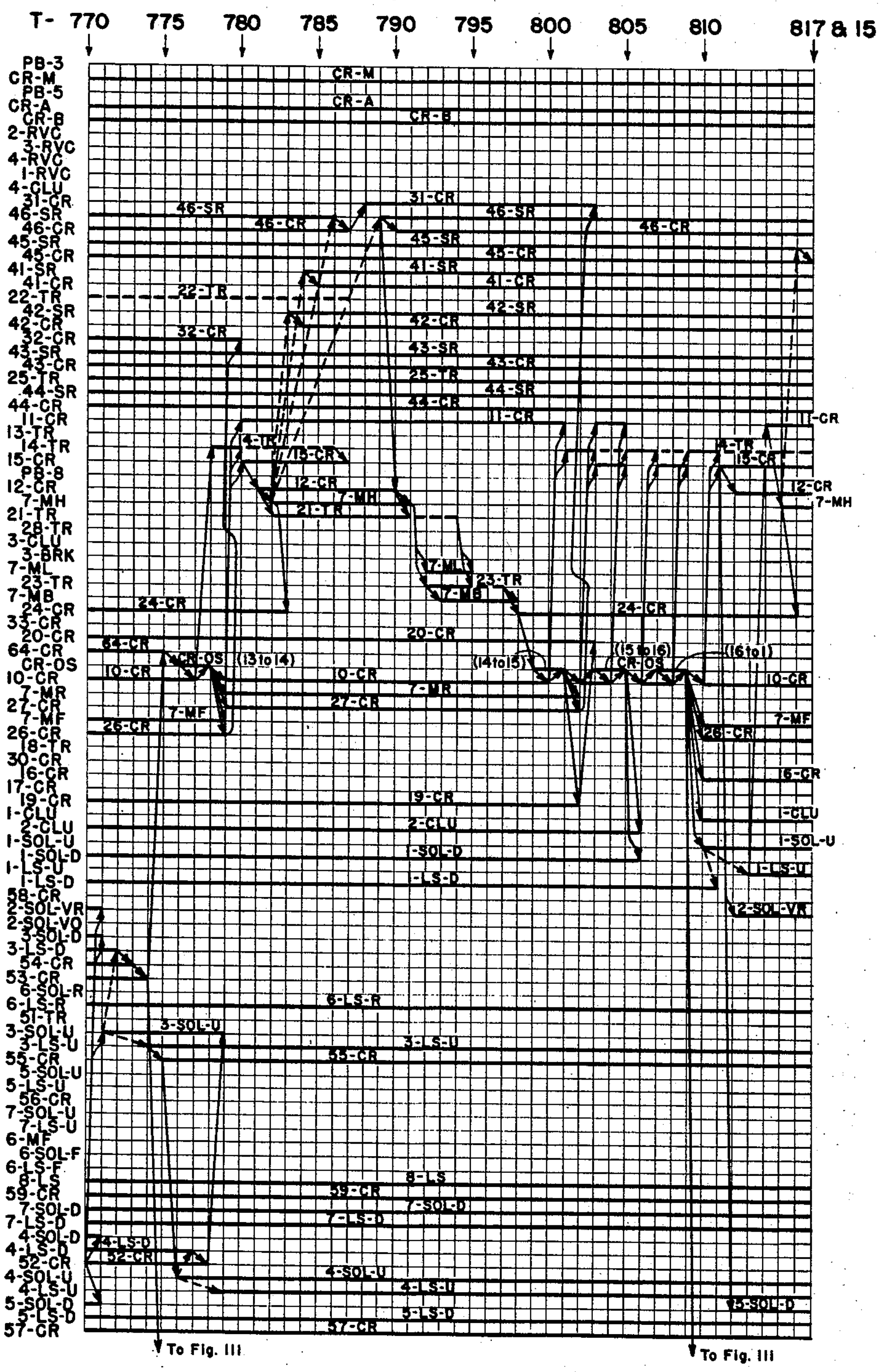

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Fig. 106

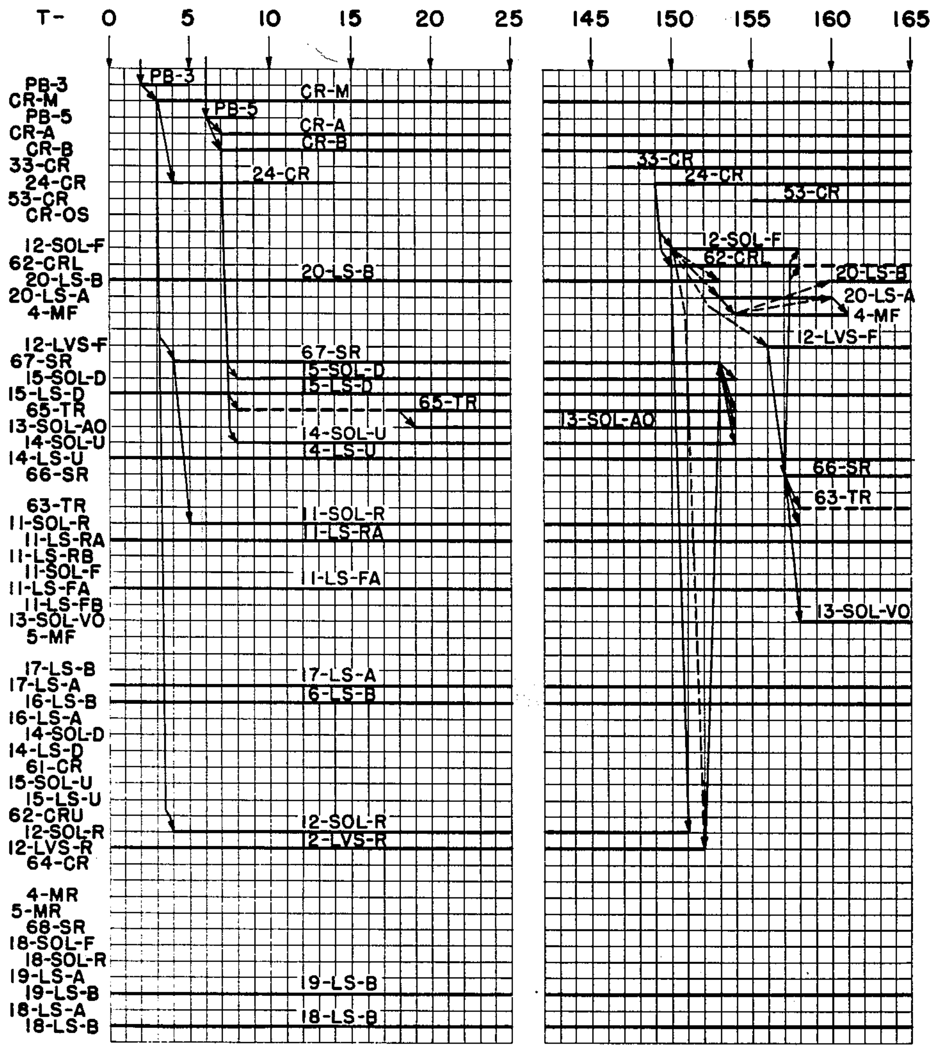

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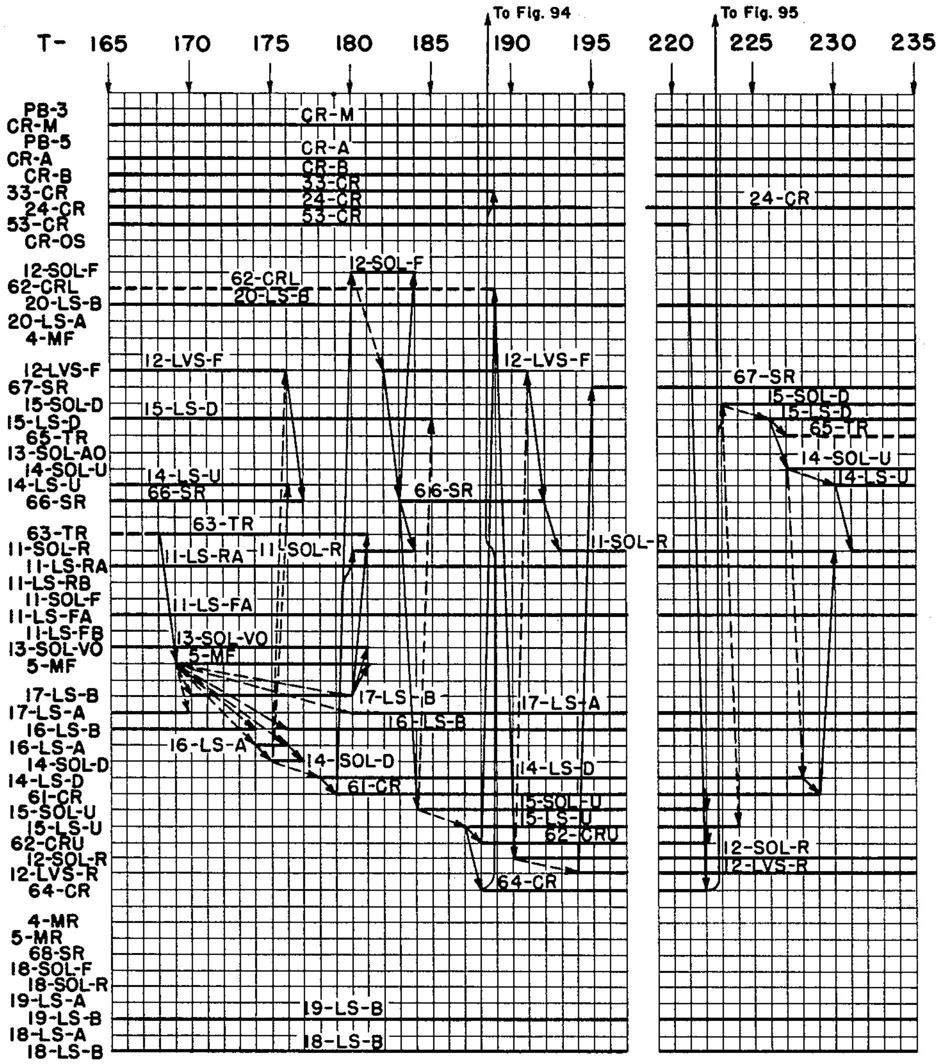
Fig. 107



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TIRE BUILDING APPARATUS

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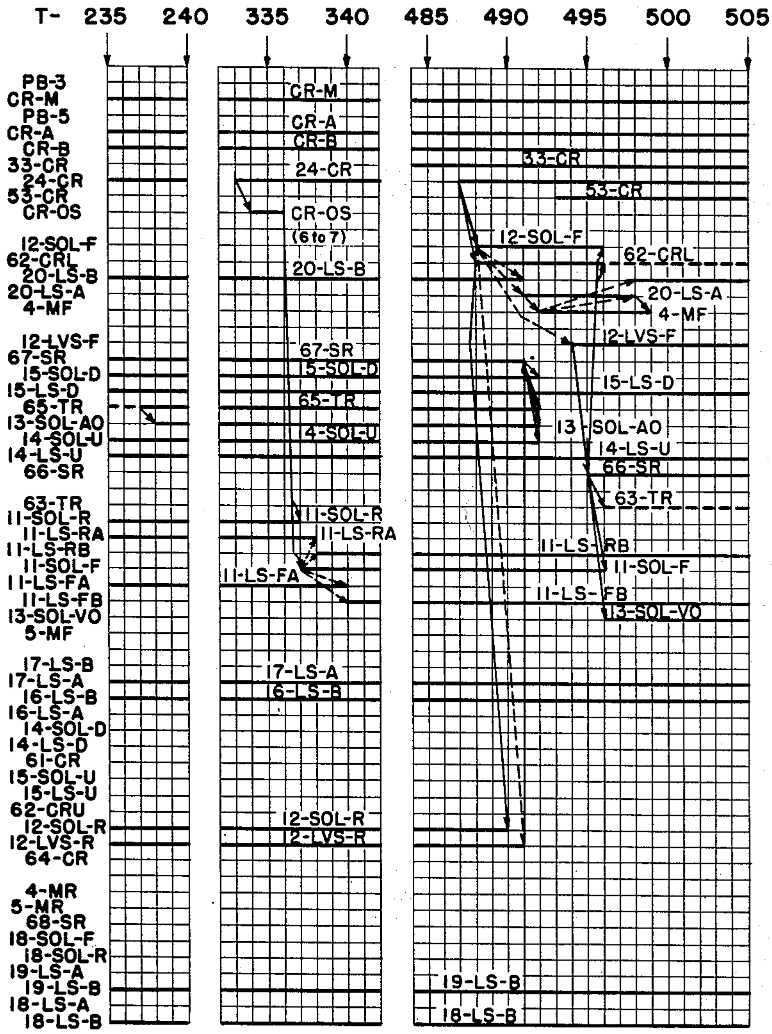
Fig. 108



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TIRE BUILDING APPARATUS

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Fig. 109

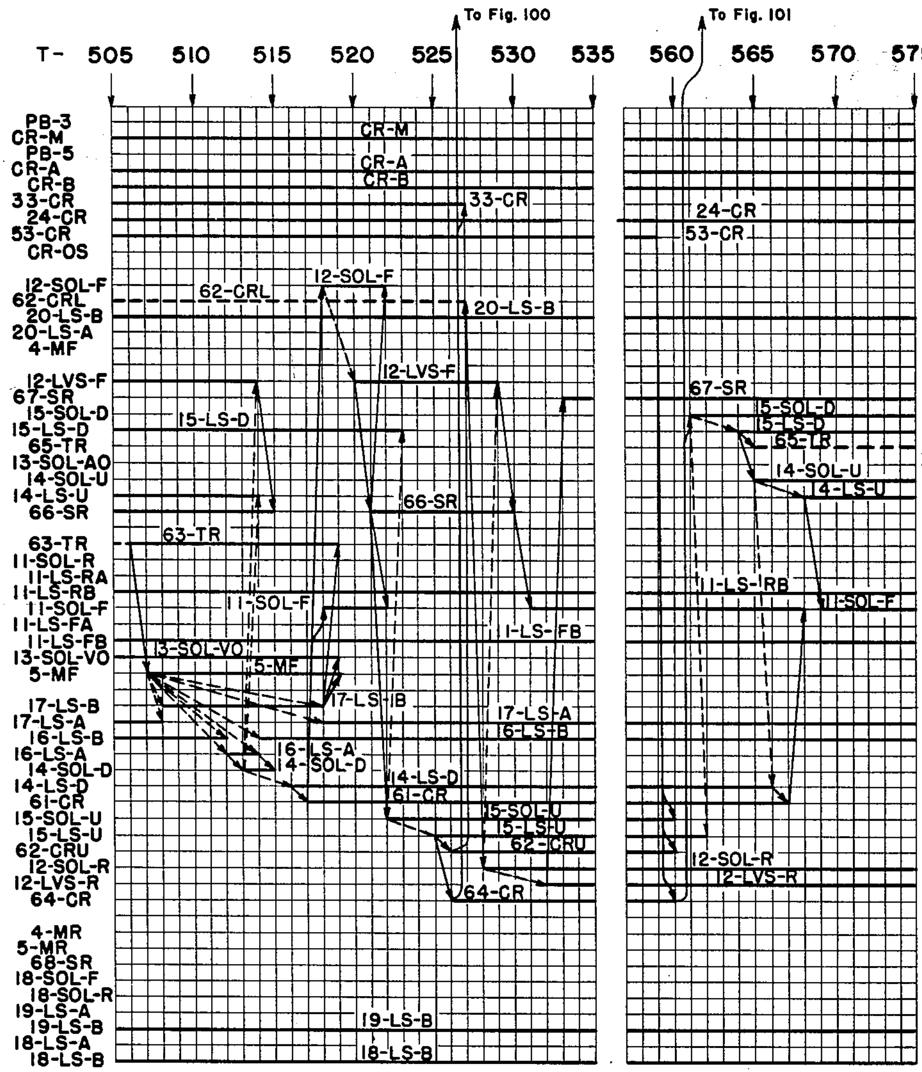

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Fig. 110

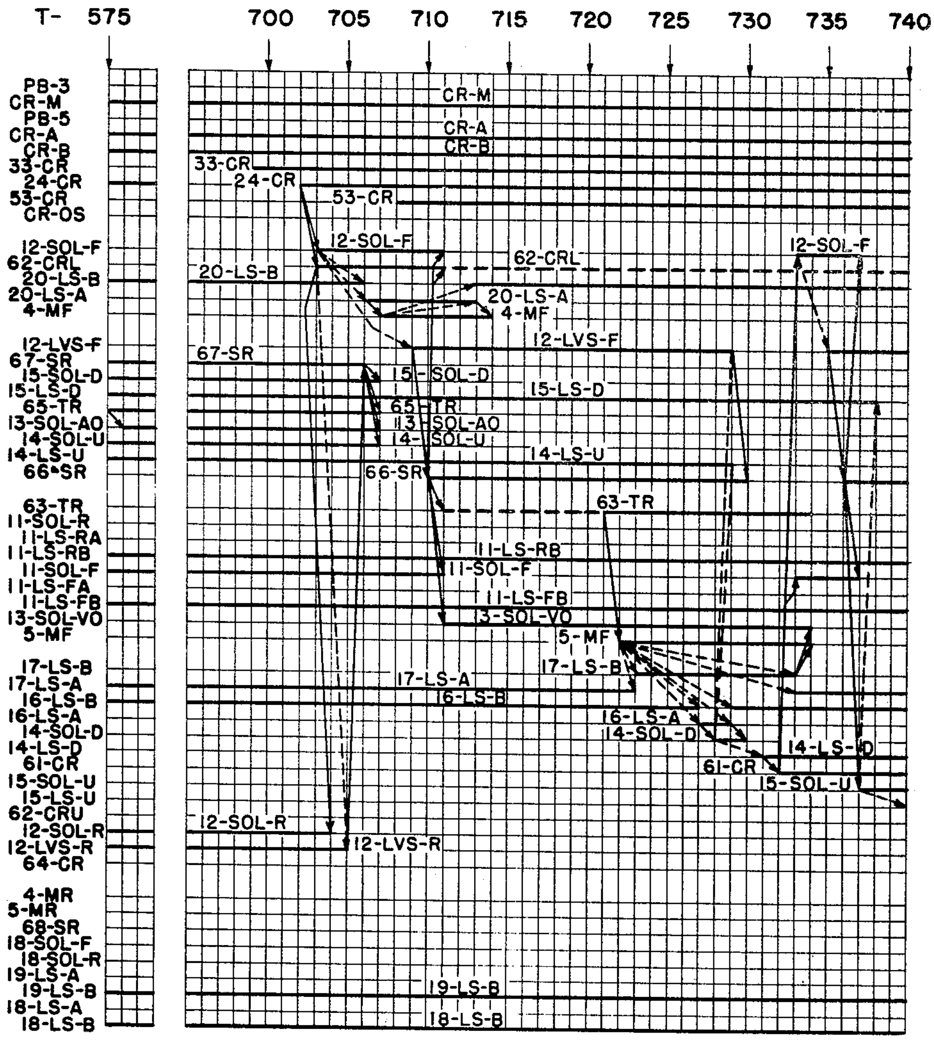

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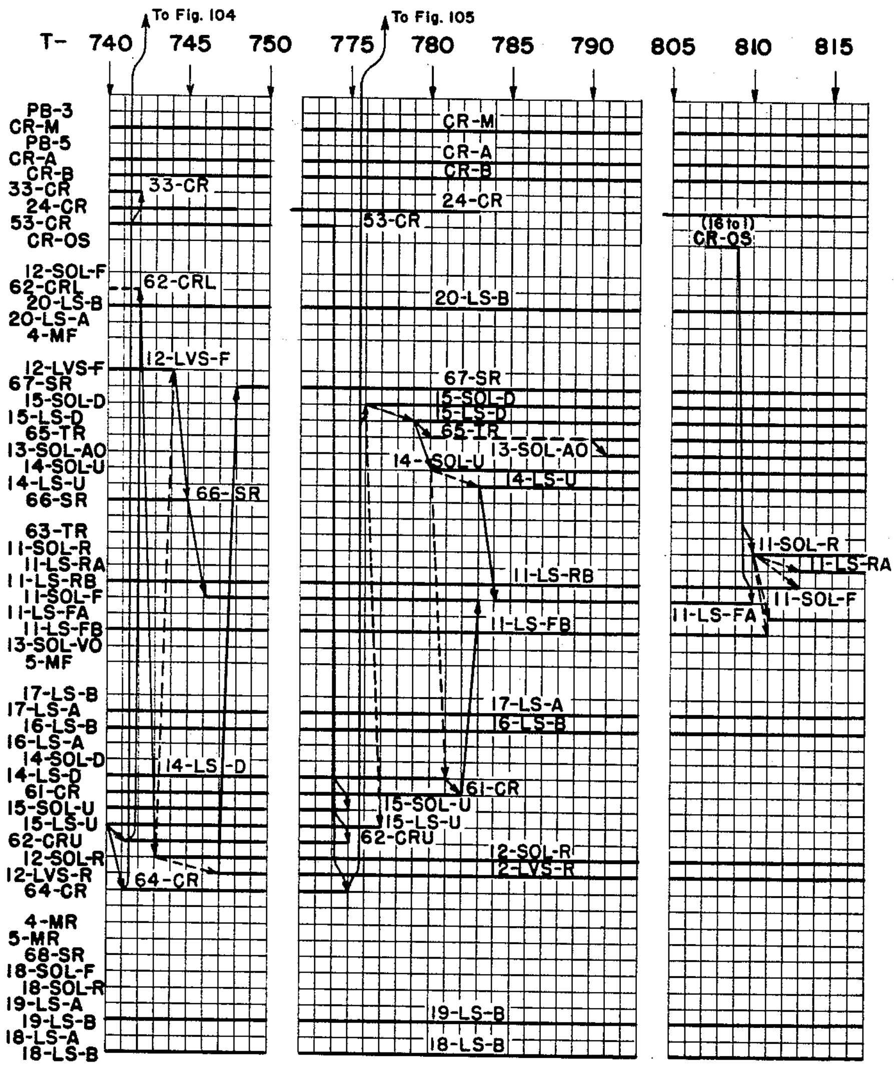
Fig. 111



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United States Patent Office

3,142,603

Patented July 28, 1964

3,142,603
TIRE BUILDING APPARATUS

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Filed Feb. 28, 1962, Ser. No. 176,229
18 Claims. (Cl. 156—405)

This invention relates to apparatus for building pneumatic tires. More particularly, it relates to automatic apparatus that: (1) bias-cuts rubber-coated tire cord fabrics to form rhomboidal sections of desired widths; (2) cuts these sections lengthwise to form plies of desired lengths; and (3) delivers the plies in proper sequence to a tire building drum for fabrication of the tire carcasses.

Carcasses for pneumatic tires are generally fabricated on cylindrical tire building drums by winding a series of layers or plies of bias-cut rubber-coated tire fabrics on the drums, the cord angle of each ply being reversed to the cord angle of the ply or plies adjacent thereto. During the winding or build-up operation, the diameter of the carcass increases as each successive ply is added and this, in turn, requires that, in a given carcass, the length of each successive ply be progressively greater than the length of the ply that immediately precedes it in order to provide suitable overlapping at the ply ends.

The foregoing requirement is met, in conventional tire building apparatus, by having an operator manually cut each ply to length as he winds the ply on the drum, the operator's skill and judgment being relied on to provide an adequate, yet not excessive, overlapping of the ply ends. In consequence of the foregoing, there is often a considerable variation in the quality and uniformity of tires made on conventional apparatus, due to differences in operator skill, operator fatigue, carelessness, and the like.

Tire quality and uniformity are also adversely affected by other aspects of present tire building apparatus. For example, in order to form a strong wrap around the bead wires, thereby eliminating defective bead regions, and to avoid the formation of air pockets or voids in the bead areas of tires, the first and second plies of each carcass are often cut to different widths so that a step-off is provided when the side edges of these plies are turned up over the bead rings. In conventional equipment, however, such plies are usually manually aligned with one another, and with the center of the drum, by the operator. Should the center lines of the two plies be offset laterally from one another, the amount of the step-offs would vary and one bead area of a carcass would have a large step-off, while the other bead area would have little or no step-off. The latter condition facilitates the formation of undesirable voids in the carcass that could lead to premature failure of the tire in service.

In a similar manner the first two plies, although aligned with one another, may be misaligned with the tire building drums. In this case, after the plies are wound on the drum and the operator has turned the ply edges over the beads, there would be a greater overlapping at one bead area than at the other. Here again untimely failure of the tire could result.

The splicing of adjacent sections of bias-cut fabrics to one another before cutting the sections to ply length is another potential source of poor tire quality and uniformity as performed on apparatus in present usage. Desirably, each splice should contain a prescribed amount of overlap between adjacent ends of the sections being joined, and the sections should be kept in longitudinal alignment during the joining. However, since this is often a manual operation, operator skill is usually determinative of the quality and uniformity achieved.

In order to overcome many of the disadvantages connected with building tires on presently used apparatus, it has been found desirable, in accordance with the present invention, to provide a tire building apparatus in which many of the formely independent steps are automatically performed by a single integrated machine which accurately and efficiently performs the various operations involved in building tires and provides uniform high quality tires.

Accordingly, it is one object of this invention to provide improved apparatus for building pneumatic tires.

Another object of this invention is to provide improved apparatus for automatically preparing and delivering plies to a tire building drum.

A further object of this invention is to provide improved apparatus for cutting tire building fabrics to ply length preparatory to winding the plies on a tire building drum.

An additional object of this invention is to provide improved apparatus for aligning tire fabric plies with one another and with a tire building drum.

It is also an object of this invention to provide improved apparatus for splicing bias-cut sections of tire fabrics to one another.

Another object of this invention is to provide an improved tire building machine having adjustments therein for building various sized tires.

Further objects and advantages of this invention will become apparent as the following description proceeds.

Briefly stated, and in accordance with one embodiment of this invention, there is provided a tire building machine comprising a bias-cutter for supplying bias-cut sections of fabric from a web of tire cord fabric, a conveyor to which the cut sections of fabric are delivered, a tire building drum at one end of the conveyor, means for cutting the sections of fabric to desired length to form from each each section a ply of desired length and a remnant piece, means for driving the conveyor in a forward direction to deliver the ply to the tire building drum, and means cooperating with the conveyor to splice the remnant piece to a succeeding section of fabric prior to cutting the succeeding section to proper ply length.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of this invention, it is believed that the invention will be better understood from the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of a preferred form of tire building apparatus in accordance with this invention but having numerous details omitted for greater clarity;

FIG. 1A is a diagrammatic view showing the relative positions of the plies with respect to the main conveyor, the tire building drum and a reference line extending therebetween;

FIG. 1B is an enlarged view of the drum, with the plies in section, showing the positions of the plies in relation to the drum;

FIG. 1C is an enlarged sectional view of a completed carcass showing the manner in which the ply edges are wound about the bead wires of the carcass;

FIG. 2 is a plan view of the bias-cutter with portions broken away for clarity;

FIG. 3 is a side elevational view of the bias-cutter, taken on line 3—3 of FIG. 2, with the main conveyor omitted for clarity;

FIG. 4 is an enlarged elevational view, partly in section, taken along the line 4—4 of FIG. 2;

FIG. 5 is a sectional view taken on line 5—5 of FIG. 4;

FIG. 6 is an enlarged sectional view taken on line **6—6** of FIG. 3;

FIG. 7 is an enlarged sectional view taken on line **7—7** of FIG. 2;

FIG. 8 is an enlarged detailed plan view of a fabric gripping means utilized in the bias-cutter;

FIG. 9 is an enlarged sectional view taken on line **9—9** of FIG. 8;

FIG. 10 is a sectional view taken on line **10—10** of FIG. 9;

FIG. 11 is an enlarged sectional view taken on line **11—11** of FIG. 8;

FIG. 12 is an enlarged sectional view, taken on line **12—12** of FIG. 2, showing portions of a mechanism employed in changing the cutting angle of the bias-cutter;

FIG. 13 is an enlarged sectional plan view of the angle changing mechanism, taken on line **13—13** of FIG. 12;

FIG. 14 is a reduced scale sectional view of the angle changing mechanism, taken on line **14—14** of FIG. 13;

FIG. 15 is an enlarged sectional view, taken on line **15—15** of FIG. 2, showing one of the wheels employed in supporting a movable frame portion of the bias-cutter from a stationary frame portion thereof;

FIG. 16 is an enlarged sectional view, taken on line **16—16** of FIG. 2, showing another one of the wheels employed in supporting the movable frame portion of the bias-cutter from the stationary frame portion thereof;

FIG. 17 is an enlarged sectional view, taken on line **17—17** of FIG. 2, showing a fabric cutting mechanism employed in the bias-cutter;

FIG. 18 is a plan view of the fabric cutting mechanism shown in FIG. 17;

FIG. 19 is a sectional view taken on line **19—19** of FIG. 18;

FIG. 20 is an enlarged sectional view taken on line **20—20** of FIG. 18;

FIG. 21 is an enlarged view of a fabric width and drop control mechanism utilized in the bias-cutter to control the widths of the sections of fabric cut therein and the positions at which these sections are dropped onto the main conveyor;

FIG. 22 is an enlarged sectional view taken on line **22—22** of FIG. 21;

FIG. 23 is an enlarged elevational view, taken on line **23—23** of FIG. 21;

FIG. 24 is an enlarged elevational view taken on line **24—24** of FIG. 21;

FIG. 25 is a sectional view taken on line **25—25** of FIG. 24;

FIG. 26 is an enlarged sectional view taken on line **26—26** of FIG. 21;

FIG. 27 is an enlarged sectional view taken on line **27—27** of FIG. 21;

FIG. 28 is a sectional plan view taken on line **28—28** of FIG. 22 showing the fabric width and drop control mechanism in a different condition of operation from that shown in FIG. 21;

FIGS. 29 and 30, together, form an elevational view of the main conveyor, the view omitting portions of the bias-cutter and being broken away at various places to provide greater clarity;

FIG. 31 is an enlarged plan view of the downstream portion of the main conveyor, taken on line **31—31** of FIG. 30, with portions of the conveyor broken away for clarity;

FIG. 32 is an enlarged plan view of the upstream portion of the main conveyor, taken on line **32—32** of FIG. 29, with portions of the conveyor broken away for clarity;

FIG. 33 is an enlarged sectional view taken on line **33—33** of FIG. 32;

FIG. 34 is an enlarged sectional view taken on line **34—34** of FIG. 32;

FIG. 35 is an enlarged sectional view taken on line **35—35** of FIG. 34;

FIG. 36 is an elevational view of a storage device used in the tire building apparatus;

FIG. 37 is an enlarged plan view, partly in section, taken on line **37—37** of FIG. 36;

FIG. 38 is an enlarged sectional view taken on line **38—38** of FIG. 37;

FIG. 39 is an enlarged sectional view taken on line **39—39** of FIG. 37;

FIG. 40 is an enlarged plan view taken on line **40—40** of FIG. 36;

FIG. 41 is an enlarged plan view taken on line **41—41** of FIG. 36;

FIG. 42 is an enlarged sectional view taken on line **42—42** of FIG. 41;

FIG. 43 is a plan view of a splicing mechanism and a cut-to-length unit used in this invention, the view being broken away at various places to provide greater clarity;

FIG. 44 is a side elevational view of the splicing mechanism and the cut-to-length unit, taken from the downstream side thereof along line **44—44** of FIG. 43;

FIG. 45 is a side elevational view of the splicing mechanism and the cut-to-length unit, taken from the upstream side thereof along line **45—45** of FIG. 43;

FIG. 46 is an enlarged end elevational view, taken along line **46—46** of FIG. 45;

FIG. 47 is an enlarged end elevational view, taken along line **47—47** of FIG. 45, the view being broken away at various places to provide greater clarity;

FIG. 48 is a sectional view, taken along line **48—48** of FIG. 44;

FIG. 49 is a sectional view, taken along line **49—49** of FIG. 44;

FIG. 50 is an enlarged sectional view, taken on line **50—50** of FIG. 44, showing details of the splicing mechanism in one condition of operation;

FIG. 51 is an enlarged sectional view, similar to that of FIG. 50, showing the splicing mechanism in a second condition of operation;

FIG. 52 is an enlarged sectional view, similar to that of FIG. 50, showing the splicing mechanism in a third condition of operation;

FIG. 53 is an enlarged sectional view, taken along line **53—53** of FIG. 43;

FIGS. 54 through 60 are a series of diagrammatic views of the splicing mechanism showing the operation of this mechanism during a splicing cycle of the apparatus;

FIG. 61 is an enlarged sectional view, taken along line **61—61** of FIG. 44;

FIG. 62 is an enlarged sectional view, taken along line **62—62** of FIG. 44;

FIG. 63 is an enlarged sectional view, taken along line **63—63** of FIG. 44;

FIG. 64 is an enlarged sectional view, taken along line **64—64** of FIG. 46;

FIG. 65 is a plan view of a mechanical lifter unit and a ply offset mechanism employed in this invention;

FIG. 66 is a sectional view, taken along line **66—66** of FIG. 65;

FIG. 67 is a sectional view, taken along line **67—67** of FIG. 66;

FIG. 68 is an end elevational view of the mechanical lifter unit and the ply offset mechanism, taken along line **68—68** of FIG. 65;

FIG. 69 is an enlarged sectional view; taken along line **69—69** of FIG. 67;

FIG. 70 is an enlarged elevational view, taken along line **70—70** of FIG. 68;

FIG. 71 is an enlarged sectional view, taken along line **71—71** of FIG. 68;

FIG. 72 is a side elevational view of an applicator conveyor and a tire building station utilized in this invention;

FIG. 73 is an enlarged sectional view, taken along line **73—73** of FIG. 72;

FIG. 74 is an enlarged plan view of the tire building station and portions of the applicator conveyor shown in FIG. 72;

FIGS. 75, 76 and 77, together, represent a diagrammatic view of the tire building apparatus and illustrate the various pneumatic and hydraulic control circuits utilized in controlling the operation of the apparatus;

FIGS. 78 through 88, together, form a schematic wiring diagram of the electrical circuits employed in controlling the operation of the tire building apparatus;

FIG. 89 is a schematic wiring diagram of a transistor type of sensitive relay that is used in the electrical control system of the apparatus;

FIG. 90 is a chart showing the condition of the contacts of an operation selector stepping relay utilized in the electrical control system of the apparatus;

FIGS. 91 through 105 represent an electrical sequential action drawing or chart showing the state of actuation or energization at any given time of the various electrical components employed in automatically controlling the operation of the main conveyor, the storage device, the splicing mechanism, the cut-to-length unit, the mechanical lifter unit, the ply offset mechanism and the applicator conveyor; and

FIGS. 106 through 111, together, represent an electrical sequential action drawing or chart showing the state of actuation or energization at any given time of the various electrical components employed in automatically controlling the operation of the bias-cutter.

GENERAL DESCRIPTION

A tire building machine made in accordance with one embodiment of this invention has been illustrated in FIG. 1, which is a perspective view wherein numerous details have been omitted in order to achieve greater clarity in understanding the overall machine. FIGS. 1A, 1B and 1C show the relationship of the plies of a four-ply tire to one another and to the apparatus, and will be referred to in conjunction with FIG. 1 in order to provide a general description of this invention.

The machine of FIG. 1 includes the following major components: a bias-cutter, shown generally at A; a main conveyor, designated generally at B; a storage device, indicated generally at C; a splicing mechanism shown generally at D; a cut-to-length unit, designated generally at E; a mechanical lifter unit, designated generally at F; a ply offset mechanism, indicated generally at G; an applicator conveyor, shown generally at H; and a tire building station, designated generally at J.

In order to establish a frame of reference for use in describing this invention, the tire building station J will be considered to be at the front of the machine, while the storage device C will be considered to be at the rear of the machine. Thus, forward operation of the main conveyor B and applicator conveyor H will cause any material carried by these conveyors to move toward the tire building station J, while reverse operation will carry the material toward storage device C. It will be understood that these components are in longitudinal alignment with one another, and, therefore, a center line or reference line X—X (FIG. 1A) may be considered to extend along the length of the machine from the tire building station J to the storage device C, the center of the drum at the tire building station J serving to establish the exact position of the reference line X—X.

The various components of the machine cooperate with one another in operation to build the tire carcass illustrated in FIG. 1C. The first and second plies **1** and **2**, respectively, of the carcass are alike in width, being relatively wide as compared with the narrower third and fourth plies **3** and **4**, respectively, which also are similar in width. In order to achieve step-offs **5** and **6** when the side edges of plies **1** and **2** are turned up over bead wires **7** and **8**, plies **1** and **2** are laterally offset from one another and from the center line of the tire building drum prior to being wound on the drum. Thus, referring to FIGS. 1 and 1A, when the bias-cut rhomboidal sections of fabric that later form plies **1** and **2** are initially deposited by the bias-cutter A onto the main conveyor B, their center lines are located at a position that is offset to one side of reference line X—X by, for example, ¼ of an inch, the intial position of ply **1** being shown in dashed line form. Subsequently, ply **1** is laterally shifted ½ of an inch by the ply offset mechanism G so that its center line is offset ¼ of an inch to the opposite side of the reference line X—X. This provides a ½ inch step-off at both bead areas of the carcass (see FIG. 1B). It is readily apparent, of course, that ply **2** could be laterally shifted rather than ply **1** with similar results, and also, that the amount of step-off desired establishes the amount of offset given to plies **1** and **2**. Plies **3** and **4**, on the other hand, are deposited on the main conveyor B with their center lines in alignment with reference line X—X.

It will be seen from the foregoing that the bias-cutter A serves to perform the following acts. It bias-cuts the tire fabric into relatively wide rhomboidal sections for plies **1** and **2** and drops these sections onto the main conveyor B with their center lines similarly offset from reference line X—X, and it also bias-cuts the tire fabric into relatively narrow rhomboidal sections for plies **3** and **4** and drops these sections onto the main conveyor B with their center lines aligned with reference line X—X.

The length of the sections cut by the bias-cutter A is usually greater than the length needed to form any of the plies of conventional passenger car tires due to the fact that the tire fabric is supplied to the bias-cutter A in relatively wide rolls. Hence, when the sections are cut to proper ply length, remnant pieces of bias-cut fabric remain. Some of these remnant pieces of fabric are delivered by the main conveyor B to the storage device C to be stored for use later on in building subsequent tire carcasses, while others are utilized in the carcass being fabricated at the tire building station J. It will be understood that separate storage areas are provided in storage device C both for the wide width remnant pieces and for the narrow width remnant pieces in order to be able to independently handle these pieces. It should also be noted that the lengths of the remnant pieces will vary with continuous operation of the machine since these pieces are spliced to subsequent sections of fabric cut by the bias-cutter A before those sections are cut to length. Hence there is a cumulative effect tending to cause the remnant pieces to get progressively longer with each carcass that is built by the machine. Eventually, when a remnant piece becomes long enough to cut a ply length from it, the control circuits of the machine will omit a cycle of the bias-cutter A to compensate for and shorten the length of the remnant piece.

Splicing of the remnant pieces to additional sections from the bias-cutter A takes place at the splicing mechanism D. The main conveyor B advances the remnant piece from the storage device C until the trailing end of the remnant reaches the splicing mechanism D. At this point the main conveyor B stops and the trailing end of the remnant is raised from above by a drilled vacuum chamber, while the remainder of the remnant on the main conveyor B is raised by the mechanical lifter unit F. The bias-cutter A then cuts a new rhomboidal section of the same width and drops it onto the main conveyor B, which advances the new section until its leading end is under the raised end of the remnant with a desired amount of overlap therebetween. The raised trailing end is then lowered, along with the remainder of the remnant, and pressed against the leading end of the new section to make the splice, thereby forming a strip of spliced fabric.

The strip of spliced fabric is cut to proper ply length by the cut-to-length unit E. This unit utilizes a photocell that is positioned downstream of a cutter to establish the length at which ply **1** is to be cut. In addition, revolution counters geared to the drive of the main conveyor B are employed to meter from subsequent strips of spliced fabric the additional lengths required for plies **2**, **3** and **4**. Thus, as each ply is required by the tire building drum, the proper length will be metered past the cutter of the cut-to-length unit E.

After the correct length of ply has been metered past the cutter of the cut-to-length unit E, the main conveyor B stops, the strip of spliced fabric is lifted above the conveyor both by the mechanical lifter unit F and the previously mentioned drilled vacuum chamber of the splicing mechanism D, the fabric is clamped on either side of the point where the cut is to be made, and a hook knife is pulled into the fabric between the clamps and then across the fabric, thereby cutting the skimcoat between two adjacent cords. Thus, the strip of spliced fabric is cut into a ply of proper length, supported by the mechanical lifter unit F, and a new remnant piece results. The new remnant piece is supported by the drilled vacuum chamber of the splicing mechanism D.

The mechanical lifter unit F includes a series of laterally spaced apart bars that move from a level below the spaced strands of the main conveyor B to a level above the strands, the bars being interspersed between the strands. The bars of the mechanical lifter unit F are carried on a framework which is supported in such a manner as to be laterally movable in addition to being vertically movable, and, in the case of ply 1 only, the ply offset mechanism G operates to laterally shift the mechanical lifter unit F and the ply thereon prior to the redepositing of the ply onto the main conveyor B.

While the ply which has been cut to length is being held above the main conveyor V by the mechanical lifter unit F, the remnant piece thereof carried by the splicing mechanism D is placed back on the main conveyor B, which, in turn, is then driven in reverse to carry the remnant piece either back to the storage device C or to a backup position about six feet upstream from the splicing mechanism D, depending on which ply is in the cut-to-length unit E. Assuming ply 1 to be in this unit, the remnant goes to the backup position, rather than the storage device C, and the main conveyor B stops. At this time the laterally shifted ply 1 is deposited on the main conveyor B, and then both the main conveyor B and the applicator conveyor H drive in a forward direction so that ply 1 is brought forward onto the applicator conveyor H and the remnant of ply 1 is moved forward toward the splicing mechanism D. When the leading edge of the remnant of ply 1 reaches the splicing mechanism D, the applicator conveyor H stops, and, shortly thereafter, the trailing edge of the remnant reaches the splicing mechanism D. Main conveyor B then stops, and at this time the remnant of ply 1 is raised above the main conveyor B by the splicing mechanism D and the mechanical lifter unit F. The bias-cutter A then cuts another wide rhomboidal section of fabric and deposits it on main conveyor B. This section is then spliced to the remnant of ply 1 and is moved into the cut-to-length unit E where it is cut to the length of ply 2, leaving a new remnant piece, the remnant of ply 2.

After ply 2 is cut to length, it remains raised above main conveyor B, on the mechanical lifter unit F, while its remnant is lowered onto main conveyor B and driven back to the wide width storage area of storage device C. When main conveyor B stops with the remnant in the storage device, mechanical lifter unit F lowers ply 2 onto main conveyor B without transversely offsetting the ply from its original position relative to reference line X—X.

With ply 1 cut to length and resting on the applicator conveyor H, and ply 2 cut to length and resting on the downstream end of main conveyor B, the apparatus is ready to commence building a carcass on the tire building drum. To facilitate this operation applicator conveyor H is provided with a shiftable end portion at tire building station J that may be brought into contact with the undersurface of the drum. This is done while the drum rotates in a counterclockwise direction (as viewed in FIG. 1) in order to transfer ply 1 (and subsequently ply 3) to the drum with the cord angles running in one direction. A separate, displaceable belt that is cooperable with applicator conveyor H at the downstream end thereof is employed in transferring ply 2 (and later ply 4) to the drum. This belt contacts the top surface of the drum while it rotates in a clockwise direction so that the cord angles of plies 2 and 4 end up reversed to those of plies 1 and 3.

The applicator conveyor H may be driven by either of two driving means. The first driving means comprises a clutch controlled power take-off from the drive for the main conveyor B so that, with the clutch engaged, applicator conveyor H is driven concurrently with main conveyor B. The second driving means comprises a separate motor which drives applicator conveyor H independently of main conveyor B.

In order to facilitate the handling of the plies at the downstream end of applicator conveyor H and the transfer of the plies to the tire building drum, an electrostatic charge is applied to the plies as they travel along the belt of applicator conveyor H. In addition, an electrically grounded plate contacts the undersurface of this belt at the shiftable end portion of applicator conveyor H, and a second electrically grounded plate contacts the back surface of the separate displaceable belt that cooperates with the downstream end of applicator conveyor H. This is done in order to hold the charged plies in position on the belts as they are carried to the drum and to facilitate the transferring, with no misalignment, of the plies between the belts and to the drum at tire building station J.

Structural details of the applicator conveyor H and the tire building station J, and the manner in which electrostatic forces are utilized in handling the plies, are shown in the copending application of Tourtellotte and Stiegler, Serial No. 99,496, filed March 30, 1961, and assigned to the assignee of the present application. Said copending application has now matured into U.S. patent No. 3,071,179. The invention of said co-pending application was made prior to this invention and it is, therefore, not intended to herein claim anything shown or described in said copending application, which is to be regarded as prior art with respect to this present application.

Remembering that ply 1 is on applicator conveyor H and ply 2 is on the downstream end of main conveyor B, this general description will now continue by leading the reader through a complete building cycle starting with ply 1 resting on applicator conveyor H and ending with the apparatus in this condition.

Assuming that the operator has expanded the drum and applied gumbo to the drum, he then starts the drum rotating counterclockwise and, concurrently, brings the shiftable end portion of the applicator conveyor H into contact with the undersurface of the drum and starts the applicator conveyor independent drive. Ply 1 is thus brought to the drum, while ply 2 remains stationary. When ply 1 is completely wound on the drum, the operator moves the shiftable end portion of applicator conveyor H out of contact with the drum and reverses the direction of rotation of the drum. He then brings the separate displaceable belt into contact with the top surface of the drum and provides a signal to the apparatus to again commence automatic operation.

When the operator's signal is received, main conveyor B starts moving forward to transfer ply 2 to applicator conveyor H, and from there ply 2 is transferred to and wound about the drum. It will be appreciated that the operator at tire building station J will then be involved with applying bead rings to the carcass and turning up the side edges of plies 1 and 2 over the bead rings. During this time, the apparatus continues in automatic operation to ready plies 3 and 4 for subsequent application to the drum.

Concurrently with the movement of ply 2 to the drum, a narrow width section of fabric that had previously been placed in storage begins moving forward from the storage device C onto the main conveyor B to begin preparation of plies 3 and 4. This narrow width section will always be of sufficient length to allow ply 3 to be directly cut therefrom without having to add to it a new bias-cut section. (It might also be noted that it is possible to have accumulated sufficient length of narrow width fabric on the storage device C to process both plies 3 and 4.) The extra length results from the fact that a new bias-cut section will have been added to the remnant piece of ply 4 of the previous carcass before that remnant was sent back to the storage device C. The extra section was added at that time because the operator at the tire building station J was involved in finishing operations on the previous carcass (e.g. applying toe strips and tread, smoothing sidewall, stitching tread, turning down edges of plies 3 and 4, removing the carcass, and applying gumbo to the bare drum) and, thus, more time was then available for the machine to perform ply preparation functions than is available now, when the operator at the tire building station J is involved in the intermediate operations occurring between the winding of plies 2 and 3 on the drum (the intermediate operations comprising breaking down the side edges of plies 1 and 2, setting the bead rings in place, turning up the side edges of plies 1 and 2 over the bead rings, and stitching these edges in place).

It should also be pointed out that the controls governing operation of the splicing mechanism D, cut-to-length unit E, and bias-cutter A are so inter-related that the splicing and bias-cutting cycles are omitted when the fabric coming from the storage device C is of sufficient length from which to cut a ply. Thus, the elongated narrow strip of spliced fabric being advanced by the main conveyor B from the storage device C moves past the splicing mechanism D until it stops in proper position for ply 3 to be cut at the cut-to-length unit E.

After the cut-to-length operation is completed, and while ply 3 remains lifted above the main conveyor B by the mechanical lifter unit F, the remnant of ply 3 is placed on the main conveyor B and moves back about six feet to the backup position. Then ply 3 is lowered onto the main conveyor B and both this conveyor and the applicator conveyor H move forward. Ply 3 is thus transferred to the applicator conveyor H, while the remnant of ply 3 moves forward toward the splicing mechanism D. When the leading edge of the remnant of ply 3 reaches the splicing mechanism D, the applicator conveyor H stops, and, shortly thereafter, the trailing edge of the remnant reaches the splicing mechanism D. Main conveyor B then stops and at this time the remnant of ply 3 is raised above main conveyor B by the splicing mechanism D and the mechanical lifter unit F.

The bias-cutter A now goes through a cycle in which it cuts a new narrow width rhomboidal section and drops this section onto main conveyor B. The new section is then spliced to the remnant of ply 3 and is cut to length to form ply 4. While ply 4 remains raised on the mechanical lifter unit F after being cut to length, the remnant of ply 4 is deposited on main conveyor B and brought to the backup position, at which time the main conveyor B stops and ply 4 is lowered onto it by the mechanical lifter unit F.

Under these conditions the machine stops all automatic activity to again await a signal from the operator at the tire building station J. Assuming that the operator has applied bead rings to the carcass and turned up the side edges of plies 1 and 2 over the bead rings during the time that plies 3 and 4 were being prepared, he now proceeds under manual control to apply ply 3 to the drum in the same manner as described in connection with the application of ply 1. Similarly he sets up the downstream end of the applicator conveyor H and the direction of rotation of the drum to prepare for the application of ply 4 to the drum. At this time he provides a signal to the apparatus to again commence automatic operation.

When the operator's signal is received, the main conveyor B starts moving forward to transfer ply 4 to the applicator conveyor H, and from there ply 4 is transferred to and wound about the drum. Concurrently with this, the remnant of ply 4 is moved into position under the splicing mechanism D. The bias-cutter A then cycles to cut a new narrow width section, and this section is then spliced to the remnant of ply 4. The resulting narrow strip of spliced fabric, which will later serve as ply 3 of the next carcass to be built, is then returned to the narrow width storage area of storage device C by the main conveyor B. It will be remembered that the applicator conveyor H is provided with an auxiliary driving system that is independent of the main conveyor B in order that the operator at the tire building station may independently control the movement to the tire building station J of those plies that are delivered to the applicator conveyor. Thus, in effect, when the plies have been transferred from the main conveyor B to the applicator conveyor H, control over these plies shifts from the automatic operation of the machine to the individual control of the operator at the tire building station.

When the remnant of ply 4 and the new section spliced thereto reach the narrow width storage area of the storage device C, the main conveyor B stops its reverse movement and begins moving in a forward direction again. At this time the remnant of ply 2, which was previously stored in the wide width storage area of the storage device C, starts forward on the main conveyor B and is positioned under the splicing mechanism D and raised above the main conveyor B. The bias-cutter A then cuts a new wide rhomboidal section and deposits it on the main conveyor B, which brings it to the splicing mechanism D. The new section and the remnant are then spliced together and conveyed to the cut-to-length unit E where a new ply 1 is cut to length. At the completion of this cut, new ply 1 is laterally shifted by the ply offset mechanism G, but still remains raised above the main conveyor B by the mechanical lifter unit F. The remnant piece of new ply 1, however, is lowered onto the conveyor and moved to the backup position.

New ply 1 is then lowered onto the main conveyor B and this conveyor and the applicator conveyor H both start moving forward to transfer new ply 1 to the applicator conveyor and to move its remnant piece under the splicing mechanism D. (By this time ply 4 has been wound on the drum and the applicator conveyor H is clear to receive new ply 1.) With the remnant piece of new ply 1 in position and raised above the main conveyor B, the bias-cutter A cycles to cut another wide rhomboidal section, and this section is deposited on the main conveyor B. It is then spliced to the remnant piece and moved to the cut-to-length unit E where new ply 2 is cut to length.

At the end of the cut-to-length operation, new ply 2 remains raised on the mechanical lifter unit F, while its remnant piece is lowered onto the main conveyor B and returned to the wide width storage area of the storage device C. With the remnant returned to storage, the main conveyor B stops and new ply 2 is lowered onto the conveyor. The machine then ceases automatic operation while the operator manually controls the application of new ply 1 to the drum. Following this, when the operator is ready to apply new ply 2 to the drum, the signal will be given to again commence automatic operation.

It will be appreciated that from the time that plies 3 and 4 were transferred to the tire building station J until the time that the operator is ready to start building a new carcass, the operator's attention is direced to: the application of plies 3 and 4; the application of toe strips; the application of tread stock; the stitching of the tread; the turning down of the ply edges; the collapsing of the drum and removal of the carcass; and the expanding of the drum and application of gumbo for a new carcass. During this same time period, however, the machine has automatically spliced a new narrow width section to the remnant of previous ply 4 and returned it to the narrow width storage area for subsequent cutting to length as a new ply 3, and has readied new plies 1 and 2 for the next carcass. Hence it will be seen that the automatic cycle of the machine is suitably correlated with the operations at the tire building station in order to supply plies to the tire building drum at a rate commensurate with the needs at the drum. Also, since the carcass building operation is considerably speeded up by using electrostatic forces to automatically wind the plies on the drum, it has been found that high quality, uniform tire carcasses can be constructed much more rapidly and efficiently in accordance with this invention than with apparatus commonly used heretofore.

With the foregoing general description in mind, a detailed discussion of each of the major components of the apparatus, and of the controls employed in conjunction therewith, follows:

The Bias-Cutter

The bias-cutter A is an improvement over the bias-cutter shown and described in the co-pending application of Phillips, Parshal, Symons and Kehoe, Serial No. 23,500, filed April 20, 1960, and assigned to the asignee of the present application. The invention of said co-pending application was made prior to this invention and it is, therefore, not intended to herein claim anything shown or described in said co-opending application, which is to be regarded as prior art with respect to this present application.

The present bias-cutter A has been illustrated in greater detail in FIGS. 2 through 27. Referring more particularly to FIGS. 2 and 3, bias-cutter A includes a movable, triangularly shaped frame, shown generally at 11, and stationary, rectangularly shaped frame, shown generally at 12. Frame 11 is supported on frame 12 in a manner allowing it to have limited rotary movement about a vertical axis or pivot 13 in order to allow small changes to be made to the bias angle at which the fabric is cut (e.g., 55° to 65°).

Movable frame 11 includes a pair of horizontally disposed structural channel members or legs 14 and 15 and a structural cross-member or base 16 which are welded together at their respective ends to form the generally triangular frame. Base member 16 of frame 11 also serves as the top cross-member of a rigid, vertical rectangular structure which includes a lower cross-member 16*a* and a pair of spaced apart vertical members 17 and 17*a*.

Vertical members 17 and 17*a* each have rigidly connected thereto one of a pair of table supporting members 18 and 18*a*, respectively, which project horizontally forward from vertical members 17 and 17*a*. The forward ends of members 18 and 18*a* are interconnected by means of a cross-member 19, while another cross-member 19*a* interconnects members 18 and 18*a* adjacent their rear ends. A wide flat plate or table 20 is welded in place on the top of cross-members 19 and 19*a* to support the fabric that is processed through bias-cutter A.

A fabric let-off unit, shown generally at 21, is positioned at the rear portion of movable triangularly shaped frame 11 (the rear portion of bias-cutter A being the right end portion as viewed in FIGS. 2 and 3). The fabric let-off unit 21 serves as a source of supply of calendered fabric for the bias-cutter assembly. It comprises (FIG. 3) a movable truck 22 that is supported on wheels 22*a* so that a roll 23 of fabric supported thereon may be conveniently moved to and from the fabric let-off unit 21. The truck 22 also supports a fabric liner roll 24, each end of which is movably carried in a channel 25 formed between vertically extending side members 26 and 27.

Calendered fabric 28 is unwound from roll 23 and led over a splicing plate 29 which is suitably and rigidly interconnected between spaced arms 30 and 30*a* that are fixedly carried by the vertical members 17 and 17*a*, respectively, of frame 11. Splicing plate 29 serves as a convenient flat surface on which the connect the leading edge of a new roll 23 of fabric to the trailing edge of a previous roll 23 of fabric when the previous roll has been exhausted. A photocell 7–EYE, carried by arm 30*a* and a lamp 31, carried by a bracket member 32, are employed as a control means for sensing when a roll 23 of calendered fabric has been exhausted. This occurs when the light beam from lamp 31 hits photocell 7–EYE as the trailing edge of an exhausted roll passes clear of the light beam.

A pair of stops 33, carried by the arms 30 and 30*a*, and a pair of guides 34, carried by vertical members 17 and 17*a*, serve to align truck 22 into proper position against the movable, triangularly shaped frame 11. The truck 22 is then locked in position by means of drop pins 35 which engage holes (not shown) formed in truck 22.

The calendered fabric 28, after passing over splicing plate 29, proceeds over a first roller 36 and then under a second roller 37. Roller 36 is connected to a driven gear 36*a* which in turn is driven by a driving gear 37*a* connected to roller 37. Driving gear 37*a* is powered by a let-off motor MTR–4 by means of a belt 38.

After passing under roller 37, the fabric 28 is passed over an idler roller 39 and then down beneath a dancer roller 40. Each end of dancer roller 40 is vertically movable within channels 41 carried on the forward side of vertical members 17 and 17*a*. A pair of limit switches 19–LS and 20–LS are employed in conjunction with one of the channels 41 to sense the upper and lower limits of movement, respectively, of dancer roller 40. After passing under dancer roller 40, the fabric 28 proceeds over another idler roller 42 and from there onto table 20 to be further utilized in bias-cutter A. Limit switch 20–LS serves to control the operation of let-off motor MTR–4 so that the motor will be in operation whenever dancer roller 40 is raised above limit switch 20–LS. This is done to insure that there is always a reservoir of fabric at dancer roller 40. However in the event a jam-up prevents fabric from reaching dancer roller 40, this roller would climb within its channels 41 to the upper position at which limit switch 19–LS becomes actuated. This in turn would shut down let-off motor MTR–4 irrespective of the fact that limit switch 20–LS is calling for the motor to run. Also, limit switch 20–LS acts as an interlock to prevent the bias-cutter from starting a new cycle when dancer roller 40 is not at the bottom of its channels 41.

A brake roller 43 is provided to lock the trailing edge of fabric 28 in position on splicing plate 29 when a fabric roll 23 has been exhausted. The roller 43 is supported for vertical movement by a pair of spaced arms 44, the arms, in turn, being keyed to a shaft 44a rotatably mounted on vertical members 17 and 17*a*. Two pneumatically operated power cylinders 45 are employed to move brake roller 43 between an upper or off position and a lower braking position in which it contacts roller 36. Normally roller 43 is held in its off position. However, when photo cell 7–EYE is illuminated as the trailing edge of fabric 28 uncovers lamp 31, the photo cell 7–EYE initiates the de-energiaztion of motor MTR–4 and also the actuation of power cylinders 45, thereby causing roller 43 to be lowered to its braking position in contact with roller 36. This places a drag on let-off motor MTR–4 to quickly stop the motor before the trailing edge of fabric 28 leaves splicing plate 29. One end of shaft 44*a* projects through vertical member 17 and is provided with an actuating cam 46 keyed thereon. Cam 46 cooperates with the arm 47 of a limit switch 18–LS to actuate this switch when brake roller 43 is lowered. The contacts of limit switch 18–LS in the electrical circuits provide insurance that motor MTR–4 will be de-energized when brake roller 43 is lowered.

In addition to fabric let-off unit 21, the movable, triangularly shaped frame 11 of bias-cutter A carries a fabric pull-out unit, shown generally at 50, which serves to grasp the leading cut end of fabric 28 on table 20 and pull predetermined amounts of the fabric out from the let-off unit 21. The fabric pull-out unit 50 is carried on the underside of and at the forward part of the horizontal legs 14 and 15 of movable frame 11.

Fabric pull-out unit 50 includes (FIG. 2) a stationary, trapezoidal shaped structure comprising a pair of longitudinally extending supports 51 and 52 and a pair of transverse members 53 and 54 which rigidly interconnect with the longitudinal supports 51 and 52. Fabric pull-out unit 50 also includes a movable, trapezoidal shaped carriage, shown generally at 55 in FIGS. 2 and 3 and in greater detail in FIGS. 4, 5, 6 and 7. The carriage 55 is movably supported on rails 56 and 57 which, in turn, are rigidly connected to the longitudinal members 51 and 52, respectively (see FIG. 5). Carriage 55 is movably supported from and located with respect to rails 56 and 57 by means of a plurality of upper wheels 58 and lower wheels 59, there being a set of such wheels adjacent each corner of carriage 55.

The carriage 55 comprises three longitudinally extending tubular members 60, 61 and 62 and two transverse tubular members 63 and 64, the members being welded together in a substantially trapezoidal configuration. Movement of carriage 55 along rails 56 and 57 is obtained (FIG. 4) by means of an hydraulically operated power cylinder 65, the piston rod 66 of which is provided at one end with a pinion gear 67. Pinion gear 67 reacts against and moves along a fixed rack gear 68 and engages a movable rack gear 69 that is fastened to the top of the central tubular member 61. Thus, when power cylinder 65 is actuated to extend piston rod 66, carriage 55 moves to the rear (to the right as viewed in FIGS. 2, 3 and 4), and, when power cylinder 65 is actuated to retract the piston, carriage 55 moves forward (to the left in FIGS. 2, 3 and 4).

The fixed rack gear 68 (FIG. 4) is supported by an angle iron 70 having one end thereof welded to a bracket 70*a* which is in turn fastened to transverse member 53. The other end of angle iron 70 is supported by the adjacent ends of a pair of transverse angle irons 71 and 72 (see FIG. 2 also), the spaced apart ends of which are rigidly connected to the longitudinally extending channel members 51 and 52, respectively.

Referring to FIGS. 3 and 7, the rear transverse tubular member 64 of carriage 55 supports a fabric gripping mechanism, shown generally at 75, by means of a series of brackets 76, 77, 78 and 79. Thus, movement of carriage 55 also causes the fabric gripping mechanism 75 to move.

The details of fabric gripping mechanism 75 and the manner in which it is supported may be more clearly seen by reference now to FIGS. 7, 8, 9, 10 and 11. The fabric gripping mechanism 75 includes (FIGS. 8 and 9) a generally triangular support member 82 which comprises a horizontal plate 83 and a vertical plate 84.

Vertical plate 84 has welded thereto a plurality of journals 85 (FIGS. 8 and 11) which rotatably support a shaft 86. Shaft 86 (FIG. 9) is keyed to a bell crank lever 87, one arm 88 of which is pivotally connected to a link 89 and the other arm 90 of which is welded to and supports the center of a fabric gripping bar 91. Gripping bar 91 is also supported at its ends for movement with shaft 86 by means of arms 92 and 93 (FIG. 8) which are welded to bar 91 and keyed to shaft 86 so that rotation of the shaft causes vertical movement of bar 91.

Gripping bar 91 includes an interior central vacuum chamber 94 (FIG. 9) that is connected to a source of vacuum by means of a flexible conduit (not shown). A plurality of laterally spaced apart apertures 95 are provided in the lower wall of gripping bar 91. These apertures extend between the lower surface of the gripping bar 91 and the vacuum chamber 94. Thus, when fabric gripping bar 91 is positioned just above a leading edge of fabric, and a vacuum is drawn in chamber 94, the leading edge of fabric is grasped and held tightly to the bar for movement therewith.

A stripping mechanism or stripper, shown generally at 96, is provided in order to release the leading edge of fabric from the gripping bar 91 after the vacuum in chamber 94 is broken. The stripping mechanism 96 (FIG. 11) includes a thin, cup-shaped stripper plate 97 which is coextensive with and adjacent to fabric gripping bar 91. Stripper plate 97 is supported by a series of spaced arms 98, each of which have one end 98*a* bolted to plate 97 and another end 98*b* rotatably journaled on shaft 86 so that rotation of shaft 86 does not directly cause movement of plate 97. Stops 98*c* are provided on the arms 98 and are employed to locate stripper plate 97 with respect to fabric gripping bar 91. A plurality of spaced apart, spring biased fingers 99, which are supported by means of brackets 99*a* from vertical plate 84, press downwardly against stripper plate 97 so that stops 98*c* abut against vertical plate 84.

The lower edge of stripper plate 97 is provided with a plurality of flat, spaced apart projections or fingers 100. Fingers 100 extend horizontally across the lower portion of gripping bar 91 within slots 101 formed in the lower wall of the bar, the fingers 100 and slots 101 being positioned at points located between the spaced apertures 95 in gripping bar 91.

Referring to FIG. 9, it will be seen that, with the fabric gripping bar 91 in the position shown, the application of a vacuum to chamber 94 causes the leading edge of the fabric 28 to be drawn up tightly against the apertures 95. With the fabric 28 being held in this manner by gripping bar 91, the entire fabric gripping means 75 can be transported by carriage 55 to draw the fabric 28 along with it.

When it is desired to release the fabric 28 from gripping bar 91, the vacuum in chamber 94 is broken and gripping bar 91 is raised from the lower "gripping" position shown in FIGS. 9 and 11 to an elevated "stripping" position at which fingers 100 project out below the level of the apertures 95 and press the fabric 28 down clear of the lower surface of the gripping bar 91. This releases the fabric from fabric gripping means 75 and, assuming the fabric has been bias-cut and laterally positioned with respect to main conveyor B (FIG. 1), drops the cut section of fabric on to the main conveyor.

Movement of fabric gripping bar 91 from its lower to its upper position is accomplished by means of a pneumatically operated power cylinder 102 that operates a piston rod 103. Referring to FIG. 10, piston rod 103 is pivotally connected at its end 104 to a crank 105, which, in turn, is keyed to one end of a shaft 106. Shaft 106 is rotatably supported on the underside of plate 83 (FIG. 9) by means of a journal 107, and the other end of shaft 106 (FIG. 10) is keyed to a second crank 108 which is pivotally connected to the aforementioned link 89. Thus, when position rod 103 is retracted into power cylinder 102, bell crank 87 rotates clockwise (as viewed in FIG. 9) to raise fabric gripping bar 91 to its elevated or stripping position. Conversely, when piston rod 103 is extended out of power cylinder 102, bell crank 87 rotates counterclockwise to lower gripping bar 91 into engagement with the fabric 28.

A neutral position limit switch 15–LS (FIGS. 8 and 9) is employed in order to provide control signals relative to the position of the fabric gripping bar 91. The limit switch is supported on the undersurface of horizontal plate 83 and includes an actuating arm 109. Arm 109 engages the slotted end of a lever 110, the other end of lever 110 being keyed to shaft 86. Thus, lever 110 moves in accordance with the rotation of shaft 86, and this actuates arm 109 and causes limit switch 15–LS to provide an electrical signal indicative of one or the other of the two operating positions of fabric gripping bar 91.

The fabric gripping mechanism 75 is provided with a pair of spaced longitudinal support members 111 and 111*a* which are welded to the triangular support member 82 at one of their ends and are connected together at their other ends by a vertical cross plate 112. Power cylinder 102 is pivotally supported at 113 on a cross brace 114 which interconnects the longitudinal members 111 and 111*a*. Members 111 and 111*a* and vertical plate 112 are further interconnected by cross braces 115 and 116 in order to provide greater rigidity to this portion of fabric gripping mechanism 75 for reasons which will become apparent hereinafter.

As indicated earlier, fabric gripping mechanism 75 is pivotally supported from carriage 55 by means of brackets 76 through 79 (see FIG. 3). When the movable frame 11 of the bias-cutter is shifted relative to the stationary frame 12 to change the angle of the bias-cut, fabric gripping means 75 must also be reoriented with respect to the leading edge of the fabric in order to properly grasp the fabric. This is accomplished by making the connections between the brackets 76 through 79 and the fabric gripping means 75 in such a manner as to allow the fabric gripping mechanism 75 to pivot relative to carriage 55. Referring to FIG. 8, the outer brackets 76 and 79 are welded to horizontal plates 117 and 117*a* respectively, while the inner brackets 77 and 78 are welded to opposite sides of a circular plate 118. The outer plates 117 and 117*a* are provided with arcuate slots 119 and 119*a*, respectively. Bolts 120 and 120*a*, which are in threaded engagement with horizontal plate 83, pass through slots 119 and 119*a* in the horizontal plates 117 and 117*a*, respectively, and, by means of springs (not shown) positioned between the heads of the bolts 120 and 120*a* and the top surfaces of their respective plates 117 and 117*a*, draw the horizontal plate 83 up against the undersurfaces of plates 117 and 117*a*. This allows limited horizontal pivotal movement, commensurate with the length of slots 119 and 119*a*, to occur between the horizontal plate 83 and plates 117 and 117*a*.

The circular plate 118 and the horizontal plate 83 are pivotally connected together by means of a bolt 121. A circular plate 122 (FIG. 9) is welded to the top of plate 83. The top surface of plate 122 cooperates with the undersurface of plate 118 to act as a bearing during pivotal movement of the fabric gripping mechanism 75. Bolt 121 is drawn up sufficiently to bring plates 118 and 122 into engagement with one another, but not so tightly as to prevent any necessary pivotal movement.

Referring to FIGS. 3 and 9, the fabric gripping mechanism 75 is also supported for pivotal movement from carriage 55 by means of a bracket 123 which is welded to and depends beneath the longitudinally extending tubular member 60 of carriage 55. Bracket 123 is provided with a pair of vertically spaced apart rollers 124 and 125 which are adapted to receive therebetween a projecting portion 126 (FIG. 9) of a horizontal plate 127. Plate 127 is welded to the longitudinal support members 111 and 111*a* and the vertical cross plate 112 of the fabric gripping mechanism 75. This arrangement provides an additional point of support for the fabric gripping mechanism 75 and also allows the fabric gripping mechanism to pivot as necessary when the angle of the bias-cut is changed, or when the fabric gripping mechanism becomes accidentally misaligned during its forward movement.

Referring now to FIGS. 2, 3, 7 and 12 through 16, the general arrangement of the stationary, rectangularly shaped frame 12 and the manner in which frame 12 supports the movable triangularly shaped frame 11 will now be considered. Stationary frame 12 includes (FIG. 2) a pair of upper longitudinally extending channel members 130 and 130*a* and a pair of upper cross channel members 131 and 131*a*, the members being welded together at their ends in such a manner as to form a rigid rectangular structure. Frame 12 also includes (FIGS. 3 and 13) a lower pair of longitudinally extending channel members 132 and 132*a* and a pair of lower cross channel members 133 and 133*a*. The upper channel members are held in spaced relation to the lower channel members and the entire frame 12 is supported from the floor by means of a plurality of legs 134 positioned about the structure.

A first vertical tubular member 135, which is supported on the floor and welded to each of the longitudinally extending channel members 132 and 130, projects upwardly from stationary frame 12 to a point which is higher than the movable frame 11. A second vertical tubular member 136, similar to member 135, projects upwardly on the opposite side of stationary frame 12. This tubular member is welded to longitudinally extending channel members 132*a* and 130*a*, and also projects upwardly above the top of movable frame 11. The vertical tubular members 135 and 136 are connected together at their upper ends by means of an upper transverse tubular member 137, the arrangement of tubular members 135, 136 and 137 being in the form of a rigid, inverted U-shaped structure.

As more clearly illustrated in FIGS. 3 and 7, a lower transverse tubular member 138 rigidly interconnects the vertical tubular members 135 and 136 at a point between the floor and the upper transverse tubular member 137. Transverse tubular members 137 and 138 serve as supports for the pivotal connections between the movable triangular frame 11 and the stationary rectangular frame 12. Referring to FIGS. 2 and 7, it may be seen that legs 14 and 15 of movable frame 11 are connected together by means of a diagonal channel member 140, while the table supporting members 18 and 18*a* of frame 11 are interconnected by a diagonal channel member 141 (FIG. 7). Diagonal channel member 140 is pivotally suspended from and connected to the upper transverse tubular member 137 by means of a swivel joint 142, the upper half of which is welded to the undersurface of member 137 and the lower half of which is welded to a bracket 143. Bracket 143, in turn, is welded to the diagonal member 140. A similar swivel joint 144 interconnects the lower tubular member 138 with a bracket 145 that is rigidly mounted on the diagonal channel member 141. This provides an additional point of support for the forward end of the structure that supports table 20.

Referring now to FIGS. 2, 3 and 15, there is illustrated one of the wheel assemblies that pivotally support movable frame 11 on stationary frame 12. The corner of the frame 12 at which longitudinal channel member 130 and cross channel member 131*a* intersect is provided with a flat plate 146. Plate 146 is welded to both of the members 130 and 131*a* and, in addition, serves as a convenient surface on which a wheel 147 may rotate. Wheel 147 is supported by a plate 148 which is welded to the undersurface of table supporting member 18 and is reinforced by means of a gusset 149.

Referring now to FIGS. 2, 3 and 16, there is illustrated in greater detail the manner in which legs 14 and 15 are joined together and supported on stationary frame 12. Upper and lower horizontal gussets 150 and 151, respectively, are provided which extend across and are welded to the legs 14 and 15. In addition, a vertical gusset 152 is welded to gussets 150 and 151 and to the legs 14 and 15 to form a rigid end connection joining the legs 14 and 15. A plate 153, which is welded to the undersurface of gusset 151, serves as a support for a pair of depending brackets 154 and 155, the bracket structure being made rigid by the addition of braces 156, 157 and 158. The brackets 154 and 155, in turn, rotatably support a wheel 159, which rests on a plate 160 that is carried by a support structure 161 projecting upwardly from the cross channel member 131 of stationary frame 12.

An angle iron 162 is welded to bracket 154. Angle iron 162 has rigidly mounted thereon a downwardly extending bolt 163. This bolt projects downwardly through an arcuate slot 164 (see FIG. 2) and is provided at its threaded lower end with a nut 165. When nut 165 is loosened on bolt 163, movable frame 11 may be pivoted with respect to stationary frame 12, since the bolt 163 will move relative to the slot 164. However, when nut 165 is tightened on bolt 163, movable frame 11 becomes locked in place with respect to stationary frame 12.

Referring now to FIGS. 2, 12, 13 and 14, the manner in which limited rotary movement is imparted to movable frame 11 is illustrated. A plate 170 (FIG. 12) is welded to the underside of table supporting member 18*a* and serves as a support for a bracket 171 which rotatably carries a wheel 172. Wheel 172 rotates upon a plate 173 that is welded to stationary frame 12 at the corner thereof where longitudinally extending channel member 130*a* (FIG. 2) and cross channel member 131*a* intersect. Plate 170 (FIG. 12) carries a pointer 174 which cooperates with a scale 175 carried by plate 173 to provide an indication of the angle of the bias-cut when changes are made in the relative position of movable frame 11 with respect to stationary frame 12.

The stationary frame 12 is provided with a pair of vertically spaced apart, horizontally extending brackets 176 and 177 which are bolted to the vertical legs 134. Brackets 176 and 177 (FIG. 14) support vertically spaced apart plates 178 and 179, respectively. A journal member 180 is pivotally supported by plates 178 and 179 and, in turn, rotatably supports a threaded shaft 181 therein (FIG. 13). Journal member 180, in addition to being pivotally mounted in plates 178 and 179 and serving as a shaft bearing for the threaded shaft 181, also serves as a thrust bearing for shaft 181. Thus, when hand wheel 182 is rotated, any axial thrust developed by shaft 181 is transmitted via the thrust bearing portion of journal 180 to stationary frame 12. Pivotal movement of journal member 180 with respect to plates 178 and 179 take place about a vertical axis denoted at 183.

A follower nut 184 is movably mounted on and in engagement with the threaded portion of shaft 181. Follower nut 184 is pivotally carried between a pair of spaced angle brackets 185 and 186 (FIG. 12) for pivotal motion with respect thereto about a vertical axis denoted at 187 (FIG. 13). The brackets 185 and 186 are welded to the vertical tubular member 17*a*, which, in turn, forms part of the structure of movable frame 11. Thus, when hand wheel 182 is rotated, follower nut 184 moves along shaft 181 carrying the vertical tubular member 17*a* along with it. This, in turn, moves the entire movable frame 11 with respect to stationary frame 12 and pivots frame 11 about vertical axis 13 (FIG. 2).

Referring to FIGS. 2, 3, 7, 17, 18, 19 and 20, the stationary frame 12 of bias-cutter A supports a fabric cutting unit, shown generally at 200 (FIG. 2). Cutting unit 200 includes a generally U-shaped track or guideway 201 (FIG. 20) having upstanding vertical rails 202 and 203. The track 201 (FIG. 19) runs transversely of bias-cutter A and is supported at one end from vertical tubular member 135 by means of a channel member 204. The other end of track 201 is supported by means of a vertical leg 205 and a pair of brackets, one of which is shown at 206. Vertical leg 205 is welded to the longitudinally extending channel member 130*a* of stationary frame 12 and extends downwardly to rest on the floor (FIG. 3).

A carriage 207 (FIG. 19) is supported for movement on track 201. Carriage 207 is provided with a pair of spaced apart shafts 208 and 209, shaft 208 carrying wheels 210 and 211 (FIG. 20), while shaft 209 is provided with wheels 212 (FIG. 7) and 213 (FIG. 19) thereon. Each of wheels 210 through 213 rests on one or the other of rails 202 and 203 to allow low friction horizontal movement of carriage 207 on track 201 during a cutting stroke of the cutting unit 200.

Carriage 207 is provided with downwardly extending, spaced side members 214 and 215 (FIG. 20) which support therebetween a saw spindle motor MTR–3 for movement with carriage 207. Motor MTR–3 drives a pulley 216 which is mounted upon the shaft of the motor, and pulley 216, by means of a belt 217, drives a second pulley 218 (FIG. 18). Pulley 218 is carried by and drives a shaft 219 (FIG. 19). Shaft 219 is rotatably supported by a pair of moveable brackets 220 and 221 (FIGS. 17 and 20), each of which are pivotally mounted on one or the other of the depending side members 214 and 215 of carriage 207. Brackets 220 and 221 may be locked in any one of a number of different positions with respect to side members 214 and 215 in order to facilitate adjusting the vertical position of shaft 219 with respect to carriage 207. A rotary, toothed blade 222 (FIGS. 7 and 17) is fixed to shaft 219 for rotation therewith. Blade 222 is partially enclosed by a protective housing 223 that is carried by bracket 220, and the housing 223 is provided with a scoop or hook 224 which projects beneath blade 222 and guides fabric 28 into contact with the blade during the cutting stroke of cutting unit 200. Brackets 220 and 221 are so adjusted with respect to carriage 207 that scoop 224 projects below the level of the fabric 28 on table 20 so that when carriage 207 is moved transversely across the bias-cutter, the scoop 224 lifts the fabric 28 into contact with blade 222 to cleanly cut the fabric 28 along the path of movement of the blade.

The cutting stroke is accomplished by moving carriage 207 from the initial starting or "rest" position, shown in FIG. 17, along the track or guideway 201 across the width of the bias-cutter and then returning carriage 207 to its initial starting position. A motor MTR–5 (FIG. 20) is employed in traversing cutter carriage 207 through its cutting stroke. Cutter carriage traverse motor MTR–5 is supported on a plate 230 which is welded to the underside of a channel member 231 that extends between the vertical tubular members 135 and 136 (see FIG. 19), the plate 230 also being welded to the vertical tubular member 136 by means of a bracket 232 (FIG. 18). A chain 233 (FIG. 17) carried by a pair of spaced sprockets including a driving sprocket 234 and a driven sprocket 235 is driven by motor MTR–5, the driving connections including a pulley 236 carried by the shaft of the motor MTR–5, a belt 237, and a pulley 238 (FIG. 7). Pulley 238 is mounted on a shaft 239 which carries the driving sprocket 234. Shaft 239 projects through the channel member 231 and is supported thereon by means of journals 240 and 241 (FIG. 18) which are rigidly connected to a bracket 242 carried by the channel member. Driven sprocket 235 is similarly carried by a shaft 239*a* which is rotatably supported by spaced journals 240*a* and 241*a* that are rigidly mounted on a bracket 242*a* carried by channel member 231. When motor MTR–5 is energized it causes the links of chain 233 to be moved through the path of the chain about sprockets 234 and 235.

The movement of chain 233 about its sprockets 234 and 235 is transmitted to cutter carriage 207 by means of a link 243 (FIG. 20), which has one of its ends 244 pivotally connected to a clamp 245 that is fixedly carried by one of the links of chain 233. The other end 246 of link 243 is pivotally connected to a bracket 247 that is fixed to a plate 248 which is welded atop carriage 207. Thus, when the link of chain 233 that carries clamp 245 moves in its path about sprockets 234 and 235, it transmits its movement to cutter carriage 207 by means of link 243 to cause the cutter carriage to move from the position shown in FIG. 17 horizontally across the path defined by track 201 to the opposite side of the track and then back to its starting position.

A pair of limit switches 16–LS and 17–LS (FIG. 17) are employed to sense the movement of the cutter carriage 207 and transmit electrical signals indicative of the arrival of the carriage either at the far end of track 201 (16–LS) or at its starting position (17–LS). Limit switch 16–LS is actuated at the far end of track 201 by means of an arm 249, carried on the undersurface of plate 248, which engages the actuating arm of limit switch 16–LS when the carriage 207 reaches its far position. Limit switch 17–LS is actuated by an arm 250, also carried on the undersurface of plate 248, which engages the actuating arm of limit switch 17–LS when carriage 207 is in its home position, as shown in FIG. 17.

In order to insure that electrical power to the saw spindle motor MTR–3 (FIG. 20) is not interrupted during the traversing movement of cutter carriage 207, an electrical power trolley mechanism 251 is provided. One end of the power trolley mechanism 251 is supported from channel member 231 by means of a bracket 252, while the other end (FIG. 17) of the power trolley mechanism 251 is supported from the vertical tubular member 135 by means of a bracket 253. Mounted within power trolley mechanism 251 (FIG. 7) are a plurality of elongated metallic electrical strips or conductors 254 which carry the three phase power necessary to drive motor MTR–3. The conductors 254 are contacted by movable contacts or shoes 255 which are resiliently biased thereagainst so that good electrical contact with conductors 254 is maintained during the cutting stroke. The shoes 255 are carried by an arm 256 which is rigidly fastened to the top plate 248 of cutter carriage 207 and moves therewith. Thus, an electrical feed arrangement is provided which keeps motor MTR–3 energized to drive cutter saw 222 during the time that cutter carriage 207 is being traversed in its path on track or guideway 201. Wires (not shown) interconnect the movable contacts 255 with motor MTR–3, while the elongated electrical strips or conductors 254 are conventionally energized from a three phase source (not shown). The power trolley mechanism 251 is preferably of the type known as a "Feedrail," Model No. 100, manufactured by the Feedrail Corporation of New York City, New York.

Referring to FIGS. 2, 7, 8 and 9, consideration will now be given to the manner in which the fabric gripping means 75 of fabric pull-out unit 50 cooperates with fabric cutting unit 200 in order to effect pivotal realignment of fabric gripping mechanism 75 when movable frame 11 is pivoted with respect to stationary frame 12.

Referring more particularly to FIGS. 8 and 9, vertical plate 84 of fabric gripping means 75 carries a pair of metallic bumpers 260 and 261 at opposite ends thereof. Metallic bumpers 260 and 261 are made of a material having good electrical conductivity properties. They are supported on vertical plate 84, but insulated therefrom, by means of insulating blocks 262 and 263, respectively. When fabric gripping means 75 is in its "rear" position, as illustrated in FIG. 7, the metallic bumpers 260 and 261 contact rail 202 of track or guideway 201. In the event that fabric gripping means 75 is misaligned with rail 202 after a change in the bias-cutting angle, one or the other of bumpers 260 and 261 will contact rail 202 first. However, the hydraulic power cylinder 65 (FIG. 2), which moves fabric gripping means 75 towards fabric cutting means 200, continues to exert a force on the carriage 55 that supports fabric gripping means 75. This causes fabric gripping means 75 to pivot and realign itself with rail 202. When fabric gripping means 75 is aligned with rail 202, and both bumpers 260 and 261 are in contact therewith (FIG. 8), rail 202 serves as an electrical shunt across the metallic bumpers 260 and 261 thereby providing an electrical signal through wires (not shown) connected to bumpers 260 and 261 indicative of the fact that fabic gripping means 75 is properly aligned with and in contact with rail 202. Bumpers 260 and 261, together with rail 202, constitute a low voltage switch 12–LVS–R which provides a signal to the electrical circuits of the apparatus when fabric gripping mechanism 75 is in alignment with and in contact with rail 202. When this signal is given the fabric gripping bar 91 (FIG. 7) is lowered into contact with the fabric 28 carried by table 20, and vacuum is drawn in chamber 94 to grasp the leading edge of the fabric 28 and hold it tightly to gripping bar 91. Thus, when fabric gripping means 75 is subsequently moved forward (away from fabric cutting unit 200), fabric 28 is drawn out from the fabric let off unit 21 preparatory to being cut into a rhomboidal section.

In order to facilitate the movement of fabric 28 across table 20 when the leading edge of the fabric is being pulled by fabric gripping bar 31, an air blast is directed into the space between table 20 and fabric 28 (FIG. 7) during this movement. The air blast comes from a chamber 264 carried at the forward undersurface of table 20. A plurality of apertures 265, which extend through table 20, provide communication between chamber 264 and the space between fabric 28 and the top of table 20. Chamber 264 is connected by conduit and valve means (not shown) to a source of pressure and a source of vacuum (not shown). Chamber 264 is adapted to be selectively pressurized or placed under a vacuum in accordance with signals developed in the electrical control circuits of the apparatus to be hereinafter considered. When pressurized, the air in chamber 264 escapes through the apertures 265 to the space between fabric 28 and the top of table 20. This provides a friction reducing layer of air between the table and the fabric and allows fabric pull-out unit 50 to withdraw fabric 28 from fabric let-off unit 21 (FIG. 2) with a minimum of friction. After the fabric pull-out unit 50 has pulled out the rhomboidal section of fabric and before the fabric cutting unit 200 has severed this section, chamber 264 (FIG. 7) is placed under a vacuum. This is done to insure that the new leading edge of fabric 28 will be drawn tightly against table 20 so that subsequently, when fabric gripping bar 91 returns to fabric cutting unit 200 to pick up a new piece of fabric 28, the leading edge of the fabric will be pulled down beneath the level of the raised gripping bar 91, thereby preventing interference between the leading edge of fabric 28 and the gripping means 75 during the approach of the latter to cutting unit 200. Also, the vacuum acts as a hold down device to prevent the leading edge of the uncut fabric from creeping back towards the dancer roller 40. This prevents the cut edges of the following section from being angular instead of parallel with respect to one another and also insures that the width of this section will be accurately metered.

Referring to FIGS. 2, 3, 9 and 21 through 28, the fabric width and drop control unit, shown generally at 275, will now be considered.

The fabric width and drop control unit 275 is carried by stationary frame 12 of bias-cutter A. It cooperates with fabric pull-out unit 50 to stop the forward movement of pull-out unit 50 in one of a plurality of differerent advanced positions, the stopping point depending on whether the bias-cutter is to cut a wide or a narrow width rhomboidal section of fabric or whether a wide or narrow width section of fabric is to be dropped onto main conveyor B. Referring to FIG. 9, it may be seen that the vertical cross plate 112 of fabric gripping means 75 carries a metallic bumper 276 that is electrically insulated from plate 112 by means of an insulating block 277. Metallic bumper 276 is made of a material having good electrical conductive properties, and the bumper forms one contact of a low voltage switch 12–LVS–F that is employed in the electrical control circuits of the apparatus to control the movement of fabric pull-out unit 50. Various grounded elements carried by the fabric width and drop control unit 275 form the cooperating second contacts of low voltage switch 12–LVS–F.

Vertical cross plate 112 also supports a camming plate 278 which cooperates with the fabric width and drop control unit 275 in positioning fabric pull-out unit 50. Camming plate 278 is reinforced by a pair of vertical plates, one of which is shown at 279, positioned between camming plate 278 and cross brace 116 to rigidly secure the camming plate in position.

Referring to FIGS. 3 and 21, the fabric width and drop control unit 275 is provided with a pair of stepped, spaced apart, side members 280 and 281 that establish two horizontal elevations in control unit 275. Side members 280 and 281 are joined together throughout their forward portion (left side as viewed in FIG. 21) by means of a base plate **282** which serves as a platform for the components positioned on the upper level of control unit **275**. The side members **280** and **281** are also interconnected throughout the rear portion of control unit **275** by means of a second base plate **283**, which establishes the lower level of control unit **275**.

Referring to FIG. 28, a pair of laterally spaced apart rails **284** and **285** extend along the length of base plate **283**, the rails being supported above the base plate by means of a pair of longitudinally spaced blocks **286** and **287**. Rails **284** and **285** support first and second movable carriages **288** and **289** thereon. Movable carriage **288** supports the various components employed in controlling the stopping point of fabric pull-out unit **50** with respect to the width of the fabric to be cut and will hereinafter be referred to as the fabric width control carriage **288**. Movable carriage **289** carries the components which are employed in controlling the stopping point of fabric pull-out unit **50** with respect to dropping the cut sections of fabric onto main conveyor B and will hereinafter be referred to as the fabric drop control carriage **289**. Carriages **288** and **289** are movably supported on rails **284** and **285** by means of sets of rollers **290** and **291** (FIG. 25), there being a set of such rollers at each of the corners of each of carriages **288** and **289**.

Referring to FIGS. 23 and 28, fabric width control carriage **288** has bolted thereto a flat support plate **292**, which, in turn, carries a pneumatically operated power cylinder **293**. Support plate **292** also carries a vertical bracket **294** which pivotally supports a cutting position stop assembly, shown generally at **295**. The stop assembly **295** includes a cam **296** that is pivotally supported on bracket **294** by means of a bolt **296*a***. Cam **296** carries an electrically grounded roller **297** that is engaged by the metallic bumper **276** of fabric pull-out unit **50**, the roller **297** and bumper **276**, together, forming low voltage switch **12–LVS–F** when pull-out unit **50** reaches the cutting position stop assembly **295**.

The cam **296** of stop assembly **295** is supported in the position shown in FIG. 23 by means of a clevis **298** that is movably connected to piston rod **299** of power cylinder **293**. Clevis **298** supports between its spaced legs an upper and lower wheel **300** and **301**, respectively. Lower wheel **301** rests on a spacer plate **302** having an adjustable stop **302*a***, while upper wheel **300** contacts a camming surface **303** formed on cam **296**. With piston rod **299** extended from power cylinder **293**, clevis **298** abuts stop **302*a*** and acts as a wedge under camming surface **303** to force cam **296** into the position shown in FIG. 23. Thus, when fabric pull-out unit **50** is pulling fabric out of fabric let-off unit **21** (FIG. 3), forward movement continues until metallic bumper **276** (FIG. 23) contacts roller **297** at which time low voltage switch **12–LVS–F** sends a signal to the electrical circuits of the apparatus to stop the movement of fabric pull-out unit **50**. The position of stop assembly **295**, therefore, establishes the width of the section of fabric to be subsequently cut by fabric cutting means **200** (FIG. 2). After fabric cutting means **200** completes the cut, piston rod **299** (FIG. 23) is retracted into power cylinder **293**, thereby removing the support of clevis **298** from camming surface **303**. Cam **296** is mounted in such a manner on bolt **296*a*** that when piston rod **299** retracts, the cam rotates counterclockwise about bolt **296*a*** to clear the path in front of fabric pull-out unit **50** for further forward movement thereof to the fabric dropping position.

A neutral position limit switch **14–LS** is carried atop power cylinder **293** and serves to signal the electrical circuits regarding the position of cutting position stop assembly **295**. Cam **296** is provided with a second camming surface **304** which cooperates with the actuating arm **305** of limit switch **14–LS** to actuate the limit switch in response to a change in position of stop assembly **295**.

Referring ot FIGS. 24, 25 and 28, fabric width control carriage **288** is provided with a journal member **306** which is welded thereto and extends transversely thereof. Journal member **306** rotatably supports a shaft **307**, one end of which is provided with a rigidly connected, upwardly extending arm **308** that carries a roller **309**, the other end of which is provided with a rigidly connected, downwardly extending arm **310** that carries a roller **311**. Arm **308** is depressed when camming plate **278** of fabric pull-out unit **50** hits roller **309** while moving forward to the cutting position stop assembly **295**. This causes shaft **307** to rotate, lowering arm **310** and causing roller **311** to depress a plate **312** that is pivotally supported on brackets **313** and **314** carried by base plate **283**. Plate **312** rests atop a roller **315** carried by the actuating arm **316** of a deceleration valve **317** which is connected in the hydraulic return line (not shown) of power cylinder **65** (FIG. 3) to decelerate or slow down the forward movement of fabric pull-out unit **50** as it approaches the cutting position stop assembly **295**.

When the metallic bumper **276** of fabric pull-out unit **50** contacts stop assembly **295** low voltage switch **12–LVS–F** closes to signal the electrical circuits of the apparatus that fabric is pulled out past cutting unit **200** (FIG. 2). The cutting unit **200** then automatically cuts the pulled out fabric into a rhomboidal section, and, upon completion of the cutting stroke, power cylinder **293** (FIG. 23) is actuated to retract piston rod **299**, thereby lowering stop assembly **295** and opening low voltage switch **12–LVS–F**. This signals the electrical circuits to actuate power cylinder **65** (FIG. 2) to again move pull-out unit **50** forwardly in order to position the cut rhomboidal section of fabric with respect to main conveyor B. Forward movement of fabric pull-out unit **50** continues until (FIG. 28) metallic bumper **276** comes into contact with an electrically grounded dropping position stop assembly, shown generally at **320**, carried by the fabric drop control carriage **289**. At this point low voltage switch **12–LVS–F** is again closed and the electrical circuits deactuate power cylinder **65**, causing fabric pull-out unit **50** to stop in contact with the dropping position stop assembly **320**. Stop assembly **320** is carried at one end of a **piston rod 321**, the other end of which is actuated by and moves within an hydraulically operated power cylinder **322**.

In order to decelerate the forward movement of pull-out unit **50** as it approaches stop assembly **320**, the fabric drop control carriage **289** is provided with a journal member **323** that is carried rearwardly thereof by means of brackets **324** and **325**. Journal member **323** rotatably supports a shaft **326** which is provided at one end thereof with a rigidly connected, upwardly extending arm **327** that carries a roller **328**. The other end of shaft **324** is provided with a rigidly connected, downwardly extending arm **329** that carries a roller **330**. The upwardly extending arm **327** cooperates with camming plate **278** of fabric pull-out unit **50**, while the downwardly extending arm **329** cooperates with plate **311** which operates the deceleration valve **317**. Thus, deceleration of fabric pull-out unit **50** as it approaches the dropping position stop assembly **320** is achieved in a manner similar to that realized when pull-out unit **50** approaches the cutting position stop assembly **295**.

Dropping position stop assembly **320** is shifted transversely with respect to the drop control carriage **289**, by means of power cylinder **322**, in order to effect changes in the position of the center lines of the rhomboidal sections of fabric with respect to the reference line X—X (FIG. 1A). Thus, piston **321** is extended out of power cylinder **322** when plies **1** and **2** are to be dropped by fabric pull-out unit **50**, and this results in the center lines of plies **1** and **2** being displaced a quarter of an inch from the reference line X—X. When plies **3** and **4** are to be dropped, however, piston rod **321** is retracted within power cylinder **322** and this shift in the position of stop assembly **320** causes the center lines of plies **3** and **4** to be dropped on top of the reference line X—X of FIG. 1*a*. This sequence of actions will appear more fully hereinafter as this description of the fabric width and drop control unit **275** proceeds.

Referring to FIG. 28, the fabric width control carriage 288 is moved longitudinally along rails 284 and 285 by means of a rack gear 331 which is bolted to the vertical bracket 294 carried by this carriage, while the fabric drop control carriage 289 is moved longitudinally with respect to rails 284 and 285 by means of a second rack gear 332 which is bolted thereto.

Referring now to FIGS. 21, 22 and 26 through 28, the forward end of rack gear 331 is connected to a piston rod 333 which is controlled by an hydraulically operated power cylinder 334. When power cylinder 334 is actuated to extend piston rod 333, rack gear 331 is driven by the piston rod and, consequently, fabric width control carriage 288 moves rearwardly along rails 284 and 285. Rack gear 331 is held in engagement with a large pinion gear 335 (FIG. 22) by means of a roller 336 in abutment therewith. Gear 335 is journaled on a shaft 337 for rotation independently of the shaft. A small pinion gear 338, which is also journaled on shaft 337, is driven by the large pinion gear 335 through a shear pin 339. Rack gear 332, which drives the drop control carriage 289, is held in engagement with the small gear 339 by means of a roller 340. Gears 335 and 338 have a two to one gear ratio, and, therefore, longitudinal movement of rack gear 331 by a given amount results in similar movement of rack gear 332 by one-half the amount of rack gear 331. Thus (FIG. 21), when power cylinder 334 is actuated and rack gear 331 moves the width control carriage 288 a prescribed amount towards the rear of control unit 275, rack gear 332 moves the drop control carriage 289 towards the rear of control unit 275 one-half of the amount moved by carriage 288. Similarly, when power cylinder 334 is actuated to retract piston rod 333, both carriages move toward the front of conrtol unit 275, with carriage 288 moving twice the amount of carriage 289.

When piston rod 333 is retracted into the power cylinder 334, and the two carriages 288 and 289 are in their forward (wide width) locations with respect to control unit 275, the fabric cutting unit 50 pulls out wide rhomboidal sections of fabric from fabric let-off unit 21 of the bias-cutter. Under this condition of operation piston rod 321 should be extended from power cylinder 322 so that the wide rhomboidal sections of fabric (which subsequently form plies 1 and 2) will be dropped with their center lines offset from the reference line X—X of FIG. 1A.

When piston rod 333 of power cylinder 334 is extended out of the power cylinder, and the carriages 288 and 289 are in their rear (narrow width) positions with respect to control unit 275, fabric pull-out unit 50 pulls out narrow rhomboidal sections of fabric from fabric let-off unit 21 of the bias-cutter. Under this condition of operation piston rod 321 of power cylinder 322 is retracted into the power cylinder so that the center lines of the narrow rhomboidal sections (which subsequently form plies 3 and 4) will be dropped in alignment with reference line X—X of FIG. 1A.

It will be seen that, with piston rod 321 retracted, the movement of carriages 288 and 289 by a two to one relationship results in the positioning of the center line of any rhomboidal section of fabric, irrespective of its width, in alignment with the reference line X—X. Hence, by adjusting the locations at which piston rod 333 stops when it is extended or retracted, the bias-cutter may be made to cut rhomboidal sections of two different widths, selected from a wide range of widths, and to deposit these sections in proper relation to main conveyor B.

The manner in which settings for desired widths of the rhomboidal sections are introduced into the apparatus is shown most clearly in FIGS. 21, 26 and 27. Control unit 275 is provided with a movable stop mechanism or slide 345 which carries a stop 346. Slide 345 is positioned atop and movable with respect to a trapezoidal shaped plate 347 carried by base plate 282. Stop 346, which is welded to slide 345, is provided with a threaded aperture that engages the threaded portion of a shaft 348, the shaft 348 being adapted to be rotated by a hand wheel 349. Slide 345 also supports a bracket 350 which, in turn, carries a limit switch 11–LS–F. The end structure of piston rod 333 projects laterally of the piston rod a sufficient amount to abut against stop 346 when the piston rod is moved out of power cylinder 355. This limits the travel of piston rod 333. Also, the end of piston rod 333 is provided with a projecting arm 351 which actuates limit switch 11–LS–F when the piston rod reaches its extended position to provide a signal that control unit 275 is set for narrow width operation. By turning hand wheel 349, threaded shaft 348 causes slide 345 to move along trapezoidal plate 347, thereby changing the extended position setting of piston rod 333 and, consequently, the narrow width setting of control unit 275. The slide 345 carries an index or pointer 352 that cooperates with a calibrated scale 353 carried by base plate 282 to indicate the narrow width setting of control unit 275 and to allow an operator to set in a desired narrow width value.

A somewhat similar arrangement is provided with respect to setting control unit 275 for cutting desired wide width rhomboidal sections. Power cylinder 334 is mounted upon a movable slide 355 which has a block 356 bolted thereto. Block 356 is provided with a threaded aperture that engages the threaded portion of a shaft 357 which is adapted to be turned by a hand wheel 358. Block 356 has fastened thereto a pointer 359 that cooperates with a calibrated scale 360.

Upon rotating hand wheel 358, block 356 is moved along shaft 357 and carries slide 355 and power cylinder 334 along with it, the slide 355 moving on trapezoidal plate 347. This changes the retracted position setting of piston rod 333 and, consequently, the wide width setting of control unit 275. Slide 355 supports a limit switch 11–LS–R for movement therewith. Limit switch 11–LS–R is actuated by the arm 351 carried by piston rod 333 when the piston rod reaches its retracted position. This limit switch is employed to provide an electrical signal signifying that control unit 275 is set for wide width operation.

While normally the two slides 345 and 355 would have the relationship in position that is shown in solid lines in FIG. 21 when large size passenger car tires are being manufactured, slide 345 has been shown in phantom at 361 to illustrate the position it would have to be set at in order to achieve the spacing of the carriages 288 and 289 as they are illustrated in FIG. 28. This spacing was selected in order to more clearly illustrate various features of control unit 275.

The Main Conveyor

The main conveyor B has been illustrated generally in FIG. 1 and in greater detail in FIGS. 29 through 35. It serves to receive the rhomboidal sections of bias-cut fabric from bias-cutter A and to transport the fabric to and between the various major components of the machine.

Referring more particularly to FIGS. 29 through 35, main conveyor B includes a stranded conveyor belt, shown generally at 400, which is supported on a generally rectangularly shaped stationary structure or frame, shown generally at 401. The downstream portion of frame 401 (FIGS. 30 and 31), comprises an upper pair of spaced, longitudinally extending side members 402 and 403 which are interconnected at their upstream ends by a cross member 404. The other ends of the side members 402 and 403 extend beyond the downstream end of belt 400 into the area of applicator conveyor H.

The downstream portion of frame 401 is also provided with a lower pair of spaced, longitudinally extending, side members 405 and 406 which are interconnected at their upstream ends by means of a cross member 407. Upper and lower side members 402 and 405, respectively, are interconnected by means of vertical legs 408, 409 and

410, the latter two of which extend downwardly below side member 405 and rest on the floor to support frame 401. Similarly, upper side member 403 and lower side member 406 are supported in vertically spaced relation by means of legs 411, 412 and 413, the latter two of which extend downwardly into contact with the floor.

The upstream portion of frame 401 (FIGS. 29 and 32) is arranged in a manner similar to the downstream portion thereof. The upstream portion of frame 401 includes an upper pair of spaced, longitudinally extending, side members 414 and 415 which are interconnected at their upstream ends by a cross member 416 and at their downstream ends by a cross member 417. The upstream portion of frame 401 also includes a lower pair of spaced, longitudinally extending, side members 418 and 419. The upstream ends of members 418 and 419 are interconnected by a cross member 420, while the downstream ends thereof are interconnected by a cross member 421. Vertical legs 422 and 423 interconnect side members 414 and 418, while vertical legs 424 and 425 interconnect side members 415 and 419, all of the legs extending downwardly to the floor to support the entire forward portion of stationary structure 401. Clamps and shims (not shown) are utilized to rigidly join the upstream and downstream portions of frame 401 together into a single unit.

Referring to FIG. 32, the stationary upper channel members 130 and 130*a* of bias-cutter A extend transversely across the upstream portion of frame 401 and are bolted to side members 414 and 415 thereof. A plurality of angle irons 426, which are welded to one or the other of side members 414 and 415, and a plurality of bolts 427, which threadedly engage one or the other of channel members 130 and 130*a*, are employed for this purpose.

Referring to FIG. 33, the stationary, lower channel members 132 and 132*a* of bias-cutter A pass beneath and are welded to the lower side members 418 and 419 of stationary frame 401. Thus, a rigid interconnection is provided between the stationary framework of bias-cutter A and the stationary framework of main conveyor B.

In order to insure that the various pieces of fabric carried by stranded main conveyor belt 400 are maintained in proper alignment with respect to reference line X—X of FIG. 1A, the conveyor belt is constructed in such a manner as to insure straight tracking and preclude transverse wandering of the fabric. This is accomplished by constructing stranded main conveyor belt 400 from a single elongated continuous length of V-belt looped around grooved end pulleys in a somewhat helical arrangement so as to form (FIGS. 29 and 30) an upper surface 428 for conveying the fabric and a lower surface 429 for the return path of the strands.

The downstream end loops of stranded main conveyor belt 400 are supported by a rotatable shaft 430 which has fixedly secured thereto a plurality of driving pulleys 431*a* through 431*r* (FIG. 31). The upstream end loops of stranded main conveyor belt 400 are supported on a shaft 432 by means of a plurality of driven pulleys 433*a* through 433*r* which are fixedly secured to shaft 432 and rotatable therewith, the pulleys being spaced apart along shaft 432 (FIG. 32).

The manner in which main conveyor belt 400 is wound about driven pulleys 433*a* through 433*r* and driving pulleys 431*a* through 431*r* will now be considered. Referring to FIG. 32, main conveyor belt 400 includes a strand 434 which proceeds from the driven pulley 433*a*, along the upper surface 428 (FIG. 29) over rollers 435, 436, 437, 438 (FIG. 31) and 439 to driving pulley 431*a*, the strand 434 being aligned longitudinally parallel to reference line X—X of FIG. 1A. After passing over driving pulley 431*a*, strand 434 proceeds over a snubbing roller 440 (FIG. 30) which insures that each of the downstream end loops of stranded main conveyor belt 400 contacts its respective driving pulley 431*a* through 431*r* over a substantial peripheral portion of the pulley. Strand 434 then proceeds downwardly to an idler roller 441 which establishes the level of the lower surface 429 of main conveyor belt 400. After passing under idler roller 431, the strand under consideration, which at this point is identified as strand 442 (FIGS. 31 and 32), proceeds along lower surface 429 at a slight angle to longitudinal reference line X—X of FIG. 1A and passes over idler rollers 439*a*, 438*a*, 437*a*, and 436*a*, until it reaches an idler roller 443, which changes the direction of movement of strand 442 and directs it upwardly towards a snubbing roller 444. Strand 442 then proceeds over snubbing roller 444 and under and around a driven pulley 433*b* at the upstream end of main conveyor B, the snubbing roller 444 being employed to insure that the upstream end loops of main conveyor belt 400 contact their respective driven pulleys throughout a substantial peripheral portion thereof. Upon passing around and over driven pulley 433*b* the strand under consideration, which at this point is identified by the numeral 445, proceeds downstream parallel to, but displaced from, the previous strand 434 until it comes to driving pulley 431*b*. It then passes around pulley 431*b*, over snubbing roller 440, under idler roller 441, and follows a path parallel to strand 442 back to the upstream end of main conveyor B. The foregoing circuits are repeated for each strand in main conveyor belt 400 until, in the final circuit, the strand under consideration, which at this point is identified as strand 446, passes over driving pulley 431*r* (FIG. 31), around snubbing roller 440, under idler roller 441 and then proceeds under a vertically disposed stabilizing wheel 447. The strand 446 then goes around a horizontally disposed crossover wheel 448 and, moving in a path generally transverse of the remaining strands of main conveyor belt 400, passes around a second horizontal crossover wheel 449. After passing around wheel 449, strand 446 proceeds under a vertically disposed stabilizing wheel 450, under idler roller 443, over snubbing roller 444 and back to the underside of pulley 433*a* in position to again start its circuitous path about the various rollers, pulleys and wheels of main conveyor B.

Since all of the strands on the upper fabric conveying surface 428 of main conveyor belt 400 are a part of one single continuous belt and, further, since all of the strands at this level are longitudinally aligned parallel to reference line X—X of FIG. 1A, the fabric conveying surface 428 moves as a unit, and there is no lateral wandering or displacement of the pieces of fabric carried thereon. It will be understood that each of the rollers 435, 436, 437, 438 and 439 are provided with grooves at the proper transverse positions therealong corresponding to the positions of the various strands of belt 400 in order to insure that the various strands maintain their proper transverse alignment during the movement from the upstream to the downstream end of main conveyor B.

Referring to FIG. 33, representative grooves in roller 437 have been designated at 450, and representative grooves in roller 435 have been designated at 451. Similarly, idler roller 443 is provided with representative grooves 452. The snubbing rollers 444 and 440, and the idler roller 441 (FIGS. 29 and 30), are also provided with grooves (not shown) which serve a similar function to grooves 450, 451 and 452 in maintaining the various strands of belt 400 in proper transverse alignment.

On the other hand, rollers 436*a*, 437*a*, 438*a* and 439*a*, which support the lower, return level 429 of main conveyor belt 400, do not contain grooves of the aforementioned type. The reason for this is that each of the lower level strands are at a slight angle to reference line X—X of FIG. 1A and, hence, they shift laterally as they proceed from pulleys 431*a* through 431*q* to pulleys 433*b* through 433*r*.

Stranded main conveyor belt 400 is driven by means of a two-speed, reversible, electric motor MTR–7 (FIG. 30). A reduction gear assembly 460 is coupled to motor

MTR–7 and the rotary output thereof is transmitted to a chain 461 by means of a driving sprocket 462. Chain 461 passes over an idler sprocket 463, under a driven sprocket 464 (employed in driving the applicator conveyor H), and then over a driven sprocket 465 which is rigidly carried by shaft 430. (The manner in which driven sprocket 464 is employed in driving applicator conveyor H will be considered in further detail hereinafter.) Thus, when main conveyor drive motor MTR–7 is driven at either high or low speed and in either its forward or reverse direction, chain 461 causes shaft 430 to rotate, thereby transmitting the rotational movement via driving pulleys 431*a* through 431*r* to main conveyor belt 400.

As indicated earlier, the lengths of the various plies of a given carcass are established by stopping main conveyor belt 400 with the leading edges of pieces of fabric thereon located at predetermined distances downstream from cut-to-length unit E (FIG. 31) and then cutting the upstream portions of the pieces of fabric at a point beneath cut-to-length unit E. Photocells 3–EYE and 4–EYE are employed in this regard, the photocells being supported on a bracket 466 which is adjustably carried by side member 402 in order to allow for longitudinal repositioning of photocells 3–EYE and 4–EYE when it is desired to change the size of the carcass to be built. Photocells 3–EYE and 4–EYE are carried above stranded main conveyor belt 400 and cooperate with lamps (not shown in the series of figures under consideration) positioned below belt 400 to provide electrical signals when the light beams of the lamps are either blocked or unblocked from the photocells. When the light beam to photocell 3–EYE is blocked by the leading edge of fabric moving downstream on belt 400, the photocell signals the electrical circuits to slow down motor MTR–7 to a "crawl" speed. Thereafter, in the case of ply 1, when the light beam of photocells 4–EYE is blocked, this photocell signals the electrical circuits to stop main conveyor drive motor MTR–7 so that the fabric is in proper position to be cut to the length of ply 1.

In order to provide a means by which plies 2, 3 and 4 of a given carcass may be metered to progressively longer lengths than ply 1 (by stopping stranded main conveyor belt 400 with the leading edge of the fabric at progressively greater distances downstream from cut-to-length unit E), a revolution counter assembly, shown generally at 467, is provided. Revolution counter assembly 467 is driven by shaft 430 upon energization of a clutch 4–CLU, there being a speed reduction mechanism 468 interposed between clutch 4–CLU and assembly 467. Revolution counter assembly 467 is provided with three separate revolution counters identified generally at 2–RVC, 3–RVC and 4–RVC, each of which is employed in conjunction with photocell 4–EYE to control the respective lengths of plies 2, 3 and 4. The electrical circuits utilized in this regard will be considered in greater detail hereinafter, it being sufficient for purposes of this discussion to understand that: (1) with clutch 4–CLU and revolution counter 2–RVC energized, the leading edge of fabric is positioned downstream of photocell 4–EYE so that ply 2 is cut to a length slightly longer than play 1; (2) with clutch 4–CLU and revolution counter 3–RVC energized, the leading edge of fabric is positioned further downstream than in (1) above so that ply 3 is cut to a length slightly longer than ply 2; and (3) with clutch 4–CLU and revolution counter 4–RVC energized, the leading edge of fabric is positioned further downstream than in (2) above so that ply 4 is to cut to a length slightly longer than ply 3.

The revolution counters 2–RVC, 3–RVC and 4–RVC are each provided with electrical contacts (not shown in the series of figures under consideration) that are actuated to change condition (from open to closed or vice versa) upon predetermined amounts of rotation of the revolution counter. These contacts are employed in the electrical control circuits of the apparatus (to be described hereinafter) and serve to by-pass the "stop" photocell 4–EYE in determining the stopping point of main conveyor belt 400 when plies 2, 3 and 4 are to be cut to length. The amount of additional travel past photocell 4–EYE may be independently and manually adjusted on each of the revolution counters 2–RVC, 3–RVC and 4–RVC. Revolution counter assembly 467 includes three revolution counters of the type known as the "Microflex Counter," Model No. HZ64, made by Eagle Signal Corp., of Moline, Illinois.

Referring to FIGS. 32, 34 and 35, the upstream end of mainconveyor B will now be considered in greater detail. Shaft 432, in addition to serving as the upstream end of main conveyor belt 400, serves as the downstream support end for the strands of a stranded conveyor belt employed in one (the lower) of the two storage areas of storage device C. Each of the strands of the lower storage area conveyor belt in storage device C is supported on shaft 432 by means of a plurality of driven pulleys 470*a* through 470*q*, which are rotatably supported on shaft 432 and interspersed between the various pulleys 433*a* through 433*r* carried by this shaft, there being one less strand in the lower storage conveyor of storage device C than in stranded main conveyor belt 400.

Referring to FIG. 35, the driven pulleys 470*a* through 470*q* are each rotatably supported on shaft 432 by means of bearings, which comprise: an outer race 471 that is held in place on the inner periphery of the pulley by means of a snap ring 472; an inner race 473 fixedly carried on the shaft 432; and ball bearings 474, which separate the inner and outer races 473 and 471, respectively, and allow independent rotation of the pulleys 470*a* through 470*q* with respect to shaft 432.

It will be apparent from the foregoing that, when main conveyor belt 400 is being driven, shaft 432 will rotate independently of pulleys 470*a* through 470*q*. Also, when the lower storage area conveyor belt of storage device C is driven, pulleys 470*a* through 470*q* will be rotated by the strands of that conveyor. A series of keys 475, one for each of the pulleys 433*a* through 433*r*, is employed in locking these pulleys to the shaft 432 for rotation therewith.

Referring to FIG. 32, shaft 432 projects outwardly from both sides of stationary structure 401. A revolution counter assembly 476 is coupled to one end of the shaft 432 so that when a revolution counter 1–RVC, located within the assembly 476, is energized, its contacts (not shown in this figure) are actuated and driven by shaft 432. Revolution counter 1–RVC is employed in controlling stranded conveyor belt 400 when it is in reverse operation. It serves to stop the reverse operation of main conveyor belt 400 at those times when it is desired to move a remnant piece of fabric to the "backup" position (a point about six feet upstream from cut-to-length unit E). The electrical control circuitry employed in this regard will be considered in greater detail hereinafter. Revolution counter 1–RVC is of the type known as "Actotrol Revolution Counter," Model No. 307A, made by Automatic Timing & Controls, Inc., of King of Prussia, Pennsylvania.

The other end of shaft 432 is employed as a power take-off to drive the upper and lower storage area conveyor belts of storage device C. Further details concerning this power take-off appear in the following section.

The Storage Device

The storage device C is positioned adjacent to and upstream of main conveyor B. It is shown diagrammatically in FIG. 1 and has been illustrated in greater detail in FIGS. 36 through 42. Storage device C includes a lower storage area, shown generally at 500, for storing wide width pieces of fabric, and an upper storage area, shown generally at 501, for storing narrow width pieces of fabric. The lower, wide width, storage area 500 includes a stationary frame, shown generally at 502. Frame 502 comprises upper, longitudinally extending, side members 503 and 504, which are joined together at their upstream ends by a transverse member 505 and at their downstream ends by a transverse member 506 (FIG. 36).

The upstream portion of frame 502 is supported on a pair of laterally spaced, vertical legs 507 and 508 which rest on the floor and project upwardly above the level of the longitudinally extending side members 503 and 504 to pivotally support the upper, narrow width, storage area 501. The downstream portion of frame 502 is also supported from the floor by a second pair of laterally spaced, vertical legs 509 and 510. Legs 509 and 510 also project upwardly above the level of side members 503 and 504 to support the upper, narrow width storage area 501.

Stationary frame 502 is rigidly interconnected to stationary frame 401 of main conveyor B in the following manner. Referring to FIGS. 32 and 34 and 36, together, the upstream cross member 416 of frame 401 has welded thereto downwardly extending angle members 511 and 512. Horizontal portions of angle members 511 and 512 are welded, respectively, to short, longitudinally disposed, channel members 513 and 514, which, in turn, are welded to and protrude downstream of transverse member 506 of frame 502. This arrangement adds further rigidity to the combined structures of storage device C and main conveyor B.

Referring more particularly to FIGS. 36 through 39, the lower, wide width, storage area 500 is provided with a stranded conveyor belt, shown generally at 520. Lower storage area stranded conveyor belt 520 is similar in structure to the stranded conveyor belt 400 of main conveyor B. It comprises a single continuous strand of belting which is wound around upstream and downstream rotatable supports in a series of consecutive, spaced-apart, loops in the same manner as main conveyor belt 400. The upstream end turns of belt 520 are supported on a grooved driving roller 521, while the downstream end turns of the belt are supported on the previously-mentioned driven pulleys 470*a* through 470*q*. Idler rollers 522 and 522*a* are provided intermediate the ends of lower storage area conveyor belt 520 to prevent sagging of the central portion thereof. Also, a snubbing roller 523 (FIG. 38) is provided adjacent driving roller 521 to insure that the upstream end turns of belt 520 make good contact with driving roller 521 over a substantial portion of the periphery of the roller. As in the case of main conveyor B, stranded conveyor belt 520 is provided with a pair of vertical stabilizer wheels 524 and 525 and a pair of horizontal crossover wheels 526 and 527 in order to return a strand 528 from pulley 470*q* to the first groove of roller 521.

The path of the strands of lower storage area conveyor belt 520 is similar to that of conveyor belt 400 on main conveyor B. Starting with the first groove (not shown) of driving roller 521, a point on conveyor belt 520 moves down the first strand 529 (FIG. 37), parallel to reference line X—X of FIG. 1A, until it reaches pulley 470*a* and passes therearound. It then comes back at a slight angle to reference line X—X, as indicated by strand 530 (FIG. 37), until it reaches the second groove (not shown) of roller 521. From there on, the path of a point on belt 520 follows a repetitive, somewhat helical path around the remaining grooves of roller 521 and pulleys 470*a* through 470*q* until it reaches pulley 470*q* and passes therebeneath. At his time it follows strand 528 over vertical stabilizer wheel 524, around horizontal crossover wheel 526, around horizontal crossover wheel 527, over vertical stabilizing wheel 525, and goes back to the first groove of roller 521, thereby completing its circuit and starting out again along the previously-mentioned strand 529. By this arrangement the fabric carrying surface of lower storage area stranded conveyor belt 520 moves horizontally as a unit. This prevents transverse wandering of pieces of fabric on belt 520 and insures that alignment will be maintained between fabric carried by belt 520 and fabric carried by belt 400 of main conveyor B.

The manner in which lower storage area conveyor belt 520 is driven will now be considered. Referring to FIG. 37, shaft 432, which is driven by stranded main conveyor belt 400, is employed as a power take-off for driving conveyor belt 520. Shaft 432 is drivingly connected to the input shaft 531 of a direction changing gear box 532 by means of a coupling assembly 533. The output of gear box 532 is carried by a shaft 535 which is coupled to a shaft 536 running longitudinally of storage device C, the shaft 536 being provided with a shield 537 supported from stationary frame 502 by means of brackets 538. Shaft 536 is, in turn, coupled to the input shaft 539 of a second direction changing gear box 540, the output of which is carried by shaft 541.

The rotary output on shaft 541 is transmitted to the driving member of a clutch 1–CLU through a coupling member 542. The driving member of clutch 1–CLU carries a chain drive sprocket 543 (FIG. 36) which drives a chain 544 in connection with driving the conveyor of the upper, narrow width, storage area 501. Thus, whenever stranded conveyor belt 400 of main conveyor B is driven, rotary motion is transmitted by shaft 432 (FIG. 37) to the driving member of clutch 1–CLU and to the chain 544. By energizing clutch 1–CLU, rotary motion is transmitted to the driven member of this clutch, which, in turn, is mounted on a shaft, 545 that carries driving roller 521. Hence, energization of clutch 1–CLU by the electrical circuits of the apparatus results in the movement of lower storage area conveyor belt 520 at the same speed as and in the same direction as main conveyor belt 400.

As heretofore indicated, lower storage area 500 receives the remnant piece of wide width fabric remaining when ply 2 is cut to length and stores this remnant for use in building ply 1 of a subsequent carcass. When the electrical circuits signal main conveyor B to return the remnant piece of fabric to lower storage area 500, clutch 1-CLU is concurrently energized with main conveyor drive motor MTR–7, and, consequently, the remnant piece of fabric is carried into storage area 500.

In order to stop the rearward (upstream) movement of main conveyor belt 400 and lower storage area conveyor belt 520 when the remnant piece of fabric is entirely within storage area 500, a photocell 5–EYE (FIG. 37) is employed. Photocell 5–EYE is supported just above the upper level of lower storage conveyor belt 520 by means of a bracket 546 carried by the longitudinally extending side member 503. A similar bracket (not shown) and a lamp (not shown) are positioned below the level of lower storage conveyor belt 520 in vertical alignment with photocell 5–EYE. Hence the light beam between the lamp and photocell 5–EYE is interrupted when the leading edge of the remnant piece of fabric intercepts the beam upon moving into storage area 500. This deactuates the photocell but no further action results. When the trailing edge of the remnant piece of fabric moves upstream beyond photocell 5–EYE, the photocell becomes actuated and a signal is sent to the electrical circuits to stop the upstream movement of main conveyor belt 400 and storage conveyor belt 520.

Referring now to FIGS. 34, 36, 40, 41 and 42, the upper (narrow width) storage area 501 of storage device C will now be considered. Storage area 501 is provided with a pivotally supported frame, shown generally at 550. Frame 550 comprises longitudinally extending, spaced apart, side members 551 and 552, which are interconnected at their upstream ends by means of a cross member 553 (FIG. 40) and at their downstream ends by a cross member 554 (FIG. 41). A cantilever pulley assembly, shown generally at 555, is carried at the downstream end of frame 550. Referring more particularly to FIGS. 34 and 41, the cantilever pulley assembly 555 comprises an upper cross plate 556, which is rigidly connected to frame 550, and a lower cross plate 557, which is connected to plate 556 by means of a plurality of bolts 558. Upper and lower cross plates 556 and 557, together with bolts 558, form a clamping arrangement by means of which a plurality of longitudinally extending, vertical plate members 559*a* through 559*q* are rigidly supported by frame 550. Each of plates 559*a* through 559*q* fit into vertically disposed grooves in the plate 556 and, when bolts 558 are drawn tight, plate 557 clamps the various plates 559*a* through 559*q* tightly in position at the downstream end of frame 550. Each of plates 559*a* through 559*q* rotatably carries a respective pulley 560*a* through 560*q* at the downstream end thereof. Each pulley 560*a* through 560*q*, together with its respective plate 559*a* through 559*q*, is of narrow enough width to be able to be moved from a level above the strands of main conveyor belt 400 to a level below the strands without interfering with the movement of belt 400. Thus, referring to FIG. 36, the upper storage area 501 may be moved from the position shown by the dot-dash line to the solid line position without contacting the strands of belt 400 during its movement. When upper storage area 501 is in its engaged or lower position, as shown in FIG. 34, the fabric moved upstream by main conveyor belt 400 is transferred smoothly to the upper, narrow width, storage area 501.

The various pulleys 560*a* through 560*q* are mounted on their respective plates 559*a* through 559*q* in the manner shown in FIG. 34. Thus, plate 559*k* is provided with a short horizontal shaft 561 which carries the inner race 562 of a bearing, while the outer race 563 of the bearing is carried by pulley 560*k*. Ball bearings 564 separate the inner and outer races 562 and 563 and rotatably support pulley 560*k* on shaft 561. The ball bearings also prevent lateral movement of the pulley with respect to plate 559*k*. The construction employed is similar to that shown in FIG. 35 with respect to pulleys 470*a* through 470*q*.

A grooved driving roller 570 (FIG. 40), carried by a shaft 571, is rotatably supported at the upstream end of frame 550. In addition, a first pair of idler rollers 572 and 572*a* (FIG. 36) and a second pair of idler rollers 573 and 573*a* support the individual strands of the conveyor belt of upper storage area 501 at points intermediate the ends thereof.

Upper storage area 501 is provided with a stranded conveyor belt, shown generally at 575, which is similar in configuration to both the stranded belt 400 of main conveyor B and the stranded belt 520 of lower storage area 500. Thus, a point on the stranded upper storage area conveyor belt 575 may be said to travel from the first groove (not shown) on roller 570 (FIG. 40) along a strand 576 in a direction parallel to longitudinal reference line X—X of FIG. 1A, until it reaches pulley 560*a* (FIG. 41) and passes therearound. At this time the point would follow strand 577 at a slight angle to reference line X—X until it reached the second groove (not shown) on roller 570 (FIG. 40). It would then follow a path along strand 578, parallel to reference line X—X, passing over and around pulley 560*b* (FIG. 41) and going on to the third groove (not shown) of roller 570 (FIG. 40). This helical path would continue until the point proceeded around pulley 560*q*. After passing around pulley 560*q*, the point, now traveling along strand 579 (FIGS. 41 and 42), passes over a vertical stabilizer wheel 580 and around a horizontal crossover wheel 581. It then proceeds transversely across the width of storage area 501, goes around a horizontal crossover wheel 582 and over a vertical stabilizer wheel 583, and then moves back under roller 571 at the first groove thereof to again pass along strand 576 (FIG. 40).

Referring to FIGS. 36 and 40, the previously-mentioned chain 544 is employed in driving upper storage area conveyor belt 575. Chain 544 engages a driven sprocket 584 which is carried by the driving member of a clutch 2–CLU. The driven member of clutch 2–CLU is carried by a rotatable shaft 585 which is supported on opposite sides of storage area 501 by means of bearings 586 and 587. The bearings 586 and 587, in turn, are rigidly supported on vertical legs 507 and 508, respectively. Shaft 585 passes through the longitudinal side members 551 and 552 of frame 550. Bearings 588 and 589, which are carried by the side members 551 and 552, respectively, support frame 550 on shaft 585 in a manner allowing pivotal motion of the frame with respect to the shaft. Shaft 585, at its end opposite clutch 2–CLU, carries a driving sprocket 590. Sprocket 590 drives a chain 591 which, in turn, drives a driven sprocket 592. Sprocket 592 is carried by shaft 571 which also carries the driving roller 570 of stranded conveyor belt 575.

A pair of idling sprockets 593 and 594 are employed to adjust the tension in chain 591 for smooth performance, the idling sprockets 593 and 594 being adjustably carried by a bracket 595 that is supported on longitudinal side member 552. Chain 544 (FIG. 36) is also provided with an idling sprocket 596 for setting the tension therein. Sprocket 596 is adjustably carried by a bracket 597 mounted on vertical leg 507.

Referring to FIGS. 36, 41 and 42, the manner in which upper storage area 501 is pivoted between its disengaged, upper position (shown in dot-dash lines in FIG. 36) and its engaged, lower position (shown in solid lines in FIG. 36) will now be considered. Frame 550 is provided with a cross member 600 adjacent its forward (downstream) end. Cross member 600 is rigidly connected to side members 551 and 552 at a position above the upper level of the strands of conveyor belt 575 so that it is clear of the pieces of fabric that move into storage area 501. As previously indicated, the vertical legs 509 and 510 (FIG. 36) extend upwardly above the level of both the lower storage area 500 and the upper storage area 501. A cross member 601 extends between legs 509 and 510 at their upper ends. Cross member 601 supports a pneumatically operated power cylinder 602 by means of a pivotal connection 603. The piston rod 604 of power cylinder 602 extends downwardly and is pivotally connected to cross member 600. Thus, when piston rod 604 is extended out of power cylinder 602, the upper storage area 501 moves into the engaged position shown in FIG. 36. However, when piston rod 604 is retracted into power cylinder 602, the storage area 501 moves into the disengaged position shown in dot-dash lines in FIG. 36.

Referring to FIGS. 41 and 42, rollers 605 and 606 are provided at the ends of cross member 600. The rollers 605 and 606 engage the inner surface of respective vertical legs 509 and 510 and act as guides during the movement of storage area 501 from its upper to its lower position and vice versa.

A neutral position limit switch 1–LS, which is actuated by arms 607 and 608 fastened to the side of longitudinal side member 551, is employed to sense the movement of upper storage area 501 between its two positions. The actuation of limit switch 1–LS by arms 608 provides a signal to the electrical circuits of the apparatus that storage area 501 is in its upper or disengaged position. When limit switch 1–LS is actuated by arm 607, a signal is sent to the electrical circuits that storage area 501 is in its lower or engaged position.

A photocell 6–EYE is supported from cross member 600 by a bracket 609. A cooperating lamp 610, which is supported from a cross member 611 by a bracket 612, is positioned in vertical alignment with photocell 6–EYE. Photocell 6–EYE is utilized to sense the arrival of narrow width strips of fabric into upper storage area 501. It operates in a similar manner to photocell 5–EYE described in connection with lower storage area 500. Thus, when the trailing edge of a strip of spliced fabric passes upstream beyond photocell 6–EYE, a signal is sent to the electrical circuits of the apparatus to indicate that the strip of spliced fabric is entirely within storage area **501**. At this time the reverse movement of main conveyor belt **400** stops and clutch 2–CLU is disengaged so that subsequent forward movement of main conveyor belt **400** does not remove the fabric from upper storage area **501**.

The Splicing Mechanism

The splicing mechanism D has been illustrated generally in FIG. 1 and in greater detail in FIGS. 43 through 60. It serves to splice the trailing edges of preceding pieces of fabric to the leading edges of subsequent pieces of fabric on the main conveyor B, thereby forming strips of spliced fabric from which plies of desired lengths may be cut.

Referring more particularly to FIGS. 43 through 49, the splicing mechanism D (FIG. 43) is carried on the upstream side of a movable frame, shown generally at **700**, while the cut-to-length unit E is carried on the downstream side of frame **700**. Movable frame **700** is pivotally supported on the downstream portion of main conveyor frame **401** so that the longitudinal axis of frame **700** (and the longitudinal axes of the splicing mechanism and the cut-to-length unit) may be aligned parallel to the leading edges of (and the cords in) the fabric pieces carried by stranded belt **400** of main conveyor B.

In order to support movable frame **700** and the components which it carries, conveyor frame **401** is provided at its opposite sides with support platforms or pedestals **702** and **703** (FIGS. 44 and 49). Platform **702** is welded to and extends horizontally outwardly of conveyor side member **402**, while platform **703** is welded to and extends horizontally outwardly of conveyor side member **403**. The upper surfaces of platforms **702** and **703** are smoothly finished in order that these surfaces may slidably support cooperating plates **704** and **705**, respectively, the undersurfaces of which are also smoothly finished. Plate **704** depends below and is rigidly connected to movable frame **700** by means of (FIG. 46) spaced vertical angle members or legs **706** and **707** and an intermediate plate **708**, while plate **705** depends below and is connected to movable frame **700** by means (FIG. 47) of spaced vertical angle members or legs **709** and **710** and an intermediate plate **711**.

An inverted U-shaped frame (FIG. 45) comprising vertical legs **715** and **716** and a transverse member **717** is also employed in connecting movable frame **700** to the conveyor frame **401**. Leg **715** is welded to each of conveyor side members **402** and **405** and projects upwardly above the level of frame **700**. Similarly, leg **716** is welded to each of conveyor side members **403** and **406** and projects upwardly above the level of frame **700**. Transverse member **717** is welded to the upper spaced ends of legs **715** and **716**. The upper half **718** of a swivel joint **719** is welded to the underside of member **717**, while the lower half **720** of swivel joint **719** is bolted to a bracket **721**. Bracket **721** is rigidly connected to movable frame **700** through blocks **722** which are welded both to the brackets **721** and to the frame **700**. Thus (FIG. 43), when a turning force is applied to one end of movable frame **700**, the frame will pivot about swivel joint **719**, while the lower extremities of the frame slide on the support platforms **702** and **703**.

The manner in which a turning force is applied to movable frame **700** has been illustrated most clearly in FIGS. 43, 48 and 49. A bracket **725** is rigidly fastened to the undersurface of support platform **703** and projects outwardly thereof. Bracket **725** pivotally supports a journal **726** adjacent its outer end, and the journal in turn rotatably supports a shaft **727**, one end **728** of which is threaded. A hand wheel **729** is keyed to the other end of shaft **727** and a pair of locking collars **730** and **731** lock the shaft from moving longitudinally with respect to journal **726**. The threaded end **728** of shaft **727** carries a complementary threaded nut **732** which is pivotally supported by a bracket **733**. Bracket **733** is welded to the plate **711** carried by movable frame **700**. Thus, when hand wheel **729** is rotated, nut **732** moves along the threaded end **728** of shaft **727** and, consequently, exerts a turning force on movable frame **700** to pivot the frame with respect to the stationary structure on which it is supported.

In order to accurately position movable frame **700**, support plate **703** is provided with a scale **734**, while plate **705**, which moves with respect thereto, carries a pointer **735** to indicate the angle that movable frame **700** makes with the stranded belt **400** of main conveyor B.

Referring to FIGS. 43 through 47, the structure of movable frame **700** will now be considered in greater detail. Frame **700** includes a longitudinally extending C-shaped channel member **740** which serves as the main strength member of the frame. An end block **741** is welded to and projects from one end of channel member **740**, while a second end block **742** is welded to and projects from the other end of channel member **140**. The end blocks **741** and **742** are mounted on the upstream surface of channel member **740**, between the upper lip **743** and lower lip **744** thereof. End blocks **741** and **742**, in turn, have end plates **745** and **746**, respectively, bolted thereto, the end plates projecting generally upstream of frame **700**.

A generally horizontal, rectangular, longitudinally extending base plate **747** (FIGS. 45 and 47) is welded to the bottom lip **744** of channel member **740**. Base plate **740** is shorter in length than channel member **740** and, referring to FIG. 45, extends from a point inwardly of one end of the channel member to a point inwardly of the other end of the channel member. Gussets **748** and **749**, which are welded both to the interior surface of channel member **740** and to the top surface of base plate **747**, rigidize and support the ends of base plate **747**, while gussets **750** and **751** serve a similar function with respect to the intermediate portions of base plate **747**.

Horizontal base plate **747** is provided at the left side thereof (as viewed in FIGS. 43 and 44) with a generally downstream extending, rectangular portion **747*a***, which, together with vertical plates **752** and **753** (FIG. 46), forms a housing for a clamping means to be described hereinafter in connection with the cut-to-length unit E.

A C-shaped channel member **754** (FIGS. 43, 44 and 46) extends generally downstream from the rear surface of the longitudinally extending C-shaped channel member **740** and is welded both to channel member **740** and to the extension **747*a*** of base plate **747** to rigidize this portion of movable frame **700**.

The opposite end of movable frame **700** is also provided with a generally downstream extending C-shaped channel member **755** which is welded to the rear surface of longitudinally extending channel member **740** (see FIGS. 43, 44 and 47). Channel member **755** has a plate **756** welded to the bottom thereof. Plate **756**, in turn, supports a downwardly depending bracket structure which includes a plate **757** and a pair of spaced apart vertical bracket members **758** and **759**. Bracket members **758** and **759** are welded to the undersurface of plate **757**, while plate **757** is bolted to the undersurface of plate **756**.

Vertical bracket members **758** and **759** each pivotally support one end of respective levers **760** and **761** (FIGS. 44, 45, 47 and 48), lever **760** being pivotally connected to bracket member **758** by means of a bolt **762**, and lever **761** being pivotally connected to bracket member **759** by means of a bolt **763**.

Levers **760** and **761** (FIG. 47) are biased apart by means of a spring **764** which is compressed between an upper block **765**, welded to lever **761**, and a lower, centrally apertured block **766**, welded to lever **760**. A threaded screw **767**, which is fixed to the upper block **765** and extends downwardly through spring **764** and the aperture in lower block **766**, projects downwardly below the lower block **766**. A nut **768** cooperates with the screw **767** and lower block **766** to limit the angular amount by which levers **760** and **761** may be spread apart by spring **764**.

A construction similar to the foregoing is employed at the opposite end of movable frame **700**. Referring to FIGS. 43, 44, 45, 46 and 48, one end of each of levers **760a** and **761a** is pivotally supported by means of bolts **762a** and **763a**, respectively, from the housing formed by extension **747a** of base plate **747** and the vertical plates **752** and **753** mentioned earlier. Bolt **763a** (FIG. 48) pivotally supports the end of lever **761a** on a bracket **769** which is bolted to the vertical member **753**, while bolt **762a** supports one end of lever **760a** on a plate **770** that is bolted in position between the vertical members **752** and **753**. As before (FIG. 46), an upper block **765a** is welded to lever **761a**, while a lower block **766a** is welded to lever **760a**. A spring **764a** is compressed between blocks **765a** and **766a** to bias the levers apart, and a threaded screw **767a** and a nut **768a** are employed to limit the angular amount by which levers **760a** and **761a** may be spread apart by spring **764a**.

The levers **760** and **760a**, which are located adjacent to opposite ends of movable frame **700**, form part of a vacuum lifter, shown generally at **780**, which serves as a means for lifting the trailing edges of pieces of fabric on the main conveyor B. The vacuum lifter **780** includes an elongated, longitudinally extending, tubular member **781** which is rigidly connected adjacent one of its ends to lever **760** by means (FIG. 47) of a bracket **782** welded therebetween and is rigidly connected adjacent the other of its ends to lever **760a** by means (FIG. 46) of a bracket **782a** welded therebetween. Thus, pivotal movement of levers **760** and **760a** about their respective bolts **762** and **762a** results in the raising and lowering of tubular member **781** with respect to stranded belt **400** of main conveyor B. Tubular member **781** is sealed at its ends to provide a vacuum chamber **783** internally thereof. A plurality of downwardly extending apertures **784** (FIGS. 50 and 52) interconnect the vacuum chamber **783** with the lower surface of the tubular member **781**.

In order to move tubular member **781** between its lower position, in which it abuts the fabric pieces carried on main conveyor B (FIG. 51), and its upper position, wherein it lifts the trailing edges of the fabric pieces clear of the main conveyor (FIG. 50), a pneumatically operated power cylinder **785** (FIG. 45) is employed. Power cylinder **785** is pivotally supported atop channel member **740** by means of spaced blocks **786** and **787** which are welded to the upper lip **743**. Power cylinder **785** operates a piston rod **788**, the end of which is pivotally connected to an arm **789** that is keyed to a shaft **790**. Shaft **790** extends longitudinally along the length of movable frame **700** and is supported adjacent its ends by means of respective journals **791** and **792**. Journal **791** is rigidly carried by vertical leg **706**, while journal **792** is rigidly carried by a vertical member **793** (FIG. 47) which is welded to the underside of the longitudinally extending base plate **747**. Thus, movement of piston rod **788** in power cylinder **785** results in rotation of shaft **790** within its journals **791** and **792**.

Referring to FIGS. 45 and 48, the ends of shaft **790** are provided with respective arms **794** and **794a** clamped thereto for rotation of the arms **794** and **794a** with the shaft **790**. Arms **794** and **794a** carry respective rollers **795** and **795a** at the ends thereof. Rollers **795** and **795a**, in turn, cooperate with the undersurfaces of levers **760** and **760a**, respectively, to raise the levers when piston rod **788** is drawn into power cylinder **785** and to allow levers **760** and **760a** to be lowered when piston rod **788** is extended out of power cylinder **785**. Shaft **790** carries, intermediate its ends, a cam **796** which is locked to the shaft and rotates therewith upon actuation of power cylinder **785**. Cam **796** cooperates with a neutral position limit switch 3–LS (FIG. 53) to provide signals to the electrical circuits of the apparatus that are indicative of the position of vacuum lifter **780**. Limit switch 3–LS is mounted upon a bracket **797** carried by gusset **751**.

The spaced levers **761** and **761a** (FIGS. 46, 47 and 48) are operated in a somewhat similar manner to the operation described above in connection with spaced lever **760** and **760a**. In this case, however, levers **761** and **761a** form a part of a stripping means or stripper, shown generally at **800**, which serves as a means for releasing the trailing edges of fabric from the vacuum lifter **780**. Stripper **800** includes an elongated angle iron **801** which extends longitudinally along the length of frame **700** between levers **761** and **761a**. At one of its ends angle iron **801** is bolted to a block **802** which, in turn, is welded to lever **761**. The other end of angle iron **801** is bolted to a block **802a** which, in turn, is welded to lever **761a**. The connections between angle **180** and respective blocks **802** and **802a** are made adjustable so that angle iron **801** may be longitudinally adjusted a small amount with respect to blocks **802** and **802a**.

Referring to FIGS. 45, 48, 50, 51 and 52, angle iron **801** has affixed thereto a thin, elongated, C-shaped member **803** which extends downwardly from the angle iron. C-shaped member **803**, in turn, is provided with a series of longitudinally spaced apart, horizontally extending fingers **804** which cooperate with complementary grooves or slots **805** (FIG. 51) formed in the lower surface of tubular member **781** of vacuum lifter **780**. Thus, with arms **761** and **761a** biased apart from arms **760** and **761a**, as in FIGS. 50 and 51, fingers **804** are recessed within slots **805** so that the bottom surface of tubular member **781** may be brought into contact with the trailing edge of a fabric piece carried on stranded belt **400** of main conveyor B. This allows the vacuum in chamber **783** to be applied to the fabric through apertures **784**, in order that the fabric may be grasped and held firmly by vacuum lifter **780**.

In order to release the fabric piece from vacuum lifter **780** the vacuum in chamber **783** is released and stripper **800** is moved from an inactive position, shown in FIG. 50, to an active position, illustrated in FIG. 52. This movement causes fingers **804** to disengage the fabric piece from tubular member **781** and results in the depositing of the fabric piece onto stranded belt **400**.

A pneumatically operated power cylinder **806** (FIG. 46) is employed in moving stripper **800** between its active and inactive positions. Referring to FIGS. 44 and 46, power cylinder **806** is pivotally supported from upper lip **743** of channel member **740** by means of a pair of blocks **807** and **808**. These blocks are bolted to a bracket **809** that is welded to upper lip **743**. Actuation of power cylinder **806** results in movement of a piston rod **810** into or out of the power cylinder. Piston rod **810** is pivotally connected at its downward end to one end of an arm **811**. The other end of arm **811** is keyed to a shaft **812** so that movement of piston rod **810** results in rotation of shaft **812**.

Shaft **812** is supported at its ends (FIG. 45) by means of journals **813** and **814**, journal **813** being bolted to end plate **745** and journal **814** being bolted to end plate **746**. Shaft **812** carries arms **815** and **815a** which are clamped to the shaft adjacent its ends. Arm **815** (FIG. 47) carries a roller **816** which is adapted to cooperate with and bear down against the upper surface of lever **761**, while arm **815a** (FIG. 46) carries a roller **816a** which is adapted to cooperate with and bear down against the upper surface of arm **761a**. Thus, referring to FIGS. 50 and 52, when piston rod **810** is extended from power cylinder **806** (as in FIG. 50), arms **815** and **815a** are horizontally disposed and are clear of arms **761** and **761a**. However, when piston rod **810** is retracted within power cylinder **806** (as in FIG. 52), arms **815** and **815a** are vertically disposed and depress arms **761** and **761a**, thereby causing stripper **800** to be lowered.

A neutral position limit switch 4–LS (FIGS. 44 and 47) is utilized to sense the posiiton of stripping means **800**. Limit switch 4–LS is carried by a bracket **817** that is welded to end plate **746**. Limit switch 4–LS is actuated by a cam **818** which is clamped to the end of shaft **812** for rotation therewith.

Referring to FIGS. 45, 48 and 49, the splicing mechanism D includes a stationary support member, shown generally at **830**, which cooperates with the vacuum lifter **780** in splicing the trailing edge of a preceding piece of fabric to the leading edge of a succeeding piece of fabric on the main conveyor B. Support member **830** is carried by a pair of brackets **831** and **831***a* which are welded to and project upwardly from a cross member **832**. Cross member **832** is welded to the undersides of conveyor side members **402** and **403** so that the stationary support member **830** is rigidly held in place beneath tubular member **781** of vacuum lifter **780**. Stationary support member **830** comprises a longitudinally extending U-shaped channel **833** which has a plurality of short angle members **834** welded thereto.

Referring to FIGS. 44 and 50, angle members **834** project upwardly, between the strands of main conveyor belt **400**, to a point just below the upper surface of the belt. Thus, angle members **834** do not interfere with the normal movement of the fabric carried on main conveyor belt **400**. However, referring to FIG. 51, when vacuum lifter **780** is lowered to superimpose the trailing edge of the preceding piece of fabric onto the leading edge of a succeeding section of fabric, the downward movement of vacuum lifter **780** against stranded conveyor belt **400** causes the belt to lower to a position below the level of the angle members **834** so that the overlapped edges of the two pieces of fabric are compressed between the vacuum lifter **780** and the upwardly projecting angle members **834** to effect a splice between the edges.

In order to properly position the edges of the fabric pieces with respect to vacuum lifter **780**, a pair of photocells 1–EYE and 2–EYE (FIGS. 46 and 48) are provided. Photocells 1–EYE and 2–EYE are carried by a vertical bracket **840** which, in turn, is supported by a horizontal bracket **841** that is welded to vertical leg **716**. Referring to FIGS. 45 and 49, lamps **842** and **843**, respectively, cooperative with photocells 1–EYE and 2–EYE. Lamps **842** and **843** are supported below the level of main conveyor B by a bracket **844** which is welded to cross member **832**.

With no fabric at the splicing mechanism D, the light beam from lamp **843** passes upwardly through an aperture **845** (FIG. 49) in U-shaped channel member **833** and then passes between a pair of angle members **834** and a pair of the strands of the belt to illuminate photocell 2–EYE. Referring to FIGS. 54 through 60, the light beam passing between lamp **843** and photocell 2–EYE forms a low angle with the horizontal stranded belt **400** and crosses the plane of the belt just below tubular member **781**. Photocell 1–EYE and its lamp **842** (FIG. 46), on the other hand, are in vertical alignment a short distance upstream of the splicing mechanism D. The light beam from lamp **842** to photocell 1–EYE passes between two of the laterally spaced apart strands of conveyor belt **400**.

Photocells 1–EYE and 2–EYE are connected in the electrical circuits of the apparatus to control the operation of the drive motor MTR–7 (FIG. 30) for the main conveyor B. Photocell 1–EYE serves to cause the conveyor speed to change from high speed to slow (crawl) speed, while photocell 2–EYE is employed in stopping the conveyor with the fabric edges in position under the splicing mechanism D.

The relation between photocells 1–EYE and 2–EYE and conveyor drive motor MTR–7 is as follows. When a remnant piece of fabric moves downstream at high speed on stranded conveyor belt **400** from the storage device C, its leading edge first intercepts the beam between lamp **842** and photocell 1–EYE; however, no action results. The leading edge of the piece of fabric then intercepts the beam from lamp **843** to photocell 2–EYE, and, again, no action results. As the high speed movement continues, and assuming the remnant piece of fabric is of insufficient length from which to cut a ply, the trailing edge thereof passes beyond "slow down" photocell 1–EYE, and at this time the photocell actuates the electrical circuits. This, in turn, causes the main conveyor to slow to a crawl speed.

Referring to FIG. 54, with the conveyor now running at crawl speed the trailing edge **850** of the remnant piece of fabric soon uncovers the beam between lamp **843** and "stop" photocell 2–EYE. This causes the conveyor to stop with the trailing edge **850** beneath vacuum lifter **780**, in position for subsequent splicing to the leading edge of a succeeding section of fabric.

Referring to FIG. 55, when stranded conveyor belt **400** stops, vacuum lifter **780** and stripper **800** are lowered and a vacuum is drawn in chamber **783**. After a slight time delay, the trailing edge **850** clings to vacuum lifter **780** and both the vacuum lifter **780** and the stripper **800** are raised to the position shown in FIG. 56. At the same time the mechanical lifter F (FIG. 1) raises the remainder of the remnant piece of fabric clear of main conveyor B.

Concurrently with the stopping of the trailing edge **850** beneath vacuum lifter **780**, the electrical circuits of the apparatus signal the bias-cutter A to initiate a new cutting cycle. Shortly thereafter, a new rhomboidal section of fabric of proper width is deposited on main conveyor B. By the time the new section of fabric is cut and deposited on main conveyor B, vacuum lifter **780** and mechanical lifter F have raised the preceding remnant piece of fabric clear of the conveyor and, with the deposit of a new section of fabric on the conveyor, the conveyor starts at high speed to deliver the new section to splicing mechanism D.

It will be appreciated that the light beam between lamp **843** and "stop" photocell 2–EYE is of a finite width. Moreover, since the light beam is at a low angle to the horizontal, the width of the beam in the horizontal plane is wider than would normally be the case if the light beam were in a vertical plane. Thus, when the trailing edge **850** (FIG. 54) initially uncovered the light beam, stranded conveyor belt **400** stopped with the downstream portion of the beam still blocked out by the trailing edge **850** of the fabric piece. When (as in FIG. 56) vacuum lifter **780** raises the trailing edge **850**, the trailing edge clears the downstream portion of the light beam so that the entire width of the beam impinges upon stop photocell 2–EYE.

When the leading edge of the new rhomboidal section of fabric reaches slow down photocell 1–EYE, conveyor belt **400** slows to a crawl speed. The leading edge **851** of the new section of fabric (FIG. 57) then moves slowly towards a position between lamp **843** and stop photocell 2–EYE. When the beam between lamp **843** and stop photocell 2–EYE is entirely interrupted by the leading edge **851** of the new section of fabric, conveyor belt **400** stops, and a signal is sent to vacuum lifter **780**, stripper **800** and mechanical lifter F to lower these components. Since the trailing edge **850** (FIG. 55) of the remnant piece of fabric only uncovered the upstream portion of the beam between lamp **843** and stop photocell 2–EYE in stopping the conveyor drive, while the leading edge **851** (FIG. 57) of the new section of fabric covers the entire beam between lamp **843** and stop photocell 2–EYE in stopping the conveyor drive, an overlap is provided between the trailing edge **850** and the leading edge **851** of the two pieces of fabric. Referring to FIG. 58, the lowering of vacuum lifter **780**, stripper **800** and mechanical lifter F causes the trailing edge **850** to be spliced to the leading edge **851**, the amount of overlap being a function of the beam width as mentioned above.

When all three components (the vacuum lifter **780**, the stripper **800** and the mechanical lifter F) have reached their lower positions, a signal is initiated to release the vacuum in chamber **783**. Shortly thereafter, vacuum lifter **780** is raised (FIG. 59), while stripper **800** is maintained in its lower position. This causes the horizontal fingers **804** of C-shaped member **803** to disengage or strip the trailing edge **850** of fabric from vacuum lifter **780**, and the spliced strip of fabric remains on conveyor belt **400**, while vacuum lifter **780** returns to its upper position.

When vacuum lifter **780** reaches its raised position, a signal is initiated which causes stripper **800** to return to its upper position (FIG. 60), thereby completing the sequence of actions involved in joining a new rhomboidal section of fabric to a previous remnant piece of fabric to form an elongated strip of spliced fabric.

When the splice is completed, conveyor belt **400** starts moving in high speed forward operation to deliver the strip of spliced fabric to cut-to-length unit E. This discussion will now continue with a description of the cut-to-length unit.

The Cut-to-Length Unit

The cut-to-length unit E has been illustrated generally in FIG. 1 and in greater detail in FIGS. 43 through 49 and 61 through 64. It serves to cut the spliced strips of fabric carried on main conveyor B into the proper lengths necessary for use as plies **1**, **2**, **3** and 4 of a completed tire carcass. As in the case of the splicing mechanism D, the cut-to-length unit E is also carried on the movable frame **700** (FIG. 43). For the most part, however, the components of the cut-to-length unit E are located on the downstream portion of this frame, while the components of the splicing mechanism are on the upstream portion of frame **700**.

Referring to FIGS. 43, 44, 61 and 63, the cut-to-length unit E is provided with a cutter assembly, shown generally at **860**, which includes a cutter carriage **861**. Carriage **861** is provided with a pair of wheels **862** which movably support the carriage on a longitudinally extending rail **863**. The ends of rail **863** are supported by means of clamps **864** and **865** in the spaced-apart channel members **754** and **755**, respectively, on the downstream side of movable frame **700**. A roller **866**, which is rotatably mounted on carriage **861**, contacts the underportion of rail **863** to prevent the carriage from being jostled off of rail **863** during movement of cutter assembly **860** through a traverse cutting stroke.

Cutter carriage **861** carries a downwardly extending arm **867**, the lower extremity of which forms a slide **868**. Slide **868** moves within and is guided by a U-shaped track or guide-way **869** which is positioned below and parallel to rail **863** and is held in place by means of an elongated L shaped plate member **870** (FIG. 63). Plate member **870** is welded both to the undersurface of guideway **869** and to the downstream surface of channel member **740**. The cooperation between slide **868** and guideway **869** prevents cutter assembly **860** from tilting or rocking during its movement along rail **863**.

The cutter assembly **860** also carries a downwardly extending bifurcated block **871** having one end of an arm **872** hinged thereto. The other end of arm **872** serves as a support for an inverted T-shaped knife **873** which is clamped thereto to facilitate replacement should damage occur to the knife. The base of knife **873** terminates (FIG. 44) at opposite ends in sharp points **874** and **875**, while sharp arcuate cutting edges **876** and **877** are provided on opposite sides of knife **873** where the vertical portion joins the base portion thereof. The undersurface of the base of knife **873** is rounded so that it will not act as a cutting edge.

As indicated above, arm **872** is hinged to block **871**. The reason for this is to allow knife **873** to deflect slightly from its normal cutting path during a cutting stroke in order to afford an opportunity for cutting edges **876** and **877** of the knife to align themselves with the spaces between cords in the fabric being cut-to-length.

It will be recalled that movable frame **700** is aligned parallel to the cords in the fabric carried on the main

conveyor B, and, similarly, the cutting path of knife **873** is also parallel to the cords in the fabric carried on the main conveyor B. Hence, when a cutting stroke is made, the initial contact between the knife and the fabric being cut might occur either on one of the cords of the fabric or between the cords of the fabric. If the cut starts on one of the cords of the fabric, the knife will shift to a point of least resistance and, thus, will end up cutting the rubber material between the cords of the fabric, rather than the cords themselves. The point **874** of knife **873** is vertically higher than the point **875** of the knife. The reason for this will become apparent hereinafter in connection with a discussion relative to a fabric clamping means employed in the cut-to-length unit E.

The cutting stroke is accomplished by moving cutter assembly **860** longitudinally with respect to movable frame **700** (transversely with respect to stranded conveyor belt **400**) from the initial starting or "rest" position shown in FIG. 44 to a position adajacent the opposite end of frame **700** and then returning cutter assembly **860** to its initial starting position. A motor MTR–6 is employed in traversing knife **873** through its cutting stroke. Knife traverse motor MTR–6 is supported on a plate **880** which is welded to top lip **743** (FIG. 63) of channel member **740**. Plate **880** is also welded to gusset **748** to provide greater rigidity for the support of motor MTR–6.

Referring to FIGS. 44, 45, 61 and 63, a chain **881**, carried by a pair of spaced sprockets including a driving sprocket **882** and a driven sprocket **882***a*, is driven by knife traverse motor MTR–6, the connection between motor MTR–6 and driving sprocket **882** including a driving sprocket **883** carried by the output shaft of motor MTR–6, a chain **884** and a driven sprocket **885**. Driven sprocket **885** is mounted at one end of a shaft **886**, the other end of which carries driving sprocket **882**. Shaft **886** projects through channel member **740** and is supported thereon by means of a journal **887** which is rigidly mounted on a bracket **888** that is welded both to channel member **740** and a bracket **889** carried by base plate **747**. Driven sprocket **882***a* is similarly carried by a shaft **886***a* which is rotatably supported by a journal **887***a*. Journal **887***a* is rigidly mounted on a bracket **888***a* welded to both the channel member **740** and a bracket **889***a* carried by base plate **747**. When motor MTR–6 is energized, it causes the links of chain **881** to be moved through the path of the chain about sprockets **882** and **882***a*.

The movement of chain **881** about is sprockets **882** and **882***a* is transmitted to cutter carriage **861** by means of a link **890**. Link **890** has one of its ends **891** pivotally connected to a clamp **892** that is fixedly carried by one of the links of chain **881**. The other end **893** of link **890** is pivotally connected to carriage **861**. Thus, when the link on which clamp **892** is mounted moves in its path about sprockets **882** and **882***a*, the movement is transmitted to carriage **861** by means of link **890**. This causes the carriage to move horizontally across the path defined by rail **863** from the position shown in FIG. 44 to the opposite end of the rail and then back to its starting position.

A limit switch 8–LS (FIGS. 44 and 61) is employed to sense the movement of carriage **861** and transmit electrical signals indicative of the departure of the carriage from its starting or rest position and the arrival of the carriage back at its starting position. Limit switch 8–LS is actuated by means of an arm **894** that is affixed to the downwardly extending arm **867** carried by carriage **861**. Limit switch 8–LS is supported with its actuating arm in the path of movement of arm **894** by means of a bracket **895** that is welded to the undersurface of base plate **747**.

As indicated earlier, the cut-to-length unit E includes a fabric clamping means or clamp, shown generally at **900** (FIG. 44), which cooperates with the cutter assembly **860** during the cutting stroke thereof. The fabric clamping means **900** serves to clamp the fabric immediately upstream and downstream of the point at which the knife **873** enters the fabric during its cutting stroke. It also serves to hold the fabric piece in position throughout the entire cutting sroke.

Referring to FIGS. 44, 46, 48, 49, 61, 62 and 64, fabric clamping means **900** comprises a clamping bar **901** (FIG. 49) which carries at its end **902** a plurality of clamping fingers **903***a* through **903***d*. Clamping bar **901** is pivotally supported between vertical plates **752** and **753** by means of an arm **904** (FIG. 64) having one end thereof welded to the clamping bar **901** and the other end thereof pivotally connected to a pin **905** which extends between the vertical plates **752** and **753**.

Clamping fingers **903***a* through **903***d* are located on the end **902** of clamping bar **901** in such a manner as to be able to move from a position below the level of stranded conveyor belt **400** to a position above the level of stranded conveyor belt **400** without contacting the belt strands during movement between the two positions. Fingers **903***a* and **903***b* are carried adjacent the downstream side of the path of the cutting stroke of cutter assembly **860**, while fingers **903***c* and **903***d* are carried adjacent the upstream side of the path of the cutting stroke of cutter assembly **860** so that when knife **873** passes thereby during the cutting stroke it passes between fingers **903***a* and **903***c* and between fingers **903***b* and **903***d*.

Clamping bar **901** is moved from its inactive lower or unclamping position to its active upper or clamping position by means of a pneumatically actuated power cylinder **906** (FIG. 44). Power cylinder **906** is pivotally mounted in a pair of spaced blocks **907** and **908** (FIG. 43) which are rigidly supported from channel member **754** by means of a bracket **909** welded therebetween. Power cylinder **906** is provided with a piston rod **910** (FIG. 44) which retracts into or extends from the cylinder in accordance with control signals developed in the electrical circuits of the apparatus. The end **911** of piston rod **910** is pivotally connected to an arm **912** which is keyed to a shaft **913**. Shaft **913** (FIG. 49) extends between and through vertical plates **752** and **753** and is rotatably supported therein by means of journals **914** and **915**.

Referring to FIGS. 49 and 64, shaft **913** carries an eccentric cam **916** at a point between the two vertical plates **752** and **753**. Eccentric cam **916** is keyed to shaft **913** for rotation therewith as the shaft is rotated by power cylinder **906**. Eccentric cam **916**, in turn, is rotatable within one end **917** of a link **918**. The other end **919** of link **918** is pivotally connected to the bifurcated end **920** of clamping bar **901**.

When piston rod **910** (FIG. 44) is fully extended out of power cylinder **906**, clamping bar **901** assumes the unclamping position shown in FIG. 44. Conversely, when piston rod **910** is fully retracted into power cylinder **906**, clamping bar **901** takes the clamping position shown in solid lines in FIG. 64. Assuming that piston rod **910** is fully retracted, when it starts moving out of power cylinder **906** shaft **913** causes eccentric cam **916** to rotate counterclockwise, as viewed in FIG. 64, and this, in turn, results in movement of the link **918** in an upward direction with respect to shaft **913**, to the broken line position shown in FIG. 64. When link **918** moves upwardly, clamping bar **901** pivots with respect to pin **905** and this causes the clamping fingers **903***a* through **903***d* to move downwardly from a point above the level of stranded conveyor belt **400** to a point below the level of the conveyor belt. Conversely when piston rod **910** is being withdrawn into power cylinder **906**, a reverse action takes place and the clamping fingers **903***a* through **903***d* move from the position below the level of stranded conveyor belt **400** to a position above the level of the conveyor belt.

Fabric clamping means **900** also includes a support plate **921** which is rigidly bolted between vertical plates **752** and **753** (FIGS. 44 and 48). Support plate **921** carries a plurality of downwardly extending fingers **922***a* through **922***d* (FIG. 64). Fingers **922***a* through **922***d* are positioned complementary to fingers **903***a* through **903***d* so that a fabric piece located at the fabric clamping means **900** will be clamped between the fingers **903***a* through **903***d* and the respective cooperating fingers **922***a* through **922***d* when piston rod **910** is retracted into power cylinder **906**. Support plate **921** is provided with a longitudinally extending slot **923** in alignment with the cutting path of knife **873**. Slot **923** is of sufficient width to allow knife **873** to move therethrough during the cutting sroke.

Referring to FIGS. 62 and 64, fabric clamping means **900** is also provided with a fabric stripping plate or stripper **925** which serves to disengage the cut pieces of fabric from the upper fingers **922***a* through **922***d* after the fingers **903***a* through **903***d* have been dropped to their lower, unclamping position. Stripping plate **925** is pivotally connected at one of its ends **926** to a pin **927** that extends between vertical plates **752** and **753**. The other end **928** of stripping plate **925** is provided with a plurality of apertures **929***a* through **929***d* which are in alignment with the downwardly projecting fingers **922***a* through **922***d*, respectively.

Thus, when the fabric clamping means **900** is raised to its clamping position and fingers **903***a* through **903***d* raise the fabric piece from the main conveyor belt, the upper surface of the fabric piece abuts against the lower ends of the downwardly projecting fingers **922***a* through **922***d* to clamp the fabric piece between the upper and lower fingers. Stripping plate **925** is provided with a slot **930** which is in alignment with and serves a similar purpose to the slot **923** in support plate **921**, namely, to allow knife **873** to pass longitudinally of stripping plate **925** during a cutting stroke.

Referring to FIG. 64, support plate **921** carries a downwardly projecting bolt **931** which passes through an aperture in stripping plate **925**. The bolt head of bolt **931** acts as a stop for stripping plate **925** in order to limit the downward travel of the plate as it pivots about pin **927**. Support plate **921** is provided with a recess **932** which serves as a housing for a spring **933**. Spring **933** biases stripping plate **925** downwardly away from support plate **921**. The purpose of this is to insure that when the clamping bar **901** is lowered to its unclamping position, the stripping plate **925** will move downwardly to strip the fabric from the ends of fingers **922***a* through **922***d*, thereby depositing the fabric pieces on the stranded conveyor belt **400**.

Clamping bar **901** is also provided with a group of upwardly extending adjustable screws **934** which are of sufficient length to abut against the undersurface of stripping plate **925** when clamping bar **901** moves upwardly to clamp the fabric. Screws **934** serve to raise the stripping plate **925** during the clamping movement so that the fabric piece may be properly clamped between the upwardly projecting fingers **903***a* through **903***d* and the downwardly projecting fingers **922***a* through **922***d*. When clamping bar **901** is lowered, screws **934** disengage from stripping plate **925** and spring **933** urges stripping plate **925** downwardly to effect disengagement of the fabric from upper fingers **922***a* through **922***d*.

Referring to FIGS. 44 and 48, a neutral position limit switch **7–LS** is provided to sense the condition of fabric clamping means **900**. Limit switch **7–LS** is carried by the vertical plate **753** and is actuated by a cam **935** which is clamped to the end of shaft **913**. Thus limit switch **7–LS** initiates electrical signals indicative of the condition of fabric clamping means **900** when the fabric clamping means is moved between its clamping and unclamping positions.

The operation of the cut-to-length unit E is as follows. Referring to FIGS. 1, 44, 47 and 61 and assuming that the main conveyor B has properly positioned the downstream edge of a strip of spliced fabric so that the prescribed ply length is downstream of the cutting axis of knife **873**, and further assuming that vacuum lifter **780** is lowered, after a short time delay during which a vacuum builds up in vacuum chamber **783**, vacuum lifter **780** raises to lift the fabric on the upstream side of cut-to-length unit E above main conveyor B. Thereafter, mechanical lifter F raises to lift the downstream portion of the fabric above main conveyor B. When the mechanical lifter F is raised, a signal is sent to actuate the fabric clamping means 900.

At this point power cylinder 906 is actuated and piston rod 910 is drawn into the power cylinder. This results in the raising of fingers 903*a* through 903*d* from their unclamping to their clamping position, which, in turn, raises the fabric to be cut into the cutting path of knife 873. When fabric clamping means 900 reaches its clamping position, the knife traverse motor MTR–6 is energized and cutter carriage 861 begins traversing rail 863, thereby carrying knife 873 through its cutting stroke.

As previously indicated, knife 873 is provided with a sharp leading point 874 that is at a higher vertical position than the sharp trailing point 875. Also, the bottom edge of knife 873 is dull. Hence, on the initial outward stroke of knife 873 the raised fabric is pierced adjacent the fingers 903*a* through 903*d* by the point 874 and, during the remainder of the outward stroke, cutting edge 876 cuts through the rubber skimcoat between adjacent cords in the fabric. Accordingly, during the outward stroke of the knife the initial cuts starts from a point adjacent the fingers 903*a* through 903*d* and carries to the far edge of the fabric. On the return stroke of knife 873, trailing point 875 acts as a scoop to raise the fabric into the sharp cutting edge 877 of the knife. Hence, the remainder of the fabric is cut while knife 873 is moving back towards its starting position. This method of cutting the fabric precludes the formation of wrinkles at the side edges of the fabric and insures against cutting across the cords of the fabric, both of which would be deleterious to the quality of the finished carcass and impede the subsequent carcass winding operation.

When carriage 861 reaches its starting position after the return stroke, limit switch 8–LS becomes actuated and this in turn results in the de-energization of knife traverse motor MTR–6. With the de-energization of motor MTR–6, a signal is sent by the electrical circuits to cause fabric clamping means 900 to shift from its clamping position to its unclamping position. This in turn results in the release of the fabric from the upper fingers 922*a* through 922*d* via the stripping plate 925. Concurrently therewith, vacuum lifter 780 lowers the leading edge of the newly formed remnant piece of fabric to main conveyor B, and then stripper 800 strips the remnant from the vacuum lifter. Thus, the operation of cut-to-length unit E is completed with the ply cut to the proper length and being completely supported by mechanical lifter unit F, while the remnant piece of fabric is completely supported by main conveyor B.

This discussion will now continue with a detailed consideration of the mechanical lifter unit F and the ply offset mechanism G.

Mechanical Lifter Unit and Ply Offset Mechanism

The mechanical lifter unit F and the ply offset mechanism G have been indicated generally in FIG. 1 and in greater detail in FIGS. 65 through 71. The mechanical lifter unit F serves to raise above the belt strands of main conveyor B those fabric pieces that are located downstream of the cut-to-length unit E so that the conveyor may run without moving such fabric pieces from their position with respect to the cut-to-length unit E. The ply offset mechanism G serves to shift the raised mechanical lifter unit F transversely with respect to the belt strands of the main conveyor B so that a ply carried by the mechanical lifter may be deposited on the main conveyor transversely displaced from its initial position on the conveyor.

Referring to FIGS. 65 through 68, the mechanical lifter unit F includes a stationary frame, shown generally at 950, which is supported from the downstream portion of the main conveyor frame 401 by means of a pair of channel members 951 and 952.

Frame 950 comprises a pair of longitudinally extending side members or channels 953 and 954, the ends of which are rigidly joined together by means of cross members or channels 955 and 956. A base plate 957 is welded atop the downstream portion of frame 950 to provide a platform for mounting various of the movable components of the mechanical lifter unit F and ply offset mechanism G.

The mechanical lifter unit F also includes a movable frame, shown generally at 960. Movable frame 960 comprises a pair of longitudinal side members 961 and 962 which are rigidly joined together at their downstream ends by a cross member 963 and adjacent their upstream ends by a plurality of cross members 964, 965 and 966. A plurality of braces 967, 968 and 969 are employed to further rigidify the structure of movable frame 960 so that the frame may be moved as a solid unit.

Affixed to the top of frame 960 are a plurality of thin, longitudinally extending, vertical plates 970*a* through 970*q* which project upwardly between the spaced-apart belt strands of main conveyor B. Plates 970*a* through 970*q* extend longitudinally downstream from cross member 966 to a point beyond cross member 963, the trailing ends of plates 970*a* through 970*q* terminating closely adjacent to the downstream end of main conveyor B. An additional series of thin longitudinally extending vertical plates 971*a* through 971*q* of progressively increasing lengths are carried atop the upstream portion of frame 960. Plates 971*a* through 971*q* terminate on cross member 965 at their downstream ends so that an open space is provided between the upstream ends of plates 970*a* through 970*q* and the downstream ends of plates 971*a* through 971*q* to accommodate the roller 439 of main conveyor B.

A brace 972, which is welded to side member 962 and extends transversely of frame 960, is employed to support the upstream ends of plates 971*a* through 971*e*, while another brace 793, which is welded to side member 961 and extends transversely of frame 960, serves to support the upstream ends of plates 971*m* through 971*q*. The remaining upstream ends of this series of vertical plates are supported by the cross member 964.

A line connecting the upstream ends of vertical plates 971*a* through 971*q* would form an angle of approximately 60° with the belt strands of main conveyor B, this angle being the approximate angle which the cut-to-length unit E forms with the main conveyor B. The purpose of progressively increasing the lengths of vertical plates 971*a* through 971*q* is to allow these plates to be positioned as closely as possible to cut-to-length unit E in order to support the fabric pieces adjacent to the cut made by that unit.

Vertical plate 970*o* is interrupted in the area of photocells 3–EYE and 4–EYE in order to avoid interfering with the light beams between these photocells and their respective lamps. Braces 974 and 975, which are welded to and extend between vertical plates 970*n* and 970*p*, serve to support the interrupted ends of vertical plate 970*o*.

Referring now to FIG. 68, the movements of frame 960 will now be considered. The solid line drawing of frame 960 represents the inactive or lower position of the frame. When the mechanical lifter unit F is actuated to raise frame 960, the frame moves only vertically and takes the upper, right side, dotted line position shown in FIG. 68. Thus the upper edges of plates 970*a* through 970*q* raise vertically from a level just below the surface of the stranded conveyor belt 400 to a level just above the surface of the belt. When the ply offset mechanism G is actuated while frame 960 is raised, frame 960 shifts to the left and takes the upper, left side, dotted line position shown in FIG. 68. Thus, vertical plates 970*a* through 970*q* shift transversely with respect to stranded belt 400.

If mechanical lifter unit F is de-actuated to lower frame **960** while the frame is shifted to the left by the ply offset mechanism G, frame **960** moves vertically down to assume a position (not illustrated) to the left of the solid line position shown in FIG. 68. Hence, if a fabric ply had been carried by frame **960** during the previous movements, the ply would end up on conveyor belt **400** at a position that is laterally displaced from the position the ply occupied prior to the movement of frame **960**. As indicated heretofore, ply offset mechanism G is only actuated once (to shift ply **1**) during the building of a four ply carcass. Thus, the most frequent function of frame **960** is to raise the fabric pieces clear of conveyor belt **400** without introducing any offset.

Referring to FIGS. 66 and 67, mechanical lifter unit F includes a pneumatically operated power cylinder **980** to effect vertical movement of frame **960**. Power cylinder **980** is pivotally supported at one of its ends from a bracket **981** that is bolted to base plate **957**. A piston rod **982** is movable into and out of power cylinder **980**. The end of piston rod **982** is pivotally connected to an arm **983** which, in turn, is keyed to a shaft **984**. Shaft **984** is supported in journals **985** and **986** that are carried by stationary frame **950**. A second arm **987** is keyed to shaft **984** for rotation therewith. Arm **987** is pivotally connected to one end of a push rod **988**, the other end of which is pivotally connected to an arm **989**. Arm **989** is keyed to a shaft **990** which, in turn, is rotatably supported in journals **991** and **991*a***. When piston rod **982** is extended out of power cylinder **980**, shaft **984** is rotated and, in turn, causes shaft **990** to similarly rotate by virtue of push rod **988**. Shaft **984** carries an eccentric cam **992** adjacent one of its ends and an eccentric cam **992*a*** adjacent the other of its ends, the eccentric cams being keyed to shaft **984** for rotation therewith. Similarly, shaft **990** is provided with an eccentric cam **993** adjacent one end thereof, the cam being keyed to the shaft for rotation therewith.

In order to convert the rotary motion of shafts **984** and **990** into reciprocating motion, eccentric cams **992**, **992*a*** and **993** are provided with respective cam followers **994**, **995** and **996**. Cam followers **994** through **996** are pivotally connected to first ends of respective links **997**, **998** (FIG. 68) and **999**, the other ends of links **997** through **999** being pivotally connected to the lower ends of respective links **1000**, **1001** and **1002**. The upper ends of links **1000**, **1001** and **1002**, in turn, are pivotally connected to respective downwardly projecting lugs **1003**, **1004** and **1005** which are carried at spaced apart points on the undersurface of frame **960**. Lugs **1003** and **1004** are welded to the undersurface of cross member **964**, while lug **1005** is welded to a central point on the undersurface of cross member **963**.

With the foregoing arrangement, when power cylinder **980** is actuated to extend piston rod **982** out of the cylinder, the resulting counterclockwise rotation of shafts **984** and **990**, as viewed in FIG. 66, causes cam followers **994** and **996** to rise. This, in turn, causes movable frame **960** to rise in an amount commensurate with the rising of cam followers **994** through **996**.

In order to prevent movable frame **960** from shifting longitudinally with respect to stationary frame **950** a restraining link **1006** (FIGS. 66 and 67) is provided. One end of link **1006** is pivotally connected to a bifurcated bracket **1007** that is welded to bracket **981**. The other end of link **1006** is pivotally connected to a downwardly extending lug **1008** which is welded to the undersurface of a brace **1009** that (FIG. 65) extends between and is welded to braces **967** and **968**. The pivotal connections between restraining link **1006**, bracket **1007** and lug **1008** allow frame **960** to be freely moved in a vertical direction. Similarly, these pivotal connections are relatively loose in order to allow frame **960** to move transversely with respect to the main conveyor B when ply offset mechanism G is actuated.

The manner in which ply offset mechanism G shifts movable frame **960** transversely with respect to main conveyor B will now be considered. Referring to FIGS. 66, 67 and 68, a pneumatically operated power cylinder **1015** (FIG. 67) is employed in this regard. Power cylinder **1015** is pivotally connected at one of its ends to a gusset plate **1016** which is welded to bracket **981**. Power cylinder **1015** controls a piston rod **1017** which is pivotally connected at its end to an arm **1018**. Arm **1018** is keyed to a shaft **1019** that is rotatably supported on stationary frame **950** by means of a pair of journals **1020** and **1021**. The opposite ends of shaft **1019** are provided with respective eccentric cams **1022** and **1023** which are keyed thereto so that the cams rotate when shaft **1019** is rotated. Cams **1022** and **1023** carry links **1024** and **1025**, respectively, the links serving as cam followers for translating the rotary motion of the cams into horizontal reciprocating motion. Links **1024** and **1025**, in turn, are pivotally connected to respective lugs **1026** and **1027** which extend downwardly from movable frame **960**. Lug **1026** is welded to cross member **966**, while lug **1027** is welded to cross member **963**.

When piston rod **1017** is moved out of power cylinder **1015**, shaft **1019** rotates counterclockwise (as viewed in FIG. 68). This causes cam follower links **1024** and **1025** to be shifted to the left and results in a shifting of movable frame **960** to the left, the final position of frame **960** being termed the "offset" position. Conversely, when piston rod **1017** is retracted into power cylinder **1015**, shaft **1019** rotates clockwise (as viewed in FIG. 68), and, therefore, movable frame **960** moves to the right, the final position of frame **960** being termed the "starting" or "home" position.

Referring to FIGS. 67 and 69, a neutral position limit switch **6**–LS is employed to provide a signal to the electrical circuits of the apparatus that movable frame **960** is either at its offset position or at its home position. Limit switch **6**–LS is actuated by a cam **1028** that is clamped to shaft **1019**. Rotation of shaft **1019** causes cam **1028** to engage actuating arm **1029** of limit switch **6**–LS, thereby initiating the signal to the electrical circuits. Limit switch **6**–LS is supported by a bracket **1030** that is bolted to longitudinal side member **954** of stationary frame **950**.

Referring to FIGS. 66 and 67, a neutral position limit switch **5**–LS is employed to provide a signal to the electrical circuits of the apparatus that movable frame **960** is either at its raised position or at its lowered position. Limit switch **5**–LS is actuated by a cam **1031** that is clamped to one end of shaft **984** and rotates therewith. Cam **1031** cooperates with the actuating arm **1032** of limit switch **5**–LS. Limit switch **5**–LS is supported by a bracket **1033** which is bolted to the longitudinal side member **953** of stationary frame **950**.

Referring to FIGS. 68, 70 and 71, a detailed description of the supporting structure for the stop and slow down photocells **3**–EYE and **4**–EYE will now be given. This structure was referred to earlier in the description of the main conveyor B; however, since the structure is located adjacent to mechanical lifter unit F, a more detailed description will be provided at this time.

It will be recalled that photocells **3**–EYE and **4**–EYE and revolution counters **2**–RVC, **3**–RVC and **4**–RVC (FIG. 31) are employed in slowing down and stopping main conveyor B with progressively increasing ply lengths downstream of the cut-to-length unit E. It will also be recalled that the differences in length between plies **1**, **2**, **3** and **4** are relatively small, since the changes in length serve to compensate for the increasing diameter of the tire building drum as the various plies are wound about the drum.

In order to compensate for the relatively large increase (or decrease) in ply length that is necessitated when the size of the tire being built is changed, bracket **466**, which supports photocells **3**–EYE and **4**–EYE, is made adjustable with respect to longitudinal side member **402** of main conveyor frame 401. Bracket 466 is provided with a block 1040 which has a threaded aperture passing therethrough. The threaded aperture in block 1040 engages a lead screw 1041 which is provided with a knurled knob 1042 at one end thereof. Lead screw 1041 is rotatably supported by spaced journals 1043 and 1044 which are carried by a guide plate 1045. Guide plate 1045, in turn, is fixed to a bracket 1045*a* that is welded to conveyor side member 402. Guide plate 1045 is provided with smoothly finished upper and lower guide rails 1046 and 1047, respectively, which cooperate with upper and lower slide members 1048 and 1049, respectively. Slide members 1048 and 1049 are fixed to a support plate 1050 which, in turn, is fixed to bracket 466. This arrangement allows the photocells 3–EYE and 4–EYE to be held in a desired position above main conveyor B and, yet, be adjustable as necessary to change over to the manufacture of different sized tires.

Bracket 466 is provided with a lower arm 1051 which serves to support lamps 1052 and 1053 in vertical alignment with photocells 3–EYE and 4–EYE, respectively. As with previously discussed photocell and lamp arrangements, lamps 1052 and 1053 are positioned below the upper level of stranded conveyor belt 400 in order that fabric pieces carried by the conveyor may interrupt the light beams between the lamps and their photocells for control purposes.

This discussion will now continue with a description of the applicator conveyor H and the tire building station J.

Applicator Conveyor and Tire Building Station

The applicator conveyor H and the tire building station J have been shown generally in FIG. 1 and in greater detail in FIGS. 72, 73 and 74. Applicator conveyor H serves to transfer the cut-to-length plies from main conveyor B to tire building station J, while at the tire building station J the plies are wound onto the tire building drum to build up a carcass.

As indicated earlier, the co-pending application of Tourtellotte and Stiegler, Serial No. 99,496, filed March 30, 1961 (now U.S. Patent No. 3,071,179), shows and claims the major structural details of applicator conveyor H and tire building station J and, in addition, describes the manner in which electrostatic forces are utilized in handling the plies and winding the plies about a tire building drum. However, for purposes of clarity and ease of understanding, a brief description of these components is included at this point.

Referring to FIGS. 72 and 73, the downstream portion of the apparatus comprises: a conventional tire building drum, shown generally at 1060, that is driven by a reversible electrical motor (not shown) so that the drum may be driven in either a clockwise or a counterclockwise direction, as viewed in FIG. 72; a conveyor, shown generally at 1061, for delivering the rubberized fabric plies to the area of tire building station J; an electrical means, shown generally at 1062, positioned along conveyor 1061 for electrostatically charging the plies as they pass thereby; a first applicator means, shown generally at 1063, for receiving the first and third charged plies from conveyor 1061 and applying these plies to tire building drum 1060 to wind them about the drum in a first direction; and a second applicator means, shown generally at 1064, for receiving the second and fourth charged plies from conveyor 1061 and applying these plies to the tire building drum 1060 to wind them about the drum in a second direction.

During application to tire building drum 1060 of the first and third plies of a four-ply tire, the drum is rotated counterclockwise, and first applicator means 1063 is in the extended position shown in broken lines in FIG. 72. At this time second applicator means 1064 is in the retracted position shown in solid lines in this figure. Similarly, when the second and fourth plies are being applied to drum 1060, the drum is rotated clockwise, and second

applicator means 1064 is in the extended position shown in broken lines in FIG. 72. At this time first applicator means 1063 is in the retracted position shown in solid lines in this figure.

Referring to FIG. 73, conveyor 1061 comprises an endless flat, rubberized belt 1065, which is provided on its undersurface with spaced-apart V-belts 1066 and 1067. V-belts 1066 and 1067 are suitably joined to the undersurface of flat belt 1065, adjacent the edges thereof, throughout the entire length of flat belt 1065. V-belt 1066 cooperates with a plurality of grooves, two of which are shown at 1066*a* and 1066*b*, while V-belt 1067 cooperates with a plurality of grooves, two of which are shown at 1067*a* and 1067*b*. These grooves are formed in the various rollers about which flat belt 1065 moves in order to insure that the belt does not wander or move transversely with respect to the rollers. Thus, the longitudinal alignment of the various plies prepared by the apparatus is retained during the transfer of these plies from main conveyor B to tire building drum 1060.

Referring to FIGS. 72, 73 and 74, flat belt 1065 is supported between, and for the most part above, longitudinal side members 402 and 403 by means of a plurality of rollers 1068 through 1076. Starting with roller 1068, which is positioned immediately adjacent to the downstream end of main conveyor B, the endless path of flat belt 1065 is as follows. Belt 1065 passes over rollers 1068 and 1069, around roller 1070, around roller 1071, under and around roller 1072, over roller 1073, under roller 1074, over roller 1075, under roller 1076, and then back to and over roller 1068.

Roller 1071, which forms a part of the first applicator means 1063, is movably carried by laterally spaced depending links 1077 and 1077*a* that are pivotally supported on extensions 402*a* and 403*a* of conveyor side members 402 and 403. Links 1077 and 1077*a* are movable between the two positions that may be assumed by first applicator means 1063.

Roller 1076 is carried between a pair of laterally spaced links, one of which is shown at 1078. These links both have one of their ends pivotally mounted on a shaft 1079 and the other of their ends joined together by means of a movable cross brace (not shown). The cross brace, in turn, is provided with a projecting lug 1080 adjacent its center. A spring 1081, having one of its ends in engagement with lug 1080 and the other of its ends connected to a lug 1082 carried by the stationary frame of the apparatus, applies a downwardly directed force to roller 1076. This, in turn, places flat belt 1065 under tension throughout its entire length. Spring 1081 serves to take up any slack developing in flat belt 1065 which results from moving first applicator means 1063 between its extended and retracted positions.

The manner in which applicator conveyor H is driven by main conveyor drive motor MTR–7, having been alluded to earlier in connection with the discussion of main conveyor B, will now be considered in greater detail. Referring to FIG. 73, conveyor 1061 is driven by means of roller 1075 which is carried by a shaft 1083. Shaft 1083 passes through sprocket 464 and is rotatable independently of the sprocket. Sprocket 464, which is driven by main conveyor driver motor MTR–7, is drivingly connected to the driving member 1084 of an electrically actuated clutch, shown generally at 3–CLU. The driven member 1085 of clutch 3–CLU is splined to shaft 1083 for rotation therewith. Thus, when clutch 3–CLU is energized, driving member 1084 and driven member 1085 are coupled together and the rotation of sprocket 464 results in rotation of roller 1075 and in the driving of conveyor 1061.

An electrical brake, shown generally at 3–BRK, is mounted coaxially with clutch 3–CLU. Brake 3–BRK is provided with a fixed member 1086 carried on a bracket 1087 that is welded to and projects from longitudinal side member 402. Brake 3–BRK also includes a movable member 1088 which is splined to shaft 1083 and fastened to the driven member 1085 of clutch 3–CLU. Thus, with clutch 3–CLU deenergized and brake 3–BRK energized, movable brake member 1088 frictionally engages stationary brake member 1086 to quickly bring conveyor 1061 to a stop.

As indicated earlier in this specification, applicator conveyor H may also be driven independently of main conveyor B. Referring to FIG. 73, shaft 1083, at its end opposite clutch 3–CLU, is in engagement with the driven member of an overrunning clutch 1090. The driving member of clutch 1090 carries a driven sprocket 1091 which is driven by a manually controlled motor 1092 through a conventional drive sprocket 1093 and chain 1094 arrangement. Motor 1092 is provided with a reduction gear 1095 so that the rotary speed of the driving member of clutch 1090 is a little below the rotary speed of shaft 1083 when this shaft is being driven by main conveyor driver motor MTR–7. Thus, in the event both motor MTR–7 and motor 1092 are running at the same time and clutch 3–CLU is energized, motor MTR–7 is physically driving the flat conveyor belt 1061. However, should main conveyor drive motor MTR–7 be stopped, or clutch 3–CLU be disengaged, while motor 1092 is running, overrunning clutch 1090 will engage and take over driving control of conveyor 1061. This arrangement allows conveyor 1061 to be controlled either by the automatic electric circuits of the apparatus or by the operator at the tire building station, depending on the function to be performed at a given time.

In order to electrostatically charge the plies as they move along conveyor 1061, electrical means 1062 is provided with a high voltage D.C. source 1091 (FIG. 72). The negative terminal (not shown) of D.C. source 1091 is connected to a rod type electrode 1092 which extends transversely across the entire width of flat belt 1065. Electrode 1092 is suitably supported by insulators (not shown) a sufficient distance above the top of flat belt 1065 to allow the fabric plies to pass therebeneath without contacting the electrode. An insulated shield 1092*a* surrounds electrode 1092 to prevent injury to personnel.

The positive terminal (not shown) of high voltage D.C. source 1091 may be electrically grounded and should also be connected to a flat, metal plate type electrode 1093 that contacts the undersurface of flat belt 1065 at an area in vertical alignment with electrode 1092. This arrangement provides an electrical field between electrode 1092 and the plate type electrode beneath flat belt 1065, and, using a D.C. potential in the neighborhood of 10,000 volts, the air space between electrode 1092 and flat belt 1065 becomes ionized. The negatively charged ions, being in a strong electrical field, move toward flat belt 1065 and, in effect, are sprayed against the upper surfaces of the plies carried by the belt. This causes the plies to become electrostatically charged and the charges remain on the plies while they move downstream into contact with tire building drum 1060.

A similar flat, metal plate type electrode 1093*a* is suitably supported between the spaced links 1077 and 1077*a* of first applicator means 1063. Electrode 1093*a*, which is connected to the positive terminal of D. C. source 1019, contacts the undersurface of flat belt 1065 during movement of the belt between rollers 1070 and 1071. When first applicator means 1063 is extended, a negatively charged ply carried by flat belt 1065 passes smoothly over roller 1070 and is electrostatically attracted to electrode 1093*a*.

The primary purpose of using electrostatic attractive forces in the applicator means is to cause the charged ply to adhere to flat belt 1065 in order to prevent a lateral movement or creeping of the ply at the bite of the belt and drum 1060. This lateral movement is due to the interaction between the bias angle of the resilient ply and the radial pressure of belt 1065 and roller 1071 against drum 1060. The lateral movement is always in one direction and is a function of the pressure. The lateral movement is harmful in that it changes the cord angle of the ply with respect to the drum, prevents a uniform overlap of the edges of the ply on the drum, and tends to wind the ply on the drum in a spiral, all of which are detrimental to tire quality.

Conventional stick cement may be employed in causing ply 1 to adhere to the electrically grounded drum 1060, or, alternatively, the electrically grounded drum may be covered with an insulating material so that electrostatic attractive forces may be employed in transferring ply 1 to the drum. Plies 2, 3 and 4, in either case, adhere to the preceding plies on the drum by virtue of the natural tackiness of the uncured rubber in the plies.

The second applicator means 1064 is employed in transferring plies 2 and 4 to drum 1060, while the drum rotates in a clockwise direction as viewed in FIG. 72. Applicator means 1064 comprises a movable framework including longitudinal side members 1100 and 1101, which are joined at their upstream ends by a cross member 1102 and interconnected at their downstream ends by means of a roller 1103. The frame of applicator means 1064 is swingably supported from the longitudinal extension members 402*a* and 403*a* by means of an upstream set of arms, including arm 1104 and arm 1105, and a downstream set of links, including link 1106 and link 1107.

Second applicator means 1064 includes an upstream roller 1108 which, together with downstream roller 1103, forms a path of movement for an endless, flat conveyor belt 1109. Flat conveyor belt 1109 is driven by means of a V-belt 1110 which extends between a pulley 1111 carried at one end of roller 1072 and a pulley 1112 carried at one end of roller 1108. Thus, whenever conveyor 1061 is being driven, V-belt 1110 drives flat belt 1109.

Second applicator means 1064 is also provided with a flat, metal plate type grounded electrode 1113 which is carried between side members 1100 and 1101 and contacts the top surface of the lower portion of belt 1109. With first applicator means 1063 in its retracted position (away from the drum 1060) and second applicator means 1064 in its extended position (in contact with drum 1064), electrostatically charged plies carried by flat belt 1065 transfer to and adhere to the lower surface of belt 1109 due to the electrostatic attractive forces developed between the negatively charged plies and the electrically grounded (positive) electrode 1113. Belt 1109, in turn, carries these plies into contact with drum 1060, which at this time is rotating in a clockwise direction (as viewed in FIG. 72). Accordingly, these plies (2 and 4) are transferred to the drum by the second applicator means 1064.

The movement of applicator means 1063 and 1064 between their respective retracted and extended positions is under the control of the operator at the tire building station. Referring to FIG. 74, a power cylinder 1114, which is pivotally carried between conveyor side members 402 and 403, is employed to shift second applicator means 1064 between its two positions. Power cylinder 1114 operates a piston rod 1114*a* having one end 1114*b* pivotally connected to one end of an arm 1115. The other end of arm 1115 is keyed to a shaft 1116 that is rotatably supported by the spaced extension members 402*a* and 403*a*. Arm 1115 extends downwardly from shaft 1116 so that movement of piston rod 1114*a* in power cylinder 1114 causes shaft 1116 to rotate to a limited degree. This rotation is utilized to shift applicator means 1064 between its extended and retracted positions due to the following. Arms 1104 and 1105 each have their lower ends keyed to shaft 1116 and their upper ends pivotally connected to a shaft 1117 which extends between side members 1100 and 1101. Thus, when shaft 1116 rotates due to the movement of piston rod 1114*a* into or out of power cylinder 1114, arms 1104 and 1105 swing in an arc centered on shaft 1116. This, in turn, causes applicator means 1064 to shift position. Limit switches 1118 and

1118*a* are employed in controlling the movement of applicator means 1064.

A pair of rotary hydraulic motors 1119, one of which is supported by extension member 402*a* and the other of which is supported by extension member 403*a*, is employed in shifting first applicator means 1063 between its extended and retracted positions. Motors 1119 rotate a shaft 1119*a* through gears 1119*b* to effect this action. Shaft 1119*a*, which is rotatably supported by extension members 1100 and 1101, rotatably supports roller 1070. In addition, the upper ends of links 1077 and 1077*a* are keyed to shaft 1119*a* so that when this shaft rotates, links 1077 and 1077*a* swing through an arc. This, in turn, causes first applicator means 1063 is shift between its extended and retracted positions. A limit switch 1119*c* is employed in controlling the movement of applicator means 1063.

Limit switches 1118 and 1118*a*, which are actuated by the movement of second aplicator means 1064, and limit switch 1119*c* which is actuated by the movement of first applicator means 1063, may serve as electrical interlocks to prevent inadvertent manual extension of both applicator means 1063 and 1064 at the same time.

Conventional toe strip rolls 1120 and 1121, which are supported by brackets 1122 and 1123, respectively, are employed to dispense rubber toe strip material as necessary during the fabrication of the carcass at building drum 1060.

A tray, shown generally at 1125, is provided for dispensing tread slabs to tire building drum 1060. Tray 1125 is pivotally connected at its upstream end to a pin 1126 supported on the stationary structure of the apparatus, and it is provided with wheels 1127 which move along an arcuate track 1128 so that the downstream end of the tray may be moved from a position directly upstream of drum 1060 to a position at one side of applicator conveyor H. Tray 1125 is provided with a series of transverse rollers 1129 which form a longitudinally extending roller conveyor.

Tray 1125 is normally in its position at the side of applicator conveyor H during the time that plies 1 through 4 are being wound about drum 1060. This is done to insure that the tray does not interfere with the movement of first applicator means 1063 between its extended and retracted positions during the winding of the plies on drum 1060. While it is in this position, the operator loads a tread slab onto the tray, and, after the plies have been wound on the drum, the operator moves tray 1125 into position upstream of the drum. He then manually feeds the tread slab from tray 1125 onto drum 1060, while the drum rotates slowly in a clockwise direction (as viewed in FIG. 72). Following this the entire carcass is pressure stitched in a conventional manner and the completed carcass is removed from the drum.

This discussion will now continue with a description of the pneumatic, hydraulic and electric control circuits employed in automatically correlating the operation of each of the components involved in the ply preparation portion of the tire building apparatus.

Pneumatic and Hydraulic Controls

The pneumatic and hydraulic controls employed in moving the various components of the tire building apparatus have been illustrated in FIGS. 75, 76 and 77. These figures, which diagrammatically portray all of the major components of the apparatus, also include the various sensing elements, such as limit switches and photocells, used in controlling the apparatus.

The bias-cutter A and its associated pneumatic and hydraulic controls have been shown in FIG. 75. As illustrated therein, movement of fabric pull-out carriage 55 between its forward position (away from fabric cutting unit 200) and its rear position (adjacent fabric cutting unit 200) is accomplished by means of hydraulic power cylinder 65. A solenoid valve 12–SOL controls the flow of high pressure oil to power cylinder 65. This valve is provided with a first solenoid 12–SOL–F which, when energized, causes piston rod 66 to be withdrawn into power cylinder 65, resulting in the movement of carriage 55 to its forward position. Similarly, valve 12–SOL is provided with a second solenoid 12–SOL–R which, when energized, causes piston rod 66 to be extended out of power cylinder 65, resulting in the movement of carriage 55 to its rear position.

The raising and lowering of fabric gripping bar 91 is under the control of a solenoid 15–SOL. When solenoid 15–SOL–U of this valve is energized, high pressure air enters power cylinder 102 in a direction that withdraws piston rod 103 into the cylinder, thereby raising fabric gripping bar 91. Similarly, when valve solenoid 15–SOL–D of this valve is energized, high pressure air enters power cylinder 102 in a direction that causes piston rod 103 to be extended from the power cylinder. This results in the lowering of fabric gripping bar 91.

Solenoid valve 15–SOL also controls the application of vacuum to vacuum chamber 94 of fabric gripping bar 91. When valve solenoid 15–SOL–D is energized, high pressure air is conducted through a conduit 1150 to the actuator 1151 of a valve 1152. This high pressure air deflects a spring loaded diaphragm in actuator 1151, thereby causing valve 1152 to shift to the left, as viewed in FIG. 75, and resulting in the application of a vacuum to vacuum chamber 94.

When valve solenoid 15–SOL–D is de-energized and valve solenoid 15–SOL–U is energized, conduit 1150 is exhausted to atmosphere and the spring in actuator 1151 returns valve 1152 to the position illustrated in FIG. 75. This, in turn, connects vacuum chamber 94 to atmosphere. Hence, when fabric gripping bar 91 is lowered, a vacuum is concurrently applied to vacuum chamber 94, and, when fabric gripping bar 91 is raised, the vacuum in chamber 94 is concurrently released.

Control over whether a vacuum or blast air is applied to chamber 264 at the leading edge of the bias-cutter table is maintained by a solenoid valve 13–SOL. When valve solenoid 13–SOL–VO of this valve is energized, a vacuum line is connected through the solenoid valve to chamber 264, thereby placing this chamber under a vacuum. Similarly, when valve solenoid 13–SOL–AO is energized, a high pressure air line is connected through valve 13–SOL to chamber 264, thereby providing the chamber with blast air.

The brake roller 43 for motor MTR–4 of fabric letoff unit 21 is moved between its forward or braking position and its return or off position by the pneumatically actuated power cylinders 45. The flow of high pressure air to these power cylinders is under the control of a solenoid valve 18–SOL. When valve solenoid 18–SOL–F is energized, high pressure air is admitted to power cylinder 45 in a direction that causes its piston rod to extend out of the power cylinder, thereby causing roller 43 to move into braking contact with fabric 28. Similarly, when valve solenoid 18–SOL–R is energized, high pressure air is admitted to power cylinder 45 in a direction that causes the piston rod of power cylinder 45 to move into the cylinder, thereby returning brake roller 43 to its off position.

The cutting position stop assembly 295 is moved between its raised and its lowered positions by means of pneumatically actuated power cylinder 293. The flow of high pressure air to this power cylinder is under the control of a solenoid valve 14–SOL. When valve solenoid 14–SOL–U of this valve is energized, high pressure air is directed to power cylinder 293 in a direction that moves the piston rod out of the cylinder. This results in the raising of cutting position stop assembly 295. Similarly, when valve solenoid 14–SOL–D is energized, the piston rod of power cylinder 293 is retracted into the power cylinder and cutting position stop assembly 295 is lowered.

Carriages 288 and 289 of fabric width and drop control unit 275 are moved between their narrow width and their wide width positions or settings by means of hydraulically actuated power cylinder **334**. The flow of high pressure oil to power cylinder **334** is controlled by a solenoid valve **11**–SOL. When valve solenoid **11**–SOL–F of this valve is energized, high pressure oil enters power cylinder **334** in a direction that causes piston rod **333** to move out of the power cylinder. This, in turn, causes carriages **288** and **289** to move to their narrow width positions. Similarly, when valve solenoid **11**–SOL–R is energized, piston rod **333** is retracted into power cylinder **334** and this results in the movement of carriages **288** and **289** to their wide width positions.

Solenoid valve **11**–SOL also controls the movement of dropping position stop assembly **320**. When solenoid **11**–SOL–R of this valve is energized, piston rod **321** extends out of power cylinder **322**, thereby causing subsequently cut, wide width, rhomboidal sections of fabric to be dropped onto the main conveyor with their centerlines ¼ of an inch short of the reference line X—X of FIG. 1A. Similarly, when valve solenoid **11**–SOL–F is energized, high pressure oil is directed to power cylinder **322** in such a manner as to cause piston rod **321** to be retracted into the power cylinder. This, in turn, results in the dropping of subsequently cut, narrow width, rhomboidal sections of fabric onto the main conveyor with their centerlines in alignment with reference line X–X of FIG. 1A.

The storage device C and the upstream portion of main conveyor B have been diagrammatically illustrated in FIG. 76. Also, the relative position of bias-cutter A has been included in phantom in this figure.

Referring to FIG. 76, upper storage area **501** is movable between its upper, or disengaged position, and its lower, or engaged position, by means of power cylinder **602**. The flow of high pressure air to power cylinder **602** is under the control of a solenoid valve **1**–SOL. When valve solenoid **1**–SOL–U of this valve is energized, high pressure air is sent to power cylinder **602** in a direction to retract piston rod **604** into the power cylinder. This, in turn, results in the raising of upper storage area **501** and in the disengaging of upper storage conveyor belt **575** from main conveyor belt **400**.

Similarly, when valve solenoid **1**–SOL–D is energized, high pressure air is sent to power cylinder **602** in a direction to extend piston rod **604** from the power cylinder. This results in the lowering of upper storage area **501** and in the engaging of upper storage belt **575** with main conveyor belt **400**. Thus, fabric pieces carried by main conveyor belt **400** may be transferred to upper storage conveyor belt **575** and vice versa.

An oil pump **1160**, which is driven by a motor MTR–**1**, is employed to provide the high pressure oil for actuating the various hydraulically operated power cylinders of the tire building apparatus. Also, suitable high pressure air and vacuum sources (not shown) are provided in conventional manners for use in the pneumatic control arrangements under discussion.

Referring now to FIG. 77, the splicing mechanism D, cut-to-length unit E, mechanical lifter unit F, ply offset mechanism G, applicator, conveyor H and tire building station J have been diagrammatically illustrated.

Considering the splicing mechanism D, it will be recalled that vacuum lifter **780** and stripper **800** thereof are spring-biased into engagement with one another. Assuming the vacuum lifter and the stripper are both in their upper positions, when piston rod **788** is extended out of pneumatically operated power cylinder **785**, the vacuum lifter and stripper are moved to their lower positions irrespective of the condition of piston rod **810** in pneumatically operated power cylinder **806**. This movement is initiated upon energization of the solenoid **3**–SOL–D of a solenoid valve **3**–SOL. Assuming vacuum lifter **780** and stripper **800** are down, however, the energization of valve solenoid **3**–SOL–U, while resulting in the raising of vacuum lifter **780**, may or may not raise stripper **800** depending on whether or not piston rod **810** is extended out

of or retracted into power cylinder **806**. If piston rod **810** is extended out of cylinder **806** when valve solenoid **3**–SOL–U becomes energized, vacuum lifter **780** and stripper **800** both will move to their raised position. If piston rod **810** is retracted into power cylinder **806** when solenoid **3**–SOL–U energizes, stripper **800** remains down while vacuum lifter **780** is raised.

The movement of piston rod **810** into and out of power cylinder **806** is controlled by a solenoid valve **4**–SOL. When solenoid **4**–SOL–U of this valve is energized, piston rod **810** extends out of power cylinder **806**, thereby allowing the spring-bias between vacuum lifter **780** and stripper **800** to raise the stripper (assuming the vacuum lifter is already up). When valve solenoid **4**–SOL–D is energized, piston rod **810** retracts into power cylinder **806**, thereby either driving stripper **800** down (if the vacuum lifter and stripper have been up) or locking the stripper in its down position so that the subsequent raising of vacuum lifter **780** separates the vacuum lifter and the stripper to effect a stripping action.

The vacuum or no vacuum status of chamber **783** in vacuum lifter **780** is controlled by a solenoid valve **2**–SOL. When solenoid **2**–SOL–VO of this valve is energized, a vacuum supply line is connected through the valve to chamber **783**, thereby placing the chamber under a vacuum. Similarly, when valve solenoid **2**–SOL–VR is energized, chamber **783** is connected through valve **2**–SOL to atmosphere, thereby releasing the vacuum in the chamber.

Considering now the mechanical lifter unit F portion of FIG. 77, the movement of mechanical lifter frame **960** between its lower and raised positions is under the control of a solenoid valve **5**–SOL. The energization of solenoid **5**–SOL–U of this valve results in a flow of high pressure air to power cylinder **980** in a direction that causes frame **960** to be raised. Similarly, the energization of valve solenoid **5**–SOL–D results in the lowering of mechanical lifter frame **960**.

Mechanical lifter frame **960** is transversely offset with respect to main conveyor belt **400** by means of the ply offset mechanism G. Power cylinder **1015**, which initiates the movement of frame **960** between its offset and its return positions, is controlled by a solenoid valve **6**–SOL. When valve solenoid **6**–SOL–F is energized, high pressure air is supplied to power cylinder **1015** in a direction to extend piston rod **1017**. This, in turn, moves frame **960** to its offset position. Similarly, when valve solenoid **6**–SOL–R is energized, high pressure air is supplied to power cylinder **1015** in a direction to retract piston rod **1017**, thereby returning frame **960** to its home or starting position.

Considering at this time the cut-to-length unit E, the raising and lowering of fabric clamping means **900** of this unit is controlled by means of solenoid valve **7**–SOL. When valve solenoid **7**–SOL–U is energized, high pressure air is directed to power cylinder **906** in such a manner as to cause clamping bar **901** to raise, thereby clamping the fabric at the cut-to-length unit E. Similarly, when valve solenoid **7**–SOL–D is energized, high pressure air is directed to power cylinder **906** in such a manner as to cause clamping bar **901** to be lowered, thereby unclamping the fabric at cut-to-length unit E.

A blower motor MTR–**2** is employed to provide cooling air for the main conveyor drive motor MTR–**7**. Blower motor MTR–**2** is normally energized whenever the tire building apparatus is in use. It serves to keep the operating temperature of main conveyor drive motor MTR–**7** from raising to a harmful level.

Electrical Control System

A. In General: The electrical system which automatically controls the tire building apparatus is schematically illustrated in FIGS. 78 through 88, the system being supplemented by the material shown in FIGS. 89 and 90. In conjunction with the foregoing a group of electrical sequential action charts comprising FIGS. 91 through 111 have been employed to assist in analysis of the electrical control system.

The electrical sequential action charts of FIGS. 91 through 111 have been broken down into two groups for greater clarity. The first group, comprising FIGS. 91 through 105, denote the sequential actions occurring in the electrical circuits with respect to automatic operation of the main conveyor B, the storage device C, the splicing mechanism D, the cut-to-length unit E, the mechanical lifter unit F, the ply offset mechanism G, and the applicator conveyor H (insofar as its operation is under automatic control). The second group of sequential action charts, comprising FIGS. 106 through 111, denote the sequential actions occurring in the electrical circuits with respect to automatic operation of the bias-cutter A. It should be understood that both groups of sequential action charts cover the same time period of operation of the apparatus.

Both groups of sequential action charts employ guide grids comprising a plurality of relatively light, horizontal, "component" lines and a plurality of relatively light, vertical, "time" lines. The electrical component represented by each horizontal component line is listed at the left edge of each chart, the component list forming a vertical column at the edge. Similarly, the time represented by each vertical time line is listed across the top of each chart, with every fifth time line being identified by a number having an arrow pointing to the time line which it represents.

When a given light component line becomes heavy (e.g., in FIG. 91, component line PB–3 becomes heavy at time T–2), it indicates that the electrical component involved becomes energized at that time or that a given set of switch contacts become closed at that time, as the case may be. When the heavy component line changes back to a light component line (e.g., in FIG. 91, component line PB–3 becomes light at T–5), it indicates that the electrical component involved becomes de-energized at that time or that the given set of switch contacts open at that time.

Diagonal solid line arrows starting at the beginning or end of one heavy component line and ending at the beginning or end of a higher or lower heavy component line at a later time indicate that the first component electrically controls the second component, and, hence, the solid line arrows are hereinafter referred to as electrical action lines. Similarly, diagonal broken line arrows starting at the beginning of one heavy component line and ending at the beginning or end of aother heavy component line at a later time indicate that the first component mechanically actuates or controls the second component. Hence, the broken line arrows are referred to as mechanical action lines.

Examples of the foregoing may be seen by referring to FIG. 91. When control relay **58**–CR becomes energized at T–**35**, it causes valve solenoids **2**–SOL–VO and **3**–SOL–D to become energized at T–**36** and causes valve solenoid **7**–SOL–D to become de-energized at the same time. These three actions are represented by the three electrical action lines (solid line arrows) extending from heavy component line **58**–CR at T–**35** to, respectively, the heavy component line lines **2**–SOL–VO, **3**–SOL–D and **7**–SOL–D. Similarly, the energization of valve solenoid **3**–SOL–D at T–**36** causes a mechanical movement which results in the opening of limit switch contacts **3**–LS–U at T–**37**. This action is represented by the mechanical action line (broken line arrow) extending from heavy component line **3**–SOL–D to heavy component line **3**–LS–U.

Time-delay features of time-delay relays are represented on the sequential action charts by means of broken heavy component lines. When a light component line becomes a broken heavy component line, it indicates that a time-delay relay has become energized but that the time-delay contacts thereof have not yet followed the movement of the relay. When such contacts finish their timing period and change condition, this action is represented by the changing of the broken heavy component line into an unbroken heavy component line. The foregoing applies to time-delay relays in which the time-delay is effected upon energization of the relay. In the case of time-delay relays in which the time-delay function is effected upon de-energization of the relay, an unbroken, heavy component line indicates that the relay is energized, while a broken heavy component line following this shows that the relay has been de-energized but that the time-delay contacts have not yet shifted. When these contacts finally shift, the broken heavy component line changes to a light component line.

Referring to FIGS. 91 and 92, an example of a time-delay relay in which the time-delay function is effected upon energization of the relay is illustrated. Time-delay relay **51**–TR becomes energized at T–**44** (broken heavy component line starts) and, at T–**52**, its time-delay contacts shift condition (broken heavy component line becomes unbroken). The de-energization of time-delay relay **51**–TR occurs at T–**61**, at which time the unbroken heavy component line ends. An example of a time-delay relay in which the time-delay function is effected upon de-energization of the relay may be seen by reference to time-delay relay **14**–TR in FIG. 91. This relay becomes energized at T–**7** (unbroken heavy component line starts) and its contacts immediately shift position to follow the relay. When this relay de-energizes at T–**10**, its time-delay contacts remain shifted and start their timing period (broken heavy component line starts). When the timing period ends, at T–**16**, the time-delay contacts shift back to their starting position. This is indicated by the ending of the broken heavy component line at that time.

For the most part, the electrical components in the first group of sequence charts (FIGS. 91 through 105) differ from those of the second group of charts (FIGS. 106 through 111). However, since both groups of charts relate to one overall electrical system and certain components of one group must be referred to in analyzing the sequential actions of the other group, a number of the components are listed in both groups of sequential action charts. Thus, for example, the following ten electrical components are duplicated both in the sequential action charts of FIGS. 91 through 105 and in the sequential action charts of FIGS. 106 through 111: PB–3; CR–M; PB–5; CR–A; CR–B; **33**–SR; **24**–CR; **53**–CR; CR–OS; and **64**–CR.

As indicated earlier, the light, vertical, time lines of the sequential action charts represent the passage of time, which is treated on a relative basis rather than on an absolute basis. At any given time, as represented by a time line, the condition of any one of the listed electrical components, be it in the first or the second group of sequential action charts, may be determined relative to all the other listed electrical components of the apparatus. This facilitates analysis of the electrical schematic drawings of FIGS. 78 through 88.

The interaction between components of one group of sequential action charts and those in the other group is indicated by electrical action lines which extend below the charts in the case of FIGS. 91 through 105 and extend above the charts in the case of FIGS. 106 through 111. Thus, referring to FIG. 93, when control relay **24**–CR becomes energized at T–**149**, an electrical action line is shown which extends down below the chart. As indicated, this line initiates an action in FIG. 106. Referring to FIG. 106, the energization of control relay **24**–CR at T–**149** is duplicated therein and electrical action lines from this relay illustrate the electrical sequence stemming from the energizing of control relay **24**–CR at T–**149**. Similarly, referring to FIG. 107, when control relay **64**–CR becomes energized at T–**188**, an electrical action line is shown which extends up above the chart. As indicated this line initiates an action in FIG. 94. Referring to FIG. 94, the energization of control relay 64–CR at T–188 is duplicated therein and an electrical action line from this relay illustrates the electrical sequence stemming from the energizing of control relay 64–CR at T–188.

Table I, below, serves as a "master list" of many of the electrical components used in the electrical circuits to control the operation of the apparatus. It sets forth the functions of the various limit switch contacts, valve solenoids, clutches, brakes, revolution counters, photocells and motors (in that order) that are utilized in the electrical circuits and serves as a reference which may be referred to during the description of the electrical drawings.

TABLE I

Electrical Component	Control Function or Effect
1. 1-LS-U	Closed when upper (narrow) storage area 501 (Fig. 76) is up.
2. 1-LS-D	Closed when upper (narrow) storage area 501 (Fig. 76) is down.
3. 3-LS-U	Closed when vacuum lifter 780 (Fig. 77) is up.
4. 3-LS-D	Closed when vacuum lifter 780 (Fig. 77) is down.
5. 4-LS-U	Closed when stripper 800 (Fig. 77) is up.
6. 4-LS-D	Closed when stripper 800 (Fig. 77) is down.
7. 5-LS-U	Closed when mechanical lifter frame 960 (Fig. 77) is up.
8. 5-LS-D	Closed when mechanical lifter frame 960 (Fig. 77) is down.
9. 6-LS-F	Closed when mechanical lifter frame 960 (Fig. 77) is shifted by ply offset mechanism G to offset (forward) position.
10. 6-LS-R	Closed when mechanical lifter frame 960 (Fig. 77) is returned by ply offset mechanism G to home position.
11. 7-LS-U	Closed when clamping bar 901 (Fig. 77) of cut-to-length unit E is at its up (clamping) position.
12. 7-LS-D	Closed when clamping bar 901 (Fig. 77) of cut-to-length unit E is at its down (unclamping) position.
13. 8-LS	Contacts are closed when knife 873 of cut-to-length unit E (Fig. 77) is at its home position.
14. 11-LS-FA and 11-LS-RA.	Closed when fabric width and drop control unit 275 (Fig. 75) set for wide width operation of bias-cutter A.
15. 11-LS-FB and 11-LS-RB.	Closed when fabric width and drop control unit 275 (Fig. 75) is set for narrow width operation of bias-cutter A.
16. 12-LVS-F	Closed when fabric pull-out unit carriage 55 (Fig. 75) is forward (away from fabric cutting unit 200) at either the cutting or the dropping position.
17. 12-LVS-R	Closed when fabric pull-out unit carriage 55 (Fig. 75) has returned to its starting position (adjacent fabric cutting unit 200).
18. 14-LS-U	Closed when cutting position stop assembly 295 (Fig. 75) is up.
19. 14-LS-D	Closed when cutting position stop assembly 295 (Fig. 75) is down.
20. 15-LS-U	Closed when fabric gripping bar 91 (Fig. 75) is up.
21. 15-LS-D	Closed when fabric gripping bar 91 (Fig. 75) is down.
22. 16-LS-A	Closed when bias-cutter saw 222 (Fig. 75) is at far side of its path during cutting stroke.
23. 16-LS-B	Closed when bias-cutter saw 222 (Fig. 75) is anywhere except at the far side of its path during cutting stroke.
24. 17-LS-A	Closed when bias-cutter saw 222 (Fig. 75) is at its home position between cutting strokes.
25. 17-LS-B	Closed when bias-cutter saw 222 (Fig. 75) is away from its home position during cutting stroke.
26. 18-LS-A	Closed when brake roller 43 (Fig. 75) is down (in braking position).
27. 18-LS-B	Closed when brake roller 43 (Fig. 75) is up (in unbraking position).
28. 19-LS-A	Closed when dancer roller 40 (Fig. 75) is at upper (jam-up) position.
29. 19-LS-B	Closed when dancer roller 40 (Fig. 75) is anywhere but at upper (jam-up) position.
30. 20-LS-A	Closed when dancer roller 40 (Fig. 75) is anywhere but at bottom position.
31. 20-LS-B	Closed when dancer roller 40 (Fig. 75) is at bottom position.
32. 1-SOL-U	Moves upper (narrow) storage area 501 (Fig. 76) up.
33. 1-SOL-D	Moves upper (narrow) storage area 501 (Fig. 76) down.
34. 2-SOL-VO	Applies vacuum to vacuum chamber 783 (Fig. 77) of vacuum lifter 780.
35. 2-SOL-VR	Releases vacuum in vacuum chamber 783 (Fig. 77) of vacuum lifter 780.
36. 3-SOL-U	Raises vacuum lifter 780 (Fig. 77).
37. 3-SOL-D	Lowers vacuum lifter 780 (Fig. 77).
38. 4-SOL-U	Raises stripper 800 (Fig. 77).
39. 4-SOL-D	Lowers stripper 800 (Fig. 77).
40. 5-SOL-U	Raises frame 960 of mechanical lifter unit F (Fig. 77).
41. 5-SOL-D	Lowers mechanical lifter frame 960 (Fig. 77).
42. 6-SOL-F	Shifts mechanical lifter frame 960 (Fig. 77) to offset position.
43. 6-SOL-R	Returns mechanical lifter frame 960 (Fig. 77) to home position.
44. 7-SOL-U	Raises clamping bar 901 of cut-to-length unit E (Fig. 77) to clamping position.
45. 7-SOL-D	Lowers clamping bar 901 of cut-to-length unit E (Fig. 77) to unclamping position.
46. 11-SOL-F	Sets fabric width and drop control unit 275 (Fig. 75) for narrow width operation of bias-cutter A.
47. 11-SOL-R	Sets fabric width and drop control unit 275 (Fig. 75) for wide width operation of the bias-cutter A.
48. 12-SOL-F	Moves fabric pull-out unit carriage 55 (Fig. 75) to forward position (away from fabric cutting unit 200).
49. 12-SOL-R	Returns fabric pull-out unit carriage 55 (Fig. 75) to its starting position (adjacent fabric cutting unit 200).
50. 13-SOL-VO	Applies vacuum to chamber 264 (Fig. 75) of bias-cutter table.
51. 13-SOL-AO	Applies air blast to chamber 264 (Fig. 75) of bias-cutter table.
52. 14-SOL-U	Raises cutting position stop assembly 295 (Fig. 75).
53. 14-SOL-D	Lowers cutting position stop assembly 295 (Fig. 75).
54. 15-SOL-U	Raises fabric gripping bar 91 (Fig. 75), and releases vacuum in vacuum chamber 94 of fabric gripping bar 91.
55. 15-SOL-D	Lowers fabric gripping bar 91 (Fig. 75), and applies vacuum to vacuum chamber 94 in fabric gripping bar 91.
56. 18-SOL-F	Moves braking roller 43 (Fig. 75) to braking position.
57. 18-SOL-R	Returns braking roller 43 (Fig. 75) from braking position.
58. 1-CLU	Couples lower storage conveyor belt 520 (Fig. 76) to main conveyor belt 400.
59. 2-CLU	Couples upper storage conveyor belt 575 (Fig. 76) to main conveyor belt 400.
60. 3-CLU	Couples applicator conveyor belt 1061 (Fig. 77) to main conveyor drive motor MTR–7.
61. 3-BRK	Brakes applicator conveyor belt 1061 (Fig. 77).
62. 4-CLU	Couples revolution counter-assembly 467 (Fig. 77) to main conveyor belt 400.
63. 1-RVC	Meters reverse movement of main conveyor belt 400 (Fig. 76) to back-up position.
64. 2-RVC	Meters forward movement of main conveyor belt 400 for cutting ply 2 to length (Fig. 77).
65. 3-RVC	Meters forward movement of main conveyor belt 400 for cutting ply 3 to length (Fig. 77).
66. 4-RVC	Meters forward movement of main conveyor belt 400 for cutting ply 4 to length (Fig. 77).
67. 1-EYE	Slows down main conveyor belt 400 for splicing fabirc pieces (Fig. 77).
68. 2-EYE	Stops main conveyor belt 400 for splicing fabric pieces (Fig. 77).
69. 3-EYE	Slows down main conveyor belt 400 for cutting plies to length.
70. 4-EYE	Stops main conveyor belt 400 for cutting ply 1 to length and cooperates with revolution counters 2-RVC, 3-RVC and 4-RVC in stopping main conveyor belt 400 for cutting plies 2, 3 and 4 to length (Fig. 77).
71. 5-EYE	Stops reverse movement of lower storage conveyor belt 520 when remnant piece of fabric is entirely in lower storage area 500 (Fig. 76).
72. 6-EYE	Stops reverse movement of upper storage conveyor belt 575 when remnant piece of fabric is entirely in upper storage area 501 (Fig. 76).
73. 7-EYE	Stops let-off motor MTR–4 when fabric in let-off unit 21 is exhausted and initiates lowering of brake roller 43 (Fig. 75).
74. MTR–1	Provides hydraulic control pressure for apparatus (Fig. 76).
75. MTR–2	Cools main conveyor drive motor MTR–7 (Fig. 77).
76. MTR–3	Rotates bias-cutter saw 222 (Fig. 75).
77. MTR–4	Feeds fabric to dancer roller 40 (Fig. 75).
78. MTR–5	Drives bias-cutter saw 222 (Fig. 75) through transverse cutting stroke.
79. MTR–6	Drives cut-to-length knife 873 (Fig. 77) through transverse cutting stroke.
80. MTR–7	Drives main conveyor belt 400 (Fig. 77).

Assuming: (1) that the bias-cutter A (FIG. 1) has a roll of fabric in place and has previously been manually cycled to cut both a narrow width rhomboidal section of fabric and a wide width rhomboidal section of fabric; (2) that the narrow width section of fabric has been moved into the upper storage area **501** of storage device C, while the wide width section of fabric has been moved into the lower storage area **500** of storage device C; and (3) that the apparatus has been shut down and it is desired to start operation, this description will continue with reference now to Table II below. Table II sets forth the initial conditions of the various components in the apparatus at time T–O (FIGS. 91 and 106), which represents the starting point from which the discussion of the electrical control circuits will begin.

TABLE II

Mechanical Component	Initial Conditions
1. Upper storage area 501 (Fig. 76).	Up (1–LS–U closed, Fig. 91).
2. Frame 960 (Fig. 77)	Not offset (6–LS–R closed, Fig. 91).
3. Vacuum lifter 780 (Fig. 77)	Up (3–LS–U closed, Fig. 91).
4. Cut-to-length knife 873 (Fig. 77)	At rest position (8–LS– contacts closed, Fig. 91).
5. Clamping bar 901 (Fig. 77)	Down (7–LS–D closed, Fig. 91).
6. Stripper 800 (Fig. 77)	Up (4–LS–U closed, Fig. 91).
7. Frame 960 (Fig. 77)	Down (5–LS–D closed, Fig. 91).
8. Dancer roller 40 (Fig. 75)	Down (20–LS–B and 19–LS–B closed, Fig. 106).
9. Fabric gripping bar 91 (Fig. 75)	Down (15–LS–D closed, Fig. 106).
10. Cutting position stop assembly 295 (Fig. 75).	Up (14–LS–U closed, Fig. 106).
11. Fabric width and drop control unit 275 (Fig. 75).	Set wide for width operation (11–LS–RA and 11–LS–FA closed, Fig. 106).
12. Bias-cutter saw 222 (Fig. 75)	At rest position (17–LS–A and 16–LS–B closed, Fig. 106).
13. Fabric cutting unit carriage 55 (Fig. 75).	At back or start position (near fabric cutting unit 200; 12–LVS–R closed, Fig. 106).
14. Brake roller 43 (Fig. 75)	Up (18–LS–B closed, Fig. 106).

Referring now to FIGS. 78 through 88, which, together, comprise an electrical schematic drawing of the electrical control system for the tire building apparatus, a line numbering system has been employed to facilitate the description of the electrical system. The line numbers have been listed on the left side of each of FIGS. 78 through 88 and run consecutively from line number **100** in FIG. 78 through number **409** in FIG. 88. Thus, FIG. 78 contains line numbers **100** through **123** of the electrical system, FIG. 79 contains line numbers **124** through **154** of the system and so forth through FIG. 88 which carries line numbers **384** through **409** of the electrical system.

The line numbers in which the contacts of relays appear have been listed on the right side of FIGS. 78 through 88 adjacent to the relays they refer to. Thus, referring to FIG. 78, master control relay CR–M (line **113**) is provided with relay contacts which are positioned in lines **114**, **115**, **116**, **117** and **155** (as indicated by these numbers being placed in the margin at the right side of master control relay CR–M).

A three phase supply voltage of, for example, 440 volts AC is delivered to the electrical control system by means of conductors L–**1**, L–**2** and L–**3** (line **100**) through a disconnect switch **1**–DISC (line **101**). Fuses F–**1**, F–**2** and F–**3** (line **102**) are employed to protect against overloading the electrical circuits in the event of a malfunction or short circuit. With disconnect switch **1**–DISC (line **101**) closed, three phase 440 volt AC is available, through suitable relay contacts, to all of the electric motors employed in the apparatus.

A step down transformer TF–**1** (line **104**) is used to reduce the 440 volt supply voltage to a suitable lower voltage, for example 120 volts, for use in the control circuits. One side of the secondary circuit of transformer TF–**1** is connected to a conductor L–**6**, which is grounded, while the other side of the secondary circuit of transformer TF–**1** is connected to a pair of conductors L–**4** and L–**5** through suitable fuses F–**4** and F–**5** (line **106**), respectively.

Assuming that suitable sources of high pressure air and vacuum are available, pressure switch **1**–PS (line **110**) and vacuum switch **1**–VS (line **110**) will be closed. Also, assuming motors MTR–**1** through MTR–**7** (FIGS. 78 and 79) are in good operating order, their overload switches in line **107** (**1**–OL, **2**–OL, **3**–OL, **4**–OL, **5**–OL, **6**–OL, **7**–OL–**1** and **7**–OL–**2**) will be closed. Hence, control voltage will be delivered from conductor L–**5** via lines **107**, **108**, **109**, **110** and **113** to a normally open, "machine start", pushbutton switch PB–**3** (line **112**). The circuit to this switch includes, in addition to the above-mentioned switches, a pair of "machine stop" pushbutton switches PB–**1** (line **108**) and PB–**2** (line **113**) which are normally closed. Upon depressing "machine start" pushbutton switch PB–**3**, master control relay CR–M (line **113**) becomes energized and a preliminary starting sequence of the apparatus begins. The depression of pushbutton switch PB–**3** is graphically illustrated at T–**2** in FIGS. 91 and 106, while the energization of master control relay CR–M occurs at T–**3**.

When master control relay CR–M (line **113**) becomes energized, its contacts in lines **115**, **116** and **117** close, thereby causing motors MTR–**1** (line **116**), MTR–**2** (line **119**) and MTR–**3** (line **122**) to become energized. These motors serve, respectively, to supply hydraulic pressure fluid to the hydraulic control circuits (FIG. 75), to supply cooling air to the main conveyor drive motor MTR–**7** (FIG. 77), and to rotate the bias-cutter saw **222** (FIG. 75).

Additionally, contacts CR–M in line **114** close, thereby locking in relay CR–M (line **113**) so that the subsequent release of pushbutton switch PB–**3** (at T–**5**) does not affect the relay. Thus, relay CR–M remains continuously energized while the apparatus is in operation unless one of the motor overload switches (line **107**), the vacuum switch (line **110**), or the pressure switch (line **110**), opens, or unless one of the machine stop pushbutton switches PB–**1** (line **109**) or PB–**2** (line **113**) is depressed.

A final set of contacts of relay CR–M are provided in conductor L–**5** at line **155**. The closing of these contacts upon energization of relay CR–M serves to supply control voltage to the remaining control circuitry of the tire building apparatus. This, in turn, results in the concurrent energization of a large group of electrical components, as indicated by the electrical action lines emanating from relay CR–M in FIGS. 91 and 106 at time T–**3**.

Prior to going into a detailed consideration of the various electrical components that are energized when contacts CR–M (line **155**) close, a brief description will be given of a 16–position "operation selector" stepping relay CR–OS (line **165**) which directly controls the sequence of operations that the apparatus performs. Referring to FIG. 90, a "relay position-contact condition" chart has been illustrated showing the condition of the various contacts (CR–OS–**1** through CR–OS–**16** and CR–OS–**1**A through CR–OS–**19**A) of stepping relay CR–OS when this relay is in each of its positions **1** through **16**. The letter "X" used in this chart is indicative of the fact that the relay contacts so marked are closed at a particular position. Thus, when relay CR–OS is in position **1**, its contacts CR–OS–**1**, CR–OS–**1**A, CR–OS–**3**A, CR–OS–**5**A, CR–OS–**12**A and CR–OS–**15**A are closed, while the remainder of its contacts are open.

The vertical column of numbers at the left-hand side of the chart of FIG. 90 indicates the line number in FIGS. 78 through 88 in which the various contacts of stepping relay CR–OS are positioned. Thus, contacts CR–OS–**1** (line **205**), which are shown as being normally open in line **205**, are closed with the stepping relay in position **1**. Similarly, contacts CR–OS–**1**A (line **234**), contacts CR–OS–**3**A (line **171**), contacts CR–OS–**5**A (line **353**), contacts CR–OS–**12**A (line **185**) and contacts CR–OS–**15**A (line **218**) are all closed with stepping relay CR–OS in position **1**. In addition to the contacts listed in FIG. 90, stepping relay CR–OS is provided with a set of contacts in line **170** which are closed whenever the stepping relay is de-energized and opened whenever the stepping relay is energized. Since stepping relay CR–OS only becomes energized during the times that it is actually indexing from one of its positions to the next of its positions, its contacts in line **170** remain closed for the most part and only open in conjunction with the indexing of the stepping relay.

An additional point to be considered, before resuming the discussion relative to the actions which follow when the contacts of relay CR–M in line **155** close at T–**3**, is that a plurality of transistor-type sensitive relays of the kind shown in FIG. 89 are employed in the electrical control system of the tire building aparatus. These transistor-type sensitive relays, which will hereinafter be referred to as "sensing relays," are standard duty, 115-volt D.C., 60/50 cycles, double pole, double throw relays and are more fully identified in the Panel Builders Handbook of A.C. and D.C. Electrical Components (5th Ed.), put out by Cutler-Hammer Inc., of Milwaukee, Wisconsin, under Catalog No. 13535Hl.

Referring to FIG. 89, the sensing relays include a sensing network, shown generally at **1170**, and a relay assembly, shown generally at **1171**, which are electrically interconnected by means of a first conductor extending between terminal **7** of the network **1170** and terminal **1** of the assembly **1171** and a second conductor extending between terminal **6** of the network **1170** and terminal **4** of the assembly **1171**.

Sensing network **1170** includes a step-down transformer **1172** whose primary is adapted to be connected by means of terminals **5** and **9** to a 115-volt A.C. source. The secondary of transformer **1172** is connected to a rectifier **1173**, a filter capacitor **1174**, and a voltage dividing network including resistors **1175** and **1176**. One end of a current limiting resistor **1177** is connected between resistors **1175** and **1176**, while the other end of resistor **1177** is connected to terminal **8** of sensing network **1170**.

Sensing network **1170** is also provided with a transistor **1178**. The emitter of transistor **1178** is connected to terminal **10** of network **1170**, to one side of resistor **1175**, and one side of additional resistor **1179**. The base of transistor **1178** is connected to the other side of resistor **1179** and also to terminal **11** of sensing network **1170**, while the collector of transistor **1178** connects with terminal **7** of network **1170**.

The relay assembly **1171** includes a relay coil **1180** which is connected in series with terminals **1** and **4** of the relay assembly. Assembly **1171** also includes a set of normally closed contacts between its terminals **2** and **15**, a set of normally open contacts between its terminals **2** and **16**, a set of normally closed contacts between its terminals **3** and **14** and a set of normally open contacts between its terminals **3** and **13**. When relay coil **1180** is energized, the above-mentioned normally closed contacts open and the normally open contacts close as in conventional relay operation.

Relay coil **1180** is connected between one side of resistor **1176** and the collector of transistor **1178** by virtue of the conductors connecting terminals **1** and **4** with terminals **6** and **7** of the sensing relay. Thus, when current flows through transistor **1178**, relay coil **1180** becomes energized and effects a control function via its contacts between terminals **2** and **15**, **2** and **16**, **3** and **14**, and **3** and **13**.

Two modes of operation are available in the sensing relay of FIG. 89. One is a normally de-energized mode of operation, while the other is a normally energized mode of operation.

In the normally de-energized mode of operation, terminal **10** is not used (left open), and relay coil **1180** becomes energized when terminals **8** and **11** are connected together and becomes de-energized again when this connection is broken. In the normally energized mode of operation, terminals **8** and **11** are permanently jumpered together (causing coil **1180** to be normally energized). Thereafter, upon connecting terminal **10** to terminal **8** or **11**, relay coil **1180** becomes de-energized, and, by opening this connection, the relay coil again energizes.

Nine sensing relays of the type shown in FIG. 89 have been employed in the electrical control circuits of FIGS. 78 through 88. These sensing relays are diagrammatically illustrated at **41**–SR (line **280**, FIG. 84), **42**–SR (line **283**), **43**–SR (line **286**), **44**–SR (line **290**), **45**–SR (line **294**), **46**–RS (line **297**), **66**–SR (line **378**, FIG. 87), **67**–SR (line **389**), and **68**–SR (line **386**, FIG. 88).

Referring to FIG. 84, various of the sensing relay terminals have been shown in circles within the general rectangular box denoting each sensing relay. Thus, the encircled numerals **5**, **1**, **8**, **11**, **4** and **9**, which are located within the rectangle denoted generally as sensing relay **41**–SR (line **280**), represent the similarly encircled terminal numbers illustrated in FIG. 89. In a like manner, the contacts of each sensing relay are illustrated together with the terminals to which they are connected. Thus, for example, normally open contacts **43**–SR in line **300** are connected between terminals **3** and **13** of sensing relay **43**–SR (line **286**).

Each of the heretofore mentioned sensing relays **41**–SR through **46**–SR and **66**–SR through **68**–SR are wired for a normally de-energized mode of operation. Accordingly, these relays become energized when terminals **8** and **11** thereof are connected together. In the case of sensing relays **41**–SR through **46**–SR and **68**–SR, photocells **1**–EYE through **7**–EYE, respectively, are employed to connect terminals **8** and **11** together. When these photocells are activated by light beams, they become quite conductive and, hence, act as a short circuit across terminals **8** and **11**. Conversely, when the light beams to these photocells are blocked, the internal resistances of the photocells increase greatly and, in effect, break the connections between terminals **8** and **11**. Sensing relays **66**–SR (line **378**) and **67**–SR (line **380**) utilize low voltage switches **12**–LVS–F (line **379**) and **12**–LVS–R (line **381**), respectively, instead of photocells, to connect and disconnect their terminals **8** and **11**.

Remembering that when contacts CR–M (line **155**) closed, conductor L–**5**A became energized, and referring to FIG. 84, a step down transformer TF–**2** (line **278**) is employed to reduce the 115 volt A.C. control voltage of conductor L–**5**A to a suitable low voltage for illuminating the lamps of photocells **1**–EYE through **6**–EYE, the lamps being identified, respectively, as follows: Lamp **842** (line **282**), lamp **843** (line **285**), lamp **1052** (line **289**), lamp **1053** (line **293**), lamp **1185** (line **296**), and lamp **610** (line **299**). Similarly, a step down transformer TF–**3** (line **389**, FIG. 88) that is connected between conductors L–**5**A and L–**6** is employed to provide a low voltage energization source for lamp **31** (line **388**). This lamp, it will be recalled, is used to illuminate photocell **7**–EYE when fabric let-off unit **21** (FIG. 75) runs out of fabric.

Since, according to earlier assumptions, fabric let-off unit **21** has a new roll of fabric therein, photocell **7**–EYE does not become illuminated when the electrical circuits are energized. Hence, sensing relay **68**–SR (line **386**) remains de-energized until this roll of fabric is exhausted. Also, since it was assumed earlier that fabric pull-out carriage **55** (FIG. 75) was positioned adjacent fabric cutting unit **200** before the electrical circuits were energized, low voltage switch contacts **12**–LVS–R (line **379**) are closed, while low voltage switch contacts **12**–LVS–F (line **379**) are open.

As a result of the foregoing, when contacts CR–M (line **155**) close with the energization of master control relay CR–M (line **113**) at T–**3**, each of the sensing relays in the electrical control system becomes energized, with the exception of sensing relays **66**–SR (line **378**) and **68**–SR (line **386**).

Referring to FIG. 91, this has been shown at time T–**4** by the start of heavy horizontal component lines for sensing relays **46**–SR, **45**–SR, **41**–SR, **42**–SR, **43**–SR and **44**–SR. It has also been shown in FIG. 106 at time T–**4** by the start of a heavy horizontal component line for sensing relay **67**–SR.

Remembering that stepping relay CR–OS is in position **1** and continuing this description of the events occurring as a result of the energization of master control relay CR–M (line **113**) at T–**3**, the closing of contacts CR–M in line **155** applies control voltage to conductor L–**5**A and causes the following actions to occur at T–**4**. Referring to FIG. 91 in conjunction with FIGS. 78 through 88, control relay 24–CR (line 231) becomes energized; control relay 10–CR (line 170) becomes energized; control relay 16–CR (line 205) becomes energized; lower storage drive clutch 1–CLU (line 175) becomes energized through bridge rectifier 2–REC (line 174); valve solenoid 1–SOL–U (line 172) becomes energized; control relay 55–CR (line 326) becomes energized; control relay 59–CR (line 348) becomes energized; and control relay 57–CR (line 328) becomes energized. Referring to FIGS. 106 and 87, valve solenoid 12–SOL–R (line 369) becomes energized at T–4 in addition to the other components mentioned in this and in the preceding two paragraphs.

As a result of the foregoing occurrences at T–4 in FIGS. 91 and 106, the following actions take place at T–5. Referring to FIG. 84, the energization of sensing relay 46–SR (line 297) causes its contacts 46–SR (line 306) to close and this, in turn, causes control relay 46–CR (line 306) to become energized at T–5. Similarly, the energization of sensing relay 45–SR (line 294) causes its contacts 45–SR (line 304) to close, thereby energizing control relay 45–CR (line 304) at T–5. Also, the energization of sensing relay 41–SR (line 280) causes its contacts 41–SR (line 240) to close, thereby energizing control relay 41–CR (line 239) at T–5.

A similar sequence of action occurs with respect to sensing relays 42–SR (line 283), 43–SR (line 286), and 44–SR (line 290). Thus, contacts 42–SR (line 276) energize control relay 42–CR (line 276), contacts 43–SR (line 300) energize control relay 43–CR (line 300) and contacts 44–SR (line 302) energize control relay 44–CR (line 302), all of these actions occurring at T–5.

Concurrently with the foregoing, contacts 10–CR (line 180), 59–CR (line 180) and 55–CR (line 182) close to energize control relay 11–CR (line 182) at T–5, while contacts 55–CR (line 321) close to energize valve solenoid 4–SOL–U (line 321) at T–5. In addition, contacts 67–SR (line 352) close, to energize valve solenoid 11–SOL–R (line 353) at T–5.

When the electrical actions occurring through T–5 have been completed, the preliminary starting sequence of the apparatus is over, and the electrical circuits are ready to receive a "cycle start" signal from the operator. This signal is introduced via a "cycle start" pushbutton switch PB–5 (line 160), which, as shown in FIGS. 91 and 106, is assumed to be depressed at T–6 and released at T–9. The depression of this pushbutton switch causes a series of sequential actions to occur in which the wide width section of fabric on lower storage conveyor belt 520 (FIG. 76) is moved forward (downstream) to begin preparation of ply 1.

As indicated earlier, the electrical system is functionally controlled by operation selector stepping relay CR–OS (line 165), and, since this relay is in position 1 when automatic operation is started, the sequential actions occurring when pushbutton switch PB–5 is depressed will be described in the following section which is entitled "Stepping Relay CR–OS in Position 1."

B. Stepping Relay CR–OS in Position 1: Cycle start pushbutton switch PB–5 (line 160) is provided with contacts in lines 160, 161, 200, 201 and 259, the latter three being identifiable from FIG. 80 by being enclosed in a hexagon which is positioned below and connected to pushbutton switch PB–5 by a broken line, this arrangement being used throughout the electrical drawings of FIGS. 78 through 88 to indicate that portions of a component appear in lines located on another figure. When pushbutton switch PB–5 is depressed at T–6, its contacts in line 160 close, thereby energizing, at T–7, "automatic" control relay CR–A (line 158), which locks itself in through its contacts in line 161. Also, the contacts of switch PB–5 in line 161 close, thereby energizing, at T–7, "bias-cutter" control relay CR–B (line 162), which locks itself in via contacts CR–B in line 162. Similarly, contacts PB–5 (line 200) close, energizing timing relay 14–TR (line 197) at T–7, while contacts PB–5 (line 201) open without further effect. Finally, contacts PB–5 (line 359) close but no action results therefrom.

When automatic control relay CR–A (line 158) energizes at T–7, its contacts in line 184 close, thereby applying control voltage to conductor L–8, which extends vertically throughout the lengths of FIGS. 81 through 88. With the application of control voltage to conductor L–8, the following components become concurrently energized at T–8: time-delay relay 25–TR (line 233); conveyor forward control relay 7–MF (line 234); control relay 26–CR (line 235); and valve solenoid 7–SOL–D (line 346).

Similarly, when bias-cutter control relay CR–B (line 371) energizes at T–7, its contacts in line 371 close, thereby resulting in the concurrent energization of the following components at T–8: valve solenoid 15–SOL–D (line 374); time-delay relay 65–TR (line 375); and valve solenoid 14–SOL–U (line 377). With the energization of time-delay relay 65–TR (line 375) at T–8, its time-delay contacts in line 376 begin a one second (approx.) time-delay period at the end of which, at T–18, they close and energize valve solenoid 13–SOL–AO (line 376).

When the operator releases cycle start pushbutton switch PB–5 (line 160) at T–9, its contacts in line 200 open, thereby de-energizing time-delay relay 14–TR (line 197) at T–10. Also, contacts PB–5 in line 201 close with the release of pushbutton switch PB–5 and, hence, control voltage is applied to control relay 15–CR (line 203) via time-delay contacts 14–TR (line 202), which remain closed for approximately 0.6 second after time-delay relay 14–TR (line 197) de-energizes at T–10. Thus, control relay 15–CR (line 203) becomes energized at T–11.

The energization of control relay 15–CR results in the closing of its contacts in line 315, and this, in turn, energizes valve solenoids 5–SOL–D (line 314) and 2–SOL–VR (line 315) at T–12 from conductor L–8, through a circuit including: contacts 15–CR (line 315); contacts 26–CR (line 315); contacts 52–CR (line 314); contacts 24–CR (line 314); and, in the case of valve solenoid 5–SOL–D only, contacts 27–CR (line 314). However, referring to FIG. 77, since the mechanical lifter frame 960 was previously assumed to be down, the energization of valve solenoid 5–SOL–D (line 314) results in no further action. Similarly, assuming that no vacuum had previously been applied to vacuum lifter 780, the energization of valve solenoid 2–SOL–VR effects no change in the condition of the apparatus.

Contacts 15–CR in line 185, on the other hand, initiate the next step in the sequential action of the apparatus. When these contacts close at T–11, an energization circuit is completed to control relay 12–CR (line 190) from conductor L–8 through the following contacts: CR–OS–12A (line 185); 15–CR (line 185); 31–CR (line 192); 32–CR (line 192); 30–CR (line 190); and 44–SR (line 190). Thus, control relay 12–CR (line 190) becomes energized at T–12.

With the energization of control relay 12–CR (line 190) its contacts 12–CR (line 218) close, thereby energizing, at T–13, conveyor high speed motor control relay 7–MH (line 224), through a circuit including: conductor L–8; contacts 11–CR and 12–CR (both in line 218); contacts 26–CR (line 220); contacts 64–CR (line 221); contacts 57–CR (line 221); contacts 22–TR (line 224); contacts 64–CR (line 223); contacts 43–SR (line 223); and contacts 27–CR (line 223). When conveyor high speed motor control relay 7–MH (line 224) energizes, its contacts in line 230 open, thereby de-energizing control relay 24–CR (line 231) with no further effect. In addition, contacts 7–MH in lines 147, 148 and 149 (FIG. 79) close, thereby completing an energization circuit to the high speed windings of main conveyor drive motor

MTR–7 (line 145) from conductors L–1, L–2 and L–3 via contacts 7–MF in lines 144, 145 and 146.

Referring to FIGS. 76 and 77 and remembering that lower storage conveyor drive clutch 1–CLU (line 175) has previously been energized, the operation of main conveyor drive motor MTR–7 in a high speed forward direction results in the forward high speed operation both of main conveyor belt 400 and lower storage conveyor belt 520. This, in turn, causes the fabric located in lower storage area 500 to move downstream onto main conveyor belt 400.

As the fabric starts moving forward from lower storage area 500, its leading edge blocks the light beam passing from lamp 1185 (line 296) to photocell 5-EYE (line 295). This causes sensing relay 45–SR (line 294) to become de-energized at T–14, and thus contacts 45–SR (line 304) open, thereby de-energizing control relay 45–CR (line 304) at T–15. However no further action occurs with the dropping out of control relay 45–CR.

High speed forward movement of the fabric from lower storage area 500 to main conveyor belt 400 continues, therefore, and, shortly thereafter, the trailing edge of the fabric uncovers the light beam between lamp 1185 (line 296) and photocell 5–EYE (line 295). Accordingly, sensing relay 45–SR again energizes at T–17.5 and, in turn, re-energizes control relay 45–CR (line 304) via its contacts 45–SR (line 304). However, no further action results therefrom.

The forward high speed movement of main conveyor belt 400 continues and, at T–19, the leading edge of the fabric passes between lamp 842 (line 282) and photocell 1–EYE (line 281), resulting in the de-energization of sensing relay 41–SR (line 280). The de-energization of sensing relay 41–SR at T–19 results in the closing of its contacts in line 227, thereby causing time-delay relay 22–TR (line 227, FIG. 82) to become energized at T–20. Also, contacts 41–SR (line 240) open, thereby de-energizing control relay 41–CR (line 239) at T–20. No further actions stem from the foregoing due to the fact that when contacts 22–TR (line 224) open, contacts 41–CR (line 223) close, thereby maintaining the energization circuit to conveyor high speed forward motor control relay 7–MH (line 224).

Since main conveyor belt 400 is still running, the leading edge of the fabric carried on the belt intercepts the light beam between lamp 843 (line 285) and photocell 2–EYE (line 284). This causes sensing relay 42–SR (line 283) to become de-energized at T–20. Thus, contacts 42–SR (line 276) open and de-energize control relay 42–CR (line 276) at T–21. This action results in the closing of contacts 42–CR (line 264), thereby causing control relay 32–CR (line 263) to become energized at T–22. No further action results from the energization of control relay 32–CR, and, consequently, main conveyor belt 400 (FIG. 77) continues to run in a high speed forward direction.

Remembering that the piece of fabric being carried by main conveyor belt 400 is of sufficient length from which to cut a ply, it will be seen (FIG. 77) that high speed forward operation of main conveyor belt 400 continues until the leading edge of the fabric reaches the cut-to-length slow down photocell 3–EYE. This action occurs prior to the time that the trailing edge of the fabric piece reaches the slow down photocell 1–EYE of splicing mechanism D. Hence, referring to FIGS. 84 and 91, at T–22 the leading edge of the fabric piece intercepts the light beam between lamp 1052 (line 289) and photocell 3–EYE (line 288), and sensing relay 43–SR (line 286) becomes de-energized. As a result of the foregoing, contacts 43–SR (line 300) open to de-energize control relay 43–CR (line 300) at T–23, and contacts 43–SR (line 223) open to de-energize conveyor high speed motor control relay 7–MH (line 224) at T–23.

The de-energization of control relay 43–CR (line 300) causes its contacts in line 232 to open, thereby deenergizing time-delay relay 25–TR (line 233) at T–24. Time-delay contacts 25–TR (line 224) remain open for approximately 3 seconds after time-delay relay 25–TR (line 233) de-energizes, the contacts eventually closing at T–54 (FIG. 92). Since contacts 43–SR (line 223) also remain open during this period of time, conveyor high speed motor control relay 7–MH (line 224) remains de-energized during the sequential actions that follow, these actions ultimately breaking the energization circuit to motor control relay 7–MH at another point prior to the closing of contacts 25–TR (line 224) at T–54.

With the de-energization of conveyor high speed motor control relay 7–MH at T–23 its contacts in line 228 close, thereby energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–24. In addition, referring to FIG. 79, the de-energization of conveyor high speed motor control relay 7–MH causes its contacts in lines 147, 148 and 149 to open; however, since low speed motor control relay 7–ML becomes energized at almost the same time, contacts 7–ML in lines 144, 145 and 146 close, thereby energizing the low speed windings of main conveyor drive motor MTR–7 (line 145) immediately after the de-energization of its high speed windings. Also, referring back to FIG. 82, the energization of conveyor brake timing relay 23–TR (line 229) at T–24 causes time-delay contacts 23–TR (line 230) to immediately close, thereby energizing conveyor brake relay 7–MB (line 230) at T–25. With the energization of conveyor brake relay 7–MB, its contacts in lines 151, 152 and 153 close, thereby applying A.C. control voltage across a bridge rectifier 1–REC (line 152) which, in turn, supplies a D.C. voltage across one leg of the high speed windings of main conveyor drive motor MTR–7 (line 145).

Thus, at T–25, the low speed windings of main conveyor drive motor MTR–7 (line 145) are energized by a three phase A.C. voltage, while one leg of the high speed windings of the motor is energized by a D.C. braking voltage. This causes main conveyor drive motor MTR–7 to rapidly slow down to a very low speed, thereby resulting in a forward "crawling" movement of main conveyor belt 400 (FIG. 77). Accordingly, the leading edge of the fabric carried on the belt slowly inches into position under cut-to-length stop photocell 4–EYE.

During the period of time in which the foregoing occurs, the trailing edge of the fabric carried on main conveyor belt 400 uncovers the light beam between lamp 842 (line 282) and splice slow down photocell 1–EYE (line 281). This causes sensing relay 41–SR (line 280) to energize at T–22.5. When sensing relay 41–SR energizes, its contacts in line 240 close, thereby energizing control relay 41–CR (line 239); however, no further action results from this. Similarly, contacts 41–SR (line 227) open, thereby de-energizing timing relay 22–TR (line 227), whose time-delay contacts 22–TR (line 224) remain open for a period of about 3 seconds before closing at T–53 (FIG. 92). No further sequential action is initiated as a result of the de-energization of relay 22–TR at this time.

Remembering that the leading edge of the fabric on main conveyor belt 400 (FIG. 77) is inching towards the cut-to-length stop photocell 4–EYE, it will be appreciated that the light beam between this photocell and its lamp 1053 (line 293) will soon be blocked. When this occurs, sensing relay 44–SR (line 290) becomes deenergized, at T–26, to initiate the next sequence of actions which results in the stopping of main conveyor belt 400.

With the de-energization of sensing relay 44–SR, its contacts in line 302 open to de-energize control relay 44–CR (line 302) without further effect at T–27. However, in addition to this, contacts 44–SR in line 190 open, thereby de-energizing control relay 12–CR (line 190) at T–27. This, in turn, causes contacts 12–CR in line 218 to open, and, thus, conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) become de-energized at T–28.

Referring to FIG. 79, the de-energization of conveyor low speed motor control relay 7–ML at T–28 causes its contacts 7–ML in lines 144, 145 and 146 to open, thereby removing the A.C. excitation voltage from the low speed windings of main conveyor drive motor MTR–7 (line 145). At the same time, referring back to FIG. 82, the de-energization of conveyor brake timing relay 23–TR (line 229) starts a brief (approximately 0.2 second) time-delay period running with respect to time-delay contacts 23–TR (line 230), which remain closed during this time, and contacts 23–TR (line 231), which remain open during this time. Thus, contacts 23–TR in line 230 keep conveyor brake relay 7–MB (line 230) energized for a short period of time after the A.C. excitation has been removed from the low speed windings of main conveyor drive motor MTR–7 (FIG. 79). Accordingly, D.C. voltage continues to be applied to one leg of the high speed windings of motor MTR–7 (via contacts 7–MB in lines 151, 152 and 153), while all A.C. excitation is removed from the motor. This causes a rapid dynamic braking action to occur in motor MTR–7. Hence, main conveyor belt 400 quickly stops with the leading edge of the fabric piece beneath photocell 4–EYE (FIG. 77).

Shortly after this, at T–30, time-delay contacts 23–TR in line 230 open, thereby de-energizing conveyor brake relay 7–MB at T–31, while time-delay contacts 23–TR in line 231 close, thereby energizing control relay 24–CR (line 231) at T–31. The de-energization of conveyor brake relay 7–MB (line 230) results in the opening of its contacts in lines 151, 152 and 153 and in the removal of D.C. voltage from the high speed windings of main conveyor drive motor MTR–7 (line 145). The energization of control relay 24–CR (line 231) initiates the next sequence of actions that occur in the electrical control system, which involves the indexing of operation selector stepping relay CR–OS (line 165) from position 1 to position 2.

When control relay 24–CR (line 231) becomes energized at T–31, its contacts in line 165 close, thereby completing an energization circuit to operation selector stepping relay CR–OS (line 165). The energization circuit to stepping relay CR–OS, which causes this relay to start indexing from position 1 to position 2, comes from line 253 (FIG. 83), as indicated by the chart located on FIG. 80 between lines 159 and 165. Thus, in indexing stepping relay CR–OS from position 1 to 2, the indexing voltage proceeds from a terminal in line 253, denoted by a small circle at one end of this line, through a conductor (not shown), to a terminal at one end of line 165, also denoted by a small circle.

The terminal of line 253 receives control voltage for indexing stepping relay CR–OS through the following circuit: conductor L–8 (FIG. 82); contacts CR–OS–1A (line 234); conductor L–9 (FIGS. 82 and 83); contacts 44–CR (line 248); contacts 64–CR (line 248); contacts 16–CR (line 254); contacts 57–CR (line 253); and contacts 33–CR (line 253). Similarly, when contacts 24–CR (line 165) close at T–31, the indexing voltage reaches stepping relay CR–OS (line 165) from the terminal in line 165 via a circuit including: contacts CR–A (line 165); the normally closed contacts of pushbutton switch PB–7 (line 165); contacts 10–CR (line 165); and contacts 24–CR (line 165). Thus operation selector stepping relay CR–OS (line 165) becomes energized at T–32 and begins indexing into position 2.

When stepping relay CR–OS becomes energized, its contacts in line 170 open, thereby de-energizing control relay 10–CR (line 170) at T–33. This, in turn, causes contacts 10–CR in line 165 to open, thereby de-energizing stepping relay CR–OS (line 165) and completing the indexing of this relay into position 2 at T–34.

C. Stepping Relay CR–OS in Position 2: Referring to FIG. 90, the indexing of operation selector stepping relay CR–OS into position 2 results in the following: contacts CR–OS–1 (line 205) open, contacts CR–OS–2 (line 401) close, contacts CR–OS–1A (line 234) open, contacts CR–OS–12A (line 185) open, and contacts CR–OS–14A (line 337) close. The remaining contacts of stepping relay CR–OS stay in the same condition they were in while the stepping relay was in position 1.

The de-energization of relay 10–CR (line 170) at T–33 also causes its contacts in line 180 to open, thereby de-energizing control relay 11–CR (line 182) at T–34. In addition, its contacts 10–CR in line 197 close, thereby energizing timing relay 14–TR (line 197) at T–34.

The de-energization of operation selector stepping relay CR–OS (line 165) at T–34 (after having stepped into position 2) results in the following electrical actions. The opening of contacts CR–OS–1 (line 205) causes control relay 16–CR (line 205) to become de-energized and also causes a position 1 lamp 1190 (line 204) to be extinguished. The closing of contacts CR–OS–2 (line 401) causes a position 2 lamp 1191 (line 401) to become energized. The opening of contacts CR–OS–1A (line 234) causes conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235) to become de-energized (at T–35). The opening of contacts CR–OS–1A (line 234) also causes line 253 to become de-energized thereby removing the indexing signal from stepping relay CR–OS. The opening of contacts CR–OS–12A (line 185) causes no further sequential action at this time. The closing of contacts CR–OS–14A (line 337), however, initiates a sequence of actions during which ply 1 is cut-to-length from the wide width fabric piece at cut-to-length unit E. This is due to the fact that the closing of contacts CR–OS–14A (line 337) causes control relay 58–CR (line 337) to become energized at T–35.

Before going into the cut-to-length sequence of actions, the following additional electrical action takes place at T–35, and thereafter, as a result of the completion of indexing of control relay CR–OS. Contacts CR–OS (line 170) close when stepping relay CR–OS de-energizes at T–34 and thereby re-energize control relay 10–CR (line 170) at T–35. This, in turn, causes the de-energization of timing relay 14–TR (line 197) at T–36 by virtue of the opening of contacts 10–CR in line 197. Similarly, contacts 10–CR in line 180 close, causing control relay 11–CR (line 182) to become energized at T–36. Also, contacts 10–CR in line 203 close, causing control relay 15–CR (line 203) to become energized at T–36, although control relay 15–CR will shortly become de-energized when time-delay contacts 14–TR (line 202) open at T–42 as a result of the de-energization of timing relay 14–TR (line 196) at T–36 (the time delay period for these contacts being about 0.6 second).

Another point to consider before going into the cut-to-length sequence of actions is that when control relay 26–CR (line 235) became de-energized at T–35 (due to the opening of contacts CR–OS–1A in line 234), its contacts 26–CR in line 264 opened, and this, in turn, resulted in the de-energizing of control relay 32–CR (line 263) at T–36. However no further action occurs as a result of this.

Resuming a consideration of the cut-to-length portion of the electrical cycle, which commences at T–35 with the energization of control relay 58–CR (line 337), three distinct actions take place a this time. First, contacts 58–CR (line 346) open, thereby de-energizing valve solenoid 7–SOL–D (line 346) at T–36, with no further effect. Secondly, contacts 58–CR (line 311) close, and, since contacts 24–CR (line 310) are closed at this time, valve solenoid 2–SOL–VO (line 309) becomes energized at T–36. Referring to FIG. 77, the energization of valve solenoid 2–SOL–VO causes a vacuum to be applied to vacuum chamber 783 of vacuum lifter 780. Thirdly, the closing of the above mentioned contacts 58–CR in line 311 also causes valve solenoid 3–SOL–D (line 310) to become energized due to the fact that contacts 53–CR (line 310) and 52–CR (line 310) are both closed at this time. Thus, at T–36, valve solenoid 3–SOL–D (FIG. 77) becomes energized and this, in turn, causes vacuum lifter 780 to begin to be lowered into contact with the fabric carried on main conveyor belt 400. Since a vacuum is being drawn on vacuum chamber 783 the fabric on main conveyor belt 400 will be attracted to vacuum lifter 780 when it reaches its lower position.

As vacuum lifter 780 begins moving down, neutral position limit switch 3–LS becomes actuated so that its contacts 3–LS–U (line 326) open at T–37. Subsequently, when vacuum lifter 780 reaches its lower position at T–39, limit switch 3–LS again actuates and its contacts 3–LS–D (line 325) close.

The opening of contacts 3–LS–U (line 326) causes control relay 55–CR (line 326) to become de-energized at T–38, while the closing of contacts 3–LS–D (line 325) causes control relay 54–CR (line 325) to become energized at T–40. The de-energization of control relay 55–CR (line 326) causes its contacts in line 321 to open, thereby de-energizing valve solenoid 4–SOL–U (line 321) at T–39, and also causes its contacts 55–CR in line 182 to open, thereby de-energizing control relay 11–CR (line 182) at T–39; however, no further sequential actions result therefrom. Similarly, the energization of control relay 54–CR (line 325) at T–40 causes its contacts 54–CR (line 322) to close, thereby energizing control relay 53–CR (line 323) at T–41. When control relay 53–CR (line 323) becomes energized, its contacts 53–CR (line 310) open, thereby de-energizing valve solenoid 3–SOL–D (line 310) without further effect.

Recalling that timing relay 14–TR (line 197) had been de-energized at T–36, but that its time-delay contacts 14–TR (line 202) remained closed during the timing period thereafter (approximately 0.6 second), at T–42 contacts 14–TR (line 202) open and cause control relay 15–CR (line 203) to become de-energized at T–43. With the de-energization of control relay 15–CR, its contacts 15–CR (line 317) close, thereby energizing valve solenoid 6–SOL–R (line 318) and timing relay 51–TR (line 319) at T–44.

Since the mechanical lifter frame 960 (FIG. 77) is already at its home position, rather than at its offset position, the energization of valve solenoid 6–SOL–R (line 318) results in no further action. Similarly, since the time-delay contacts 51–TR (line 317) of timing relay 51–TR (line 319) are provided with about a 0.8-second delay prior to closing when this timing relay becomes energized, no sequential action immediately follows. The purpose of providing a time delay in the closing of contacts 51–TR (line 317) is to allow the vacuum in vacuum chamber 783 (FIG. 77) to build up so that the fabric at vacuum lifter 780 will be gripped by the vacuum lifter.

After the time-delay period has ended, contacts 51–TR (line 317) close, at T–52 (FIG. 92), thereby causing valve solenoid 3–SOL–U (line 316) to become energized (at T–53). Referring to FIG. 77, when valve solenoid 3–SOL–U becomes energized, it causes vacuum lifter 780 to start raising, thereby also lifting the fabric from main conveyor belt 400.

When vacuum lifter 780 starts to raise, neutral position limit switch 3–LS becomes actuated, thereby opening contacts 3–LS–D (line 325) and, when vacuum lifter 780 reaches its raised position, contacts 3–LS–U (line 326) close. Thus, at T–54, contacts 3–LS–D (line 325) open, thereby de-energizing control relay 54–CR (line 325) at T–55 without further effect. Similarly, at T–56, contacts 3–LS–U (line 326) close, thereby energizing control relay 55–CR (line 326) at T–57.

With the energizing of control relay 55–CR, the following actions occur. First, contacts 55–CR (line 182) close, thereby energizing control relay 11–CR (line 182) at T–58 without further effect. Secondly, contacts 55–CR (line 321) close, thereby energizing valve solenoid 4–SOL–U (line 321) at T–58. However, referring to FIG. 77, since the stripper 800 has not previously been down, no action occurs as a result of this. The third action occurring with the energization of control relay 55–CR is that its contacts 55–CR (line 317) close, thereby energizing valve solenoid 5–SOL–U (line 317) at T–58.

Referring to FIG. 77, when valve solenoid 5–SOL–U becomes energized, it causes mechanical lifter frame 960 to start raising. This, in turn, causes neutral position limit switch 5–LS to initially actuate as frame 960 starts moving up and to again actuate when frame 960 reaches its upper position. Thus, referring to FIG. 85, as T–59 contacts 5–LS–D (line 328) open as frame 960 starts moving up, thereby de-energizing control relay 57–CR (line 328) at T–60. Similarly when frame 960 reaches its raised position at T–61, contacts 5–LS–U (line 327) close, thereby causing control relay 56–CR (line 327) to become energized at T–62.

The de-energization of control relay 57–CR (line 328) at T–60 results in the opening of contacts 57–CR (line 317) and in the following electrical actions which stem therefrom at T–61: the de-energization of timing relay 51–TR (line 319); the de-energization of valve solenoid 6–SOL–R (line 318); the de-energization of valve solenoid 5–SOL–U (line 317); and the de-energization of valve solenoid 3–SOL–U (line 316). However, the de-energization of these components does not cause any further sequential action.

With the energization of control relay 56–CR (line 327) at T–62 (due to the closing of contacts 5–LS–U in line 327), its contacts 56–CR (line 338) close, thereby energizing valve solenoid 7–SOL–U (line 338) at T–63. Referring to FIG. 77, the energization of valve solenoid 7–SOL–U causes clamping bar 901 of fabric clamping means 900 to start raising in order to clamp the fabric at cut-to-length unit E. This causes neutral position limit switch 7–LS to actuate once when clamping bar 901 starts raising and again when the clamping bar reaches its raised position.

Referring to FIG. 80, contacts 7–LS–D (line 181) open at T–64 as clamping bar 901 starts raising. This, in turn, causes control relay 11–CR (line 182) to become de-energized at T–65; however, no further action results therefrom. When contacts 7–LS–U (line 345) close at T–66 (due to the arrival of clamping bar 901 at its raised position) knife traverse motor control relay 6–MF (line 345) becomes energized. The energization of motor control relay 6–MF at T–67 initiates the next sequence of actions involved in the cutting of the fabric at cut-to-length unit E into ply 1 and a remnant piece of fabric from ply 1.

When knife traverse motor control relay 6–MF (line 345) energizes at T–67, its contacts in line 198 close, thereby energizing timing relay 14–TR (line 197), at T–68, without further effect. Additionally, contacts 6–MF in lines 138, 139 and 140 close, thereby energizing the drive windings and brake release windings of the cut-to-length knife traverse motor MTR–6 (line 139). Accordingly, referring to FIG. 77, knife 873 of cut-to-length unit E begins moving forward to start its cutting stroke and limit switch 8–LS becomes actuated (T–68).

Referring to FIG. 86, the contacts of limit switch 8–LS in line 348 open at this time, thereby de-energizing control relay 59–CR (line 348) at T–69. With the de-energization of control relay 59–CR, its contacts 59–CR (line 336) close, thereby energizing the indexing signal terminal of line 333. This, in turn, energizes operation selector stepping relay CR–OS (line 165), thereby causing the stepping relay to start indexing from position 2 to position 3 at T–70.

The energization of stepping relay CR–OS (line 165) causes its contacts CR–OS (line 170) to open, thereby de-energizing control relay 10–CR (line 170) at T–71. This, in turn, causes contacts 10–CR (line 165) to open, thereby de-energizing operation selector stepping relay CR–OS (line 165) at T–72 to complete the indexing of the stepping relay into position 3. When stepping relay CR–OS re-energizes, its contacts CR–OS (line 170) close, thereby reenergizing control relay 10–CR (line 170) at T–73. However, as will appear more clearly in the following section, no further action results from this due to the fact that stepping relay CR–OS has been shifted to position 3 and there is no longer an indexing signal coming into line 165.

D. Stepping Relay CR–OS in Position 3: Referring to FIG. 90, with the indexing of operation selector stepping relay CR–OS into position 3, the following changes occur in the condition of its contacts in order to facilitate the subsequent offsetting of ply 1 and moving of the remnant of ply 1 to the back-up position: Contacts CR–OS–2 (line 401) open, thereby de-energizing position 2 lamp 1191 (line 401 at T–73); contacts CR–OS–3 (line 329) close, thereby energizing position 3 lamp 1192 (line 329); contacts CR–OS–2A (line 236) close, thereby energizing conveyor reverse contral relay 7–MR (line 236) and also energizing control relay 27–CR (line 237) at T–73; contacts CR–OS–12A (line 185) close without further effect; contacts CR–OS–13A (line 259) close, thereby energizing control relay 30–CR (line 260) at T–73; contacts CR–OS–74A (line 337) open, thereby de-energizing control relay 58–CR (line 337) at T–73 and removing the indexing signal voltage from the terminal in line 333; contacts CR–OS–15A (line 218) open without further effect; and, finally, contacts CR–OS–17A (line 265) close without further effect.

The de-energization of control relay 58–CR (line 337), via contacts CR–OS–14A, causes contacts 58–CR (line 311) to open. This, in turn, results in the de-energization of valve solenoid 2–SQL–VO (line 309) at T–74. Referring to FIG. 77, when valve solenoid 2–SOL–VO becomes de-energized, it preconditions solenoid valve 2–SOL for subsequent releasing of the vacuum in vacuum chamber 783.

During the time that the indexing of operation selector stepping relay CR–OS and the above actions take place, knife 873 (FIG. 77) continues going through its cutting stroke, and, finally, at T–78, the cutting stroke is completed when limit switch 8–LS becomes actuated as the knife returns to its starting position. Thus, the fabric at cut-to-length unit E has been severed, and ply 1, which is of proper length, rests on the raised mechanical lifter frame 960 above main conveyor belt 400.

With the actuation of limit switch 8–LS at T–78, its contacts in line 348 close, thereby energizing control relay 59–CR (line 348) at T–79. Hence, contacts 59–CR (line 340) open, thereby de-energizing valve solenoid 7–SOL–U (line 338) at T–80 and de-energizing knife traverse motor control relay 6–MF (line 345) at T–80. The de-energization of valve solenoid 7–SOL–U at this time causes no further sequential actions. However, with the de-energization of motor control relay 6–MF at T–80, a new series of actions is begun.

When motor control relay 6–MF (line 345) de-energizes, contacts 6–MF in lines 138, 139 and 140 open to de-energize cut-to-length knife traverse motor MTR–6 (line 139) and the integral brake therein. This causes knife 873 (FIG. 77) to quickly come to a stop back at its starting position. In addition, contacts 6–MF (line 346) close, thereby energizing valve solenoid 7–SOL–D (line 346) at T–81. Referring to FIG. 77, the energization of valve solenoid 7–SOL–D causes fabric clamping means 900 to unclamp the fabric at cut-to-length unit E, due to the downward movement of clamping bar 901. As clamping bar 901 starts moving down, contacts 7–LS–U (line 345) open at T–82, without further effect. When clamping bar 901 reaches its lower position, contacts 7–LS–D (line 181) close at T–84; however no further action results from this either. In addition to the foregoing, the de-energization of motor control relay 6–MF causes contacts 6–MF (line 198) to open, thereby de-energizing timing relay 14–TR (line 197) at T–81. However, time delay contacts 14–TR (line 202) remain closed during the approximately 0.6-second timing period that follows the de-energization of timing relay 14–TR. Finally, contacts 6–MF (line 203) close, thereby completing a cicruit to control relay 15–CR (line 203) and energizing this relay at T–81.

When control relay 15–CR becomes energized at T–81, its contacts 15–CR (line 258) close, thereby energizing conveyor back-up revolution counter 1–RVC (line 259) at T–82, and also energizing control relay 29–CR (line 258), which is not listed in the sequential action diagrams of FIGS. 91 through 111. Control relay 29–CR merely serves (via its contacts in line 259) to lock in conveyor back-up revolution counter 1–RVC (line 259) so that the subsequent opening of contacts 15–CR (line 258) will not de-energize this revolution counter.

Contacts 15–CR (line 185) also close when control relay 15–CR (line 203) becomes energized at T–81, and this, in turn, results in the energization of control relay 12–CR (line 190) at T–82 through a circuit including the following contacts: CR–OS–12A (line 185), 15–CR (line 185), 42–SR (line 193), 64–CR (line 193), and 27–R (line 194). However, the energization of control relay 12–CR (line 190) results in no further action at this time.

Before continuing with the remaining actions resulting from the energization of control relay 15–CR (line 203) at T–81, a brief discussion of the operation of revolution counter 1–RVC (line 259) is advisable. It will be recalled that, when energized, this revolution counter (FIG. 76) is coupled to and driven by main conveyor belt 400. The mechanical rotation of the revolution counter, in turn, causes its contacts to change condition at predetermined times. Thus, the condition of contacts 1–RVC (line 194) follows a predetermined schedule set forth adjacent to these contacts on FIG. 81. For example, when revolution counter 1–RVC is energized, contacts 1–RVC in line 194 are in their "reset" position and, therefore, remain open. When main conveyor belt 400 begins operating while counter 1–RVC is energized, the counting period starts and at this point contacts 1–RVC (line 194) assume their "count" position and close. When main conveyor belt 400 has moved a sufficient amount to cause revolution counter 1–RVC to reach its "count out" position contacts 1–RVC in line 194 open. And finally, when revolution counter 1–RVC (line 259) is de-energized, contacts 1–RVC (line 194) go into their "off" position and remain open, as shown in FIG. 81.

Similarly, the revolution counter 1–RVC contacts in line 272 follow the schedule set forth adjacent to these contacts in FIG. 83. In this case, when revolution counter 1–RVC (line 259) is energized, its contacts in line 272 open ("reset" position) and remain open at the start of the "count" period. However, when "count out" is reached, contacts 1–RVC in line 272 close and remain closed when revolution counter 1–RVC (line 259) becomes de-energized ("off" position).

A similar schedule has been set forth adjacent the contacts of each of the remaining revolution counters 2–RVC, 3–RVC and 4–RVC in the electrical control system, and these schedules should be referred to in considering the operation of the various revolution counters at appropriate times during this discussion.

Resuming consideration of the sequence of events following the energization of control relay 15–CR (line 203) at T–81, when this relay energizes, its contacts in line 315 close, thereby energizing valve solenoid 2–SOL–VR (line 315) through a circuit including the following contacts: 15–CR (line 315); 27–CR (line 316); 52–CR (line 314); and 24–CR (line 314). Referring to FIG. 77, the energization of valve solenoid 2–SOL–VR causes the vacuum in vacuum chamber 783 of vacuum lifter 780 to be released.

In addition to the above, the energization of control relay 15–CR at T–81 results in the energization of valve solenoid 3–SOL–D (line 310) by means of the same circuit that energized valve solenoid 2–SOL–VR and further including contacts 27–CR (line 313), 58–CR (line 311), 33–CR (line 311), the normally closed contacts of selector switch 5–SS in line 310, and contacts 52–CR (line 310). Thus, valve solenoid 3–SOL–D (line 310) becomes energized at T–82. Referring to FIG. 77, the energization of valve solenoid 3–SOL–D causes vacuum lifter 780 to start moving down. Thus, at T–83, contacts 3–LS–U (line 326) open, thereby de-energizing control relay 55–CR (line 326) at T–84. This, in turn, causes contacts 55–CR (line 321) to open and results in the de-energization of valve solenoid 4–SOL–U (line 321) at T–85. No further sequential action results from this.

When vacuum lifter 780 reaches its lower position, contacts 3–LS–D (line 325) close (at T–85), causing control relay 54–CR (line 325) to become energized at T–86. The energization of control relay 54–CR results in the following two concurrent actions at T–87: contacts 54–CR (line 330) close, thereby energizing valve solenoid 6–SOL–F (line 330); and, contacts 54–CR (line 313) close, thereby energizing valve solenoid 4–SOL–D (line 313).

Referring to FIG. 77, the foregoing two actions result, respectively, in the offsetting of mechanical lifter frame 960, thereby shifting ply 1 with respect to the center line of the tire building drum, and in the lowering of the operating mechanism of stripper 800 so that the stripper will be held in its lower position when vacuum lifter 780 is subsequently raised. When frame 960 begins moving to its offset position, neutral position limit switch 6–LS initially actuates to open contacts 6–LS–R (line 317); however, no further action results from this. When frame 960 reaches its offset position, limit switch 6–LS is again actuated and contacts 6–LS–F (line 219) close; however, no sequential actions result from this either. Similarly, when the operating mechanism of stripper 800 begins lowering, neutral position limit switch 4–LS initially becomes actuated and contacts 4–LS–U (line 181) open at T–88, without further effect. Also, when the operating mechanism of stripper 800 reaches its lower position, limit switch 4–LS is again actuated, causing contacts 4–LS–D (line 320) to close at T–90, thereby energizing control relay 52–CR (line 320) at T–91.

It will be recalled that, at T–81, control relay 14–TR (line 197) became de-energized and its time-delay contacts 14–TR (line 202) started their time-delay period during which time they remain closed. At the end of this time-delay period (T–87) contacts 14–TR (line 202) open, thereby de-energizing control relay 15–CR (line 203) at T–88. The de-energization of control relay 15–CR causes its contacts 15–CR (line 315) to open, thereby de-energizing valve solenoids 2–SOL–VR (line 315), 3–SOL–D (line 310) and 4–SOL–D (line 313) at T–89. However, there is no further effect as a result of the foregoing.

The energization of control relay 52–CR (line 320) at T–91 causes its two sets of contacts 52–CR in line 316 to close, thereby energizing valve solenoid 3–SOL–U (line 316) at T–92. Referring to FIG. 77, the energization of valve solenoid 3–SOL–U causes vacuum lifter 780 to start raising (while stripper 800 remains held down). Thus, limit switch contacts 3–LS–D (line 325) open at T–93. This, in turn, causes control relay 54–CR (line 325) to become de-energized at T–94. When control relay 54–CR becomes de-energized, its contacts in line 322 open, thereby de-energizing control relay 53–CR (line 323) at T–95, without further effect.

When vacuum lifter 780 (FIG. 77) reaches its upper position, limit switch contacts 3–LS–U (line 326) close, thereby energizing control relay 55–CR (line 326) at T–96.

Before going into a discussion of the sequential actions that follow the energization of control relay 55–CR at this time, the effect of the foregoing operations will be considered. It will be recalled that, after ply 1 was cut-to-length, its remnant was lowered to main conveyor belt 400 by vacuum lifter 780, the vacuum in chamber 783 was removed, and the operating mechanism of stripper 800 was lowered. Consequently, the subsequent raising of vacuum lifter 780, while stripper 800 was held down, caused the remnant piece of fabric from ply 1 to be stripped from vacuum lifter 780 and deposited onto main conveyor belt 400.

Resuming the discussion of the sequential actions that follow the energization of control relay 55–CR (line 326) at T–96, when this relay becomes energized its contacts 55–CR (line 321) close, thereby energizing valve solenoid 4–SOL–U (line 321) at T–97. Referring to FIG. 77, the energization of valve solenoid 4–SOL–U causes stripper 800 to begin to rise towards its upper position.

When stripper 800 starts moving up, limit switch contacts 4–LS–D (line 320) open (T–98), thereby de-energizing control relay 52–CR (line 320) at T–99. This, in turn, causes the two sets of contacts 52–CR in line 316 to open, resulting in the de-energization of valve solenoid 3–SOL–U (line 316) at T–100. However, no action follows as a result of this.

When stripper 800 (FIG. 77) reaches its raised position, contacts 4–LS–U (line 181) close (T–100), thereby causing control relay 11–CR (line 182) to become energized at T–101. The energization of control relay 11–CR initiates the next sequence of actions during which the remnant of ply 1 is moved upstream to the backup position while ply 1 remains raised and offset on mechanical lifter frame 960.

As a result of the energizing of control relay 11–CR (line 182) contacts 11–CR (line 218) close, thereby energizing main conveyor high speed motor control relay 7–MH (line 224) and timing relay 21–TR (line 225) at T–102. Motor control relay 7–MH (line 224) is energized through a circuit including the following contacts: 11–CR (line 218), 12–CR (line 218), 27–CR (line 218), 19–CR (line 218), 56–CR (line 218), and 6–LS–F (line 219). Timing relay 21–TR (line 225) is energized by the same circuit that energizes motor control relay 7–MH plus the addition of contacts 27–CR (line 226), which are closed at this time.

The energization of motor control relay 7–MH (line 224) causes its contacts 7–MH (line 230) to open, thereby de-energizing control relay 24–CR (line 231) at T–103; however, no further action results from this. In addition, the energization of motor control relay 7–MH (line 224) results in the closing of its contacts 7–MH in lines 147, 148 and 149. Since conveyor reverse control relay 7–MR (line 236) has previously been energized, its contact 7–MR in lines 147, 148 and 149 are also closed. Thus, the high speed windings of main conveyor drive motor MTR–7 (line 145) become energized and reverse rotation of the motor at high speed occurs. Main conveyor belt 400 thus begins moving in reverse to carry the remnant piece of fabric from ply 1 approximately six feet upstream to the backup position of the conveyor.

When main conveyor belt 400 starts moving upstream, contacts 1–RVC (line 194) close due to the fact that revolution counter 1–RVC begins its counting period. Thus, referring to FIG. 93, the counting or timing period of revolution counter 1–RVC begins at T–103.

With main conveyor belt 400 moving upstream, the upstream edge of the remnant piece of fabric from ply 1 blocks the light beam between slow down photocell 1–EYE (line 281) and its lamp 842 (line 282), thereby causing sensing relay 41–SR (line 280) to de-energize at T–104. Shortly thereafter, the downstream edge of the remnant piece of fabric from ply 1 uncovers the light beam between photocell 2–EYE (line 284) and its lamp 843 (line 285), thereby causing sensing relay 42–SR (line 283) to become energized at T–105. When sensing relay 41–SR (line 280) de-energizes at T–104, its contacts 41–SR (line 240) open, thereby de-energizing control relay 41–CR (line 239) at T–105, without further effect. Similarly, when sensing relay 42–SR (line 283) energizes at T–105, its contacts 42–SR (line 276) close, thereby energizing control relay 42–CR (line 276) at T–106, without further effect.

As the upstream movement of main conveyor belt 400 continues, the downstream edge of the remnant piece of fabric from ply 1 soon unblocks the light beam between photocell 1–EYE (line 281) and its lamp 842 (line 282), thereby resulting in the energization of sensing relay 41–SR at T–106. When this relay energizes, contacts 41–SR (line 240) close, thereby energizing control relay 41–CR (line 239) at T–107. However no further action results from this occurrence.

Eventually, the upstream movement of main conveyor belt 400 carries the remnant piece of fabric from ply 1 to the backup position. This position is reached when revolution counter 1–RVC (line 259) completes its counting period. Referring to FIG. 93, this occurs at T–108, and, consequently, contacts 1–RVC (line 194) open at T–108 when "count out" is reached. With the opening of contacts 1–RVC in line 194, control relay 12–CR (line 190) becomes de-energized at T–109. This, in turn, results in the opening of contacts 12–CR (line 218). When this happens, conveyor high speed motor control relay 7–MH (line 224) and timing relay 21–TR (line 225) become de-energized at T–110.

Although timing relay 21–TR (line 225) becomes de-energized at T–110, its contacts 21–TR in line 228 remain open and its contacts 21–TR (line 229) remain closed for a time-delay period of approximately 0.3 second duration, the time-delay period ending at T–113.

With the de-energization of motor control relay 7–MH (line 224) at T–110, its contacts 7–MH (line 228) close, thereby energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–111 via contacts 21–TR (line 229) which remain closed during their time-delay period. In addition, contacts 7–MH in lines 147, 148 and 149 open, de-energizing the high speed windings of main conveyor drive motor MTR–7.

The energization of motor control relay 7–ML results in the closing of its contact 7–ML (lines 144, 145 and 146) to thereby energize the low speed windings of main conveyor drive motor MTR–7 (line 145). Also, with the energization of timing relay 23–TR, its contacts 23–TR in line 230 immediately close and its contacts 23–TR in line 231 immediately open. Thus, conveyor brake control relay 7–MB (line 230) becomes energized at T–112 via contacts 23–TR (line 230).

With the energization of conveyor brake control relay 7–MB, its contact 7–MB in lines 151, 152 and 153 close, causing a D.C. voltage to be applied to one leg of the high speed windings of main conveyor drive motor MTR–7 (line 145). This, in turn, results in rapid deceleration of the motor to its crawling speed.

Shortly thereafter, time-delay contacts 21–TR (line 229) open, de-energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–114. After a short time-delay period (approximately 0.2 second) contacts 23–TR (line 230) open, thereby de-energizing conveyor brake control relay 7–MB (line 230) at T–117, and contacts 23–TR (line 231) close, thereby energizing control relay 24–CR (line 231) at T–117.

During the time-delay period between the de-energization of conveyor low speed motor control relay 7–ML (line 228) and the de-energization of conveyor brake control relay 7–MB (line 230), a D.C. voltage is applied to main conveyor drive motor MTR–7 (line 145) while no A.C. voltage is applied to the motor. Thus the main conveyor drive motor MTR–7 is dynamically braked and quickly comes to a stop during this time-delay period.

The energization of control relay 24–CR (line 231) at T–117 initiates the next sequence of events that occur in the electrical control system. When control relay 24–CR energizes, its contacts 24–CR (line 165) close, thereby energizing operation selector stepping relay CR–OS (line 165) at T–118 from line 265. The energization circuit to stepping relay CR–OS at this time includes the following contacts: 30–CR (left side of line 272), 27–CR (line 271), 1–RVC (line 272), 53–CR (line 272), 30–CR (right side of line 272), 2–SS (line 272), 14–TR (line 272), CR–OS–17A (line 265), C–RA (line 165), PB–7 (line 165), 10–CR (line 165) and 24–CR (line 165). Thus, at T–118, operation selector stepping relay CR–OS (line 165) becomes energized and starts indexing from position 3 to position 4.

At the start of indexing, contacts CR–OS (line 170) open, thereby de-energizing control relay 10–CR (line 170) at T–119. Contacts 10–CR (line 180) thus de-energize control relay 11–CR (line 182) at T–120; however, no further action results therefrom. Also, contacts 10–CR (line 197) close, thereby energizing timing relay 14–TR (line 197) at T–120. Again no sequential action occurs. In addition, contacts 10–CR (line 165) open, thereby de-energizing operation selector stepping relay CR–OS (line 165) at T–120 and completing the indexing of this relay into position 4. The de-energization of stepping relay CR–OS (line 165) at this time causes control relay 10–CR (line 170) to become energized at T–121 by virtue of the closing of its contacts CR–OS in line 170.

E. Stepping Relay CR–OS in Position 4: Referring to FIG. 90, when operation selector stepping relay CR–OS shifts to position 4, the following changes occur in the condition of its contacts: contacts CR–OS–3 (line 329) open; contacts CR–OS–4 (line 207) close; contacts CR–OS–1A (line 234) close; contacts CR–OS–2A (line 236) open; contacts CR–OS–12A (line 185) open; contacts CR–OS–13A (line 259) open; contacts CR–OS–15A (line 218) close; and, contacts CR–OS–17A (line 265) open.

The opening of contacts CR–OS–3 (line 329) results in the de-energization of valve solenoid 6–SOL–F (line 330), without further effect, and in the de-energization of position 3 lamp 1192 (line 329).

The closing of contacts CR–OS–4 (line 207) results in the energization of revolution counter 2–RVC (line 206), in the energization of control relay 17–CR (line 207), and in the lighting of position 4 lamp 1193 (line 208). However, no further sequential actions result from the foregoing.

The closing of contacts CR–OS–1A (line 234) causes conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235) to become energized, the energization of conveyor forward control relay 7–MF resulting in the closing of its contact 7–MF in lines 144, 145 and 146. However, no further sequential action occurs from the foregoing.

The opening of contacts CR–OS–2A (line 236) results in the concurrent de-energization of conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237), the de-energization of conveyor reverse control relay 7–MR (line 236), in turn, causing its contacts 7–MF in lines 147, 148 and 149 to open without further effect.

The opening of contacts CR–OS–12A (line 185) results in no sequential follow-up action.

The opening of contacts CR–OS–13A (line 259) causes revolution counter 1–RVC (line 259) to become de-energized, control relay 30–CR (line 260) to become de-energized, and control relay 29–CR (line 258) to become de-energized, the latter relay not being identified on the sequential action diagrams of FIGS. 91 through 111.

The closing of contacts CR–OS–15A (line 218) results in no additional sequential action.

Finally, the opening of contacts CR–OS–17A (line 265) results in the removal of the indexing voltage that was employed in indexing operation selector stepping relay CR–OS (line 165) from position 3 to position 4.

It will be recalled that when operation selector stepping relay CR–OS shifted into position **4**, control relay **10**–CR (line **170**) became energized at T–**121** due to the closing of contacts CR–OS (line **165**) upon de-energization of the stepping relay. As a result of this, contacts **10**–CR (line **180**) close, thereby energizing control relay **11**–CR (line **182**) at T–**122**, without further effect. Similarly contacts **10**–CR (line **197**) open, thereby de-energizing timing relay **14**–TR (line **197**) at T–**122**. Although timing relay **14**–TR de-energizes at this time, its time-delay contacts **14**–TR (line **202**) remain closed during the timing period that follows (T–**122** through T–**128**). In addition to the foregoing, contacts **10**–CR (line **203**) close, thereby causing control relay **15**–CR (line **203**) to become energized at T–**122** through the above-mentioned closed time-delay contacts **14**–TR (line **202**).

When control relay **15**–CR (line **203**) energizes, its contacts in line **315** close, thereby causing valve solenoids **2**–SOL–VR (line **315**) and **5**–SOL–D (line **314**) to become energized at T–**123**. The circuit through which valve solenoid **2**–SOL–VR becomes energized includes contacts **15**–CR (line **315**), contacts **26**–CR (line **315**), contacts **52**–CR (line **314**), and contacts **24**–CR (line **314**). The circuit by which valve solenoid **5**–SOL–D (line **314**) becomes energized includes all of the aforementioned contacts, and, in addition, includes contacts **27**–CR (line **314**).

Referring to FIG. 77 the energization of solenoid valve **2**–SOL–VR has no effect on vacuum chamber **783** of vacuum lifter **780** due to the fact that this chamber had previously been connected to atmosphere. The energization of valve solenoid **5**–SOL–D, on the other hand, causes frame **960** of mechanical lifter unit F to start lowering (while it is still in its offset condition).

When mechanical lifter frame **960** starts lowering, contacts **5**–LS–U (line **327**) open, thereby de-energizing control relay **56**–CR (line **327**) at T–**125**; however, no further sequential action results from this. When mechanical lifter frame **960** reaches its lower position, contacts **5**–LS–D (line **328**) close, thereby energizing control relay **57**–CR (line **328**) at T–**127**. However, here again, no further sequential action results.

As mentioned earlier, time-delay contacts **14**–TR (line **202**) open at T–**128** when their time-delay period expires. This causes control relay **15**–CR (line **203**) to become de-energized at T–**129**. With the de-energization of control relay **15**–CR, its contacts **15**–CR in line **315** open, thereby de-energizing valve solenoids **2**–SOL–VR (line **315**) and **5**–SOL–D (line **314**) at T–**130**. However, no further sequential action results from the de-energization of these solenoids. Thus, at T–**130**, the electrical control system of the apparatus becomes inactivated pending the arrival of a signal from the operator at the tire building station to begin preparation of ply **2**.

The reason for awaiting an operator's signal at this time is that ply **1** is now resting on main conveyor belt **400** (FIG. 77), at its downstream end, and, prior to starting the main conveyor belt in a forward direction, the applicator conveyor belt **1061** must be free to receive this ply. Assuming the operator at tire building station J has wound ply **4** of the previous carcass on building drum **1060** and that, therefore, applicator conveyor belt **1061** is free to receive ply **1**, the operator's signal will be introduced into the electrical control system of FIGS. 78 through 88 by the depression of pushbutton switch PB–**8** (line **186**). This has been illustrated as occurring during the waiting period between T–**130** and T–**132** on FIG. 93.

It will be apparent that the manual depression of pushbutton switch PB–**8** (line **186**) may be obviated by substituting an automatic signal therefor. Such an automatic signal could be derived from the movement of second applicator means **1064** (FIG. 77). Thus, when second applicator means **1064** is moved to its retracted position for the second time during each carcass building cycle (after applying ply **4**), this movement could be used to energize a relay having a set of contacts in line **186** that replace the contacts of pushbutton switch PB–**8** in that line. Additional circuitry would, of course, be needed in an arrangement of this type to insure that the added relay contacts were open at all times other than when an operator's signal is required to start the main conveyor belt **400** moving in a forward direction.

When the operator's signal is applied during the waiting period between T–**130** and T–**132** by the depression of pushbutton switch PB–**8**, control relay **12**–CR (line **190**) becomes energized at T–**132** through a circuit including the following contacts: PB–**8** (line **186**); **31**–CR (line **192**); **32**–CR (line **192**); **30**–CR (line **190**); **2**–RVC (line **191**); **3**–RVC (line **191**); **4**–RVC (line **191**); **16**–CR (line **191**); and, **19**–CR (line **191**).

With the energization of control relay **12**–CR (line **190**), its contacts in line **188** close, thereby providing an alternate path of energization for control relay **12**–CR so that the subsequent release of pushbutton PB–**8** (line **186**) does not de-energize this relay. In addition, contacts **12**–CR in line **218** close, thereby energizing conveyor high speed motor control relay **7**–MH (line **224**) at T–**133** through a circuit including the following contacts: **11**–CR (line **218**), **12**–CR (line **218**), **26**–CR (line **220**), **64**–CR (line **221**), **57**–CR (line **221**), **22**–TR (line **224**), **64**–CR (line **223**), **25**–TR (line **224**), and **27**–CR (line **223**).

With the energization of conveyor high speed motor control relay **7**–MH at T–**133**, its contacts **7**–MH (line **213**) close, thereby energizing timing relay **18**–TR (line **213**) at T–**134**. The contacts of this delay in lines **240** and **245** thereupon start their time-delay periods (of approximately 0.6 second) prior to changing condition; however, no further sequential actions occur due to the shifting of these contacts at the end of the timing period.

The energization of motor control relay **7**–MH (line **224**) at T–**133** also causes its contacts **7**–MH (line **230**) to open, thereby de-energizing control relay **24**–CR (line **231**) at T–**134**, without further effect. In addition, contacts **7**–MH (line **240**) close, resulting in the energization of time relay **28**–TR (line **240**) and in the energization of clutch **3**–CLU (line **243**) at T–**134**, the clutch **3**–CLU being energized via a bridge rectifier **4**–REC (line **242**). The energization of timing relay **28**–TR (line **240**) causes no further sequential actions; however, the energization of clutch **3**–CLU causes applicator conveyor belt **1061** (FIG. 77) to become coupled to the main conveyor drive motor MTR–**7** for subsequent driving thereby.

A further action resulting from the energization of conveyor high speed forward motor control relay **7**–MH at T–**138** is that its contacts in lines **147**, **148** and **149** close, thereby exciting the high speed windings of main conveyor drive motor MTR–**7** (line **145**). Hence this motor begins driving at high speed in a forward direction. Since applicator conveyor belt **1061** (FIG. 77) is coupled to main conveyor drive motor MTR–**7**, both applicator conveyor belt **1061** and main conveyor belt **400** begin moving downstream at high speed. Accordingly, ply **1**, which was formerly carried at the downstream end of main conveyor belt **400**, begins moving onto applicator conveyor belt **1061**, while the remnant piece of fabric from ply **1**, which was formerly at the backup position on main conveyor belt **400**, starts moving downstream towards splicing mechanism D.

With the downstream movement of ply **1**, its trailing edge soon uncovers the light beam between lamp **1052** (line **289**) and photocell **3**–EYE (line **288**). This causes sensing relay **43**–SR (line **286**) to become energized at T–**136**. The energization of sensing relay **43**–SR causes its contacts in line **300** to close, thereby energizing control relay **43**–CR (line **300**) at T–**137**. This, in turn, causes the energization of timing relay **25**–TR (line **233**) at T–**138** by virtue of the closing of contacts

43–CR in line **232**. No further sequential action results from this.

As ply **1** continues to move downstream on main conveyor belt **400** onto applicator conveyor belt **1061**, its trailing edge uncovers the light beam between lamp **1053** (line **293**) and photocell **4**–EYE (line **292**), thereby energizing sensing relay **44**–SR (line **290**) at T–**137**. This causes contacts **44**–SR (line **302**) to close, thereby energizing control relay **44**–CR (line **302**) at T–**138**; however, no further sequential action occurs therefrom, and ply **1** continues transferring to applicator conveyor belt **1061**.

As indicated earlier, the remnant piece of fabric from ply **1** moves downstream on main conveyor belt **400** while ply **1** transfers from the main conveyor belt to applicator conveyor belt **1061**. Hence, the lending edge of this remnant eventually blocks the light beam between photocell **1**–EYE (line **281**) and its lamp **842** (line **282**). This causes sensing relay **41**–SR (line **280**) to become de-energized at T–**138**.

The de-energization of sensing relay **41**–SR causes its contacts in line **240** to open, thereby concurrently de-energizing clutch **3**–CLU (line **243**), timing relay **28**–TR (line **240**), and control relay **41**–CR (line **239**) at T–**139**. Similarly, contacts **41**–SR (line **227**) close, thereby energizing timing relay **22**–TR (line **227**) at T–**139**. When clutch **3**–CLU de-energizes, applicator conveyor belt **1061** (FIG. 77) becomes uncoupled from main conveyor drive motor MTR–**7** preparatory to the stopping of the applicator conveyor belt. When timing relay **28**–TR de-energizes, its time delay contacts in line **246** start their time-delay period of approximately one second duration before opening at T–**149**. When timing relay **22**–TR energizes, its contacts in line **224** immediately open, without further effect. When control relay **41**–CR de-energizes at T–**139**, however, a sequence of actions involving the braking of applicator conveyor belt **1061** begins.

With the de-energization of control relay **41**–CR (line **239**), its contacts in line **246** close, thereby energizing applicator conveyor brake **3**–BRK (line **245**) at T–**140** via the still closed time-delay contacts **28**–TR (line **246**) and bridge rectifier **5**–REC (line **246**). Thus, the applicator conveyor belt **1061** quickly comes to a stop with ply **1** entirely on the conveyor, at its upstream end.

In the meantime, the leading edge of the remnant piece of fabric from ply **1** continues downstream on main conveyor belt **400** and soon blocks the beam between lamp **843** (line **285**) and photocell **2**–EYE (line **284**). This causes sensing relay **42**–SR (line **283**) to become de-energized at T–**139**. With the de-energization of sensing relay **42**–SR, its contacts **42**–SR (line **276**) open, thereby de-energizing control relay **42**–CR (line **276**) at T–**140**. This, in turn, causes control relay **32**–CR (line **263**) to become energized at T–**141** by virtue of the closing of contacts **42**–CR (line **264**). However, no further sequential action results from the energization of control relay **32**–CR.

As the downstream movement of main conveyor belt **400** continues, the trailing edge of the remnant piece of fabric uncovers the light beam between lamp **842** (line **282**) and photocell **1**–EYE (line **281**). This causes sensing relay **41**–SR (line **280**) to become energized at T–**140**. The energization of sensing relay **41**–SR causes its contacts in line **240** to close, thereby energizing control relay **41**–CR (line **239**) at T–**141**. Also, contacts **41**–SR (line **227**) open, thereby de-energizing timing relay **22**–TR (line **227**) at T–**141**. However, contacts **22**–TR (line **224**) start their time delay period of approximately three seconds at this time and, thus, no further action results due to the de-energizing of timing relay **22**–TR (line **227**).

With the energization of control relay **41**–CR (line **239**) at T–**141**, its contacts **41**–CR (line **223**) open, and, since time-delay contacts **22**–TR (line **224**) are open, conveyor high speed motor control relay **7**–MH (line **224**) becomes de-energized at T–**142**. With the de-energization of motor control relay **7**–MH, its contacts in line **213** open, thereby de-energizing timing relay **18**–TR (line **213**) at T–**143**. This causes contacts **18**–TR (line **245**) to immediately open, de-energizing applicator conveyor brake **3**–BRK (line **245**) at T–**144**. Also, contacts **7**–MH (line **228**) close, thereby concurrently energizing conveyor low speed motor control relay **7**–ML (line **228**) and conveyor brake timing relay **23**–TR (line **229**) at T–**143**. Similarly, contacts **7**–MH in lines **147**, **148** and **149** open to de-energize the high speed windings of main conveyor drive motor MTR–**7** (line **145**); however, immediately thereafter, contacts **7**–ML in lines **144**, **145** and **146** close, thereby energizing the low-speed windings of motor MTR–**7**.

In addition to the foregoing, with the energization of conveyor brake timing relay **23**–TR at T–**143**, contacts **23**–TR (line **230**) immediately close, energizing conveyor brake relay **7**–MB (line **230**) at T–**144**. Thus, contacts **7**–MB (lines **151**, **152** and **153**) close, thereby applying a D.C. voltage to one leg of the high speed windings of main conveyor drive motor MTR–**7** (line **145**). This causes main conveyor drive motor MTR–**7** to slow down to a crawling speed.

Depending on the length of the remnant piece of fabric from ply **1**, the trailing edge of the remnant soon uncovers the light beam between lamp **843** (line **285**) and photocell **2**–EYE (line **284**). This causes sensing relay **42**–SR (line **283**) to become energized at T–**144**. When sensing relay **42**–SR energizes, its contacts in line **193** open, thereby de-energizing control relay **12**–CR (line **190**) at T–**145**, and its contacts **42**–SR in line **276** close, thereby energizing control relay **42**–CR (line **276**) at T–**145**.

The energization of control relay **42**–CR (line **276**) causes its contacts in line **273** to close, thereby energizing control relay **33**–CR at T–**146**. This, in turn, causes contacts **33**–CR in line **265** to open, de-energizing control relay **32**–CR (line **263**) at T–**147** without further effect. Similarly, with the de-energizing of control relay **12**–CR (line **190**) at T–**145**, its contacts **12**–CR in line **218** open, thereby concurrently de-energizing conveyor low speed motor control relay **7**–ML (line **228**) and conveyor brake timing relay **23**–TR (line **229**) at T–**146**.

The de-energization of conveyor low speed motor control relay **7**–ML (line **228**) at T–**146** causes its contacts in lines **144**, **145** and **146** to open, de-energizing the low speed windings of main conveyor drive motor MTR–**7** (line **145**). Similarly, the de-energization of timing relay **23**–TR (line **229**) at T–**146** causes its time-delay contacts in lines **230** and **231** to begin their timing period of approximately 0.2 second (contacts **23**–TR in line **230** remaining closed during this period and contacts **23**–TR in line **231** remaining open during this period).

Referring to FIG. 79, and remembering that both of the motor control relays **7**–MH and **7**–ML are de-energized while the conveyor braking relay **7**–MB is energized, it will be seen that D.C. voltage is being applied to one leg of the high-speed windings of main conveyor drive motor MTR–**7** while all A.C. excitation has been removed from the motor. Thus, motor MTR–**7** is dynamically braked to a quick stop with the trailing edge of the remnant piece of fabric from ply **1** positioned beneath vacuum lifter **780** of the splicing mechanism D (FIG. 77).

When the timing period of time-delay relay **23**–TR (line **229**) ends at T–**148**, its contacts in line **230** open, thereby de-energizing conveyor brake relay **7**–MB (line **230**) at T–**149**, while its contacts **23**–TR (line **231**) close, thereby energizing control relay **24**–CR (line **231**) at T–**149**. The de-energization of conveyor brake relay **7**–MB (line **230**) causes its contacts **7**–MB (lines **151**, **152** and **153**) to open, thereby removing the D.C. voltage from the high speed windings of main conveyor drive motor MTR–**7** (line **145**), but no further sequential action results.

The energization of control relay **24–CR** (line **231**) at T–**149**, on the other hand, initiates two concurrent, yet separate, sequences of actions in the electrical control system. In one sequence of actions, extending from T–**150** through T–**176** (FIGS. 93 and 94), the trailing edge of the remnant piece of fabric from ply **1** is lifted by vacuum lifter **780** and mechanical lifter frame **960** (FIG. 77) to await the arrival of a new, wide width, rhomboidal section of fabric that will be spliced to the remnant. In the second sequence of actions a new, wide width, rhomboidal section of fabric is cut by bias cutter A (FIG. 75) and deposited on main conveyor belt **400** for subsequent delivery to splicing mechanism D. This sequence of actions occurs between T–**150** (FIG. 106) and T–**188** (FIG. 107).

The electrical action line starting when control relay **24–CR** energizes at T–**149** and extending downwardly to a point below all of the horizontal component lines of FIG. 93 serves to indicate that a signal from control relay **24–CR** is being applied to the bias cutter sequential action charts of FIGS. 106 through 111. The energization of control relay **24–CR** at T–**149** is duplicated in FIG. 106 at T–**149** to show the interrelation between FIGS. 93 and 106.

The sequence of actions involving the raising of the trailing edge of the remnant piece of fabric from ply **1** will be considered next, and, when this is completed, the sequence of actions involving the cutting of the new, wide width, rhomboidal section of fabric will be treated.

Referring to FIG. 93, the energization of control relay **24–CR** (line **231**) at T–**149** causes its contacts **24–CR** (line **310**) to close, thereby energizing valve solenoids **2–SOL–VO** (line **309**) and **3–SOL–D** (line **310**) at T–**150**. Valve solenoid **2–SOL–VO** (line **309**) is energized via a circuit including contacts **33–CR** (line **310**), contacts **24–CR** (line **310**), and the normally closed contacts of selector switch **4–SS** in line **310**. Valve solenoid **3–SOL–D** (line **310**) is energized by a circuit having the same contacts as those in the case of valve solenoid **2–SOL–VO** and also including contacts **53–CR** (line **310**), the normally closed contacts of selector switch **5–SS** (line **310**), and contacts **52–CR** (line **310**).

Referring to FIG. 77, the energization of valve solenoid **2–SOL–VO** causes a vacuum to be applied to vacuum chamber **783** of vacuum lifter **780**, without further effect, while the energization of valve solenoid **3–SOL–D** causes vacuum lifter **780** to start moving toward its lower position. When vacuum lifter **780** starts moving down, contacts **3–LS–U** (line **326**) open, thereby de-energizing control relay **55–CR** (line **326**) at T–**152**. The de-energization of control relay **55–CR**, in turn, causes contacts **55–CR** in line **321** to open, thereby de-energizing valve solenoid **4–SOL–U** (line **321**) at T–**153**; however, no further action results from this. Similarly, the de-energization of control relay **55–CR** (line **326**) causes contacts **55–CR** in line **182** to open, thereby de-energizing control relay **11–CR** (line **182**), at T–**153**, without further effect.

When vacuum lifter **780** (FIG. 77) reaches its lower position, contacts **3–LS–D** (line **325**) close, thereby energizing control relay **54–CR** (line **325**) at T–**154**. This causes contacts **54–CR** in line **322** to close, energizing control relay **53–CR** (line **323**) at T–**155**. Referring to FIGS. 85 and 94, when control relay **53–CR** energizes at T–**155**, its contacts in line **310** open, thereby de-energizing valve solenoid **3–SOL–D** (line **310**), at T–**156**, without further effect. Similarly, its contacts **53–CR** (line **317**) close, thereby energizing timing relay **51–TR** (line **319**) and valve solenoid **6–SOL–R** (line **318**) at T–**156**. However, since time-delay contacts **51–TR** (line **317**) must go through approximately 0.8 second of time delay before following the movement of timing relay **51–TR**, further sequential actions resulting from the energization of timing relay **51–TR** await the completion of this time-delay period at T–**164**.

Referring to FIG. 77, the energization of valve solenoid **6–SOL–R** at T–**156**, on the other hand, causes mechanical lifter frame **960** to start shifting from its offset position back to its home position, the frame **960** being in its lowered position (below main conveyor belt **400**) when this occurs. As frame **960** starts moving from its offset position toward its home position, contacts **6–LS–F** (line **219**) open, without further effect, at T–**157**. When frame **960** reaches its home position, contacts **6–LS–R** in line **317** close (T–**159**), but again no further sequential actions follow.

At T–**164**, time-delay contacts **51–TR** (line **317**) complete their 0.8 second time-delay period and close, thereby causing valve solenoid **3–SOL–U** (line **316**) to become energized at T–**165**. Referring to FIG. 77, the energization of valve solenoid **3–SOL–U** causes vacuum lifter **780** to start raising. Since vacuum chamber **783** was under a vacuum during the time-delay period of contacts **51–TR** (line **317**), the trailing edge of the remnant piece of fabric from ply **1** clings to vacuum lifter **780** and begins rising along with the vacuum lifter. When vacuum lifter **780** starts to raise, contacts **3–LS–D** (line **325**) open, thereby de-energizing control relay **54–CR** (line **325**) at T–**167**, without further effect.

When vacuum lifter **780** reaches its raised position, contacts **3–LS–U** (line **326**) close, energizing control relay **55–CR** (line **326**) at T–**169**. This results in the closing of contacts **55–CR** (line **317**), causing valve solenoid **5–SOL–U** (line **317**) to become energized at T–**170**. Also, contacts **55–CR** (line **321**) close, thereby energizing valve solenoid **4–SOL–U** (line **321**) at T–**170**. Similarly, contacts **55–CR** (line **182**) close, thereby causing control relay **11–CR** (line **182**) to become energized, at T–**170**, without further effect.

Since the operating mechanism for stripper **800** (FIG. 77) had previously been up, and since stripper **800** moves up with vacuum lifter **780** when the vacuum lifter is raised, the energization of valve solenoid **4–SOL–U** at T–**170** causes no further action. On the other hand, the energization of valve solenoid **5–SOL–U** at T–**170** causes mechanical lifter frame **960** to start raising from its lower to its upper position. When frame **960** starts moving up, contacts **5–LS–D** (line **328**) open, thereby deenergizing control relay **57–CR** (line **328**) at T–**172**. This causes contacts **57–CR** in line **317** to open, thereby concurrently deenergizing timing relay **51–TR** (line **319**), valve solenoid **6–SOL–R** (line **318**), valve solenoid **5–SOL–U** (line **317**), and valve solenoid **3–SOL–U** (line **316**), all at T–**173**; however, no further sequential actions result from these occurrences.

When mechanical lifter frame **960** reaches its raised position, contacts **5–LS–U** (line **327**) close, thereby energizing control relay **56–CR** (line **327**) at T–**174**. This causes contacts **56–CR** (line **195**) to close, energizing timing relay **13–TR** (line **195**) at T–**175**. The energization of timing relay **13–TR** causes its time-delay contacts in line **180** to immediately open, thereby de-energizing control relay **11–CR** (line **182**) at T–**176**, and causes its time-delay contacts **13–TR** in line **187** to immediately close, thereby energizing control relay **12–CR** (line **190**) at T–**176**.

Neither the de-energization of control relay **11–CR** nor the energization of control relay **12–CR**, at T–**176**, causes any further sequential action to occur in the electrical control system. Hence, the electrical circuits represented by the sequential action chart of FIG. 94 remain inactive from T–**176** through T–**188**, while waiting for the bias cutter to complete the sequence of actions involving the cutting of a new, wide width, rhomboidal section of fabric and the depositing of this section of fabric onto main conveyor belt **400**. This waiting period has been emphasized in FIG. 94 by the omission of vertical "time" lines between T–**180** and T–**187**.

Before considering in detail the bias-cutter actions stemming from the energization of control relay **24–CR** (line **231**) at T–**149** (FIGS. 94 and 106), a preliminary discussion relative to the status of bias-cutter A (FIG. 75) at that time is appropriate. Referring to FIG. 75, cutting position stop assembly **295** is up, preparatory to stopping the movement of fabric pull out carriage **55** in its subsequent fabric metering stroke. In addition, fabric width and drop control unit **275** is set for wide width operation. Also, fabric pull out carriage **55** is in its starting, or home, position (near fabric cutting unit **200**), and dancer roller **40** is down.

As a result of the foregoing, the following conditions exist in the bias-cutter circuits at T–**149**. Contacts **14**–LS–U (line **352**) are closed because cutting position stop assembly **295** is up. Contacts **12**–LVS–R (line **381**) are closed, sensing relay **67**–SR (line **380**) is energized, and contacts **67**–SR (line **352**) are closed, due to carriage **55** being at its home position. Contacts **11**–LS–RA (line **354**) and **11**–LS–FA (line **354**) are closed, while contacts **11**–LS–RB (line **356**) and **11**–LS–FB are open, due to the fabric width and drop control unit **275** being set for wide width operation. And finally, contacts **20**–LS–B (line **358**) are closed, due to dancer roller **40** being in its lower position.

Accordingly, referring to FIGS. 87 and 106, when control relay **24**–CR (line **231**) becomes energized at T–**149**, its contacts **24**–CR in line **358** close, thereby concurrently energizing valve solenoid **12**–SOL–F (line **358**) and the latching coil **62**–CRL (line **359**) of a dual coil latching relay at T–**150**. The second, unlatching, coil **62**–CRU of this latching relay is in line **373**. Coils **62**–CRL and **62**–CRU are mechanically interlocked and control contacts **62**–CRL in lines **353**, **359** and **369** in the following manner. Referring to FIGS. **87**, **106** and **107**, when latching coil **62**–CRL (line **359**) is energized, contacts **62**–CRL in lines **353** and **359** close, while contacts **62**–CRL in line **369** open. Thereafter, when latching coil **62**–CRL de-energizes (as at T–**158**), these contacts remain in the above condition (as indicated by the broken heavy component line for **62**–CRL between T–**158** and T–**189**). Finally, when unlatching coil **62**–CRU (line **373**) energizes (as at T–**188**), contacts **62**–CRL in lines **353** and **359** open, while contacts **62**–CRL in line **369** close (as indicated at T–**189**). The subsequent de-energization of unlatching coil **62**–CRU (as at T–**222**) does not affect any of the contacts **62**–CRL.

When latching coil **62**–CRL (line **359**) energizes at T–**150**, contacts **62**–CRL in lines **353** and **359** close to provide an alternate energization path for valve solenoid **12**–SOL–F (line **358**) and latching coil **62**–CRL (line **359**). In addition, contacts **62**–CRL in line **369** open, thereby deenergizing valve solenoid **12**–SOL–R (line **369**) at T–**151**.

It will be recalled that valve solenoid **12**–SOL–F (line **358**) was energized at T–**150**. With the energization of valve solenoid **12**–SOL–F, fabric pull out carriage **55** (FIG. 75) starts moving forward (away from fabric cutting unit **200**). Since fabric gripping bar **91** had previously been lowered into engagement with the leading edge of fabric at fabric cutting unit **200**, and, since vacuum had previously been applied to vacuum chamber **94** of fabric gripping bar **91**, the forward movement of fabric pull out carriage **55** will result in the metering of a wide width section of fabric past fabric cutting unit **200**.

As carriage **55** starts moving forward, switch contacts **12**–LVS–R (line **381**) open, thereby de-energizing sensing relay **67**–SR (line **380**) at T–**153**. This causes contacts **67**–SR (line **352**) to open without further effect. Additionally, contacts **67**–SR (line **374**) open, thereby de-energizing valve solenoid **15**–SOL–D (line **374**), timing relay **65**–TR (line **375**), valve solenoid **13**–SOL–AO (line **376**) and valve solenoid **14**–SOL–U (line **377**), all without futher effect.

As fabric pull out carriage **55** moves forward, drawing fabric out of fabric let-off unit **21** (FIG. 75), dancer roller **40** starts rising and, in turn, actuates limit switch **20**–LS. This results in the opening of contacts **20**–LS–B (line **358**), without further effect, and in the closing of contacts **20**–LS–A (line **394**). The closing of contacts **20**–LS–A causes let-off forward motor control relay **4**–MF (line **396**) to become energized at T–**154**, thereby closing contacts **4**–MF in lines **127**, **128** and **129** and energizing bias-cutter let-off motor MTR–**4** (line **128**). Accordingly, let-off motor MTR–**4** begins feeding additional fabric to dancer roller **40** while carriage **55** is moving forward.

When the metallic bumper **276** on fabric pull-out carriage **55** reaches cutting position stop assembly **295**, contacts **12**–LSV–F (line **379**) close (T–**156**), thereby energizing sensing relay **66**–SR (line **378**) at T–**157**. As a result of this, contacts **66**–SR (line **352**) open, thereby de-energizing valve solenoid **12**–SOL–F (line **358**) at T–**158** and stopping the forward metering movement of fabric pull out carriage **55** (FIG. 75). The opening of contacts **66**–SR in line **352** also results in the de-energization of latching coil **62**–CRL (line **359**); however, its contacts do not shift condition for reasons mentioned earlier. Further, the opening of contacts **66**–SR in line **352** causes valve solenoid **11**–SOL–R (line **353**) to become de-energized at T–**158**, without further effect.

In addition to the foregoing, when sensing relay **66**–SR (line **378**) became energized at T–**157**, its contacts **66**–SR (line **361**) closed, thereby concurrently energizing valve solenoid **13**–SOL–VO (line **361**) and timing relay **63**–TR (line **362**) at T–**158**. Contacts **63**–TR (line **365**) are provided with approximately a one second time-delay period prior to closing upon energization of timing relay **63**–TR (line **362**). Hence, no action results immediately from the energization of this timing relay. Referring to FIG. 75, the energization of valve solenoid **13**–SOL–VO at T–**158** results in the application of a vacuum to chamber **264** of the bias-cutter table. Accordingly, the fabric beneath fabric cutting unit **200** is held securely to the table prior to the start of a cutting stroke by the fabric cutting unit.

Remembering that bias-cutter let-off motor MTR–**4** (line **128**) is sill running and that fabric pull out carriage **55** is stopped, it will be apparent (FIG. 75) that dancer roller **40** begins to move down and continues this move- until limit switch **20**–LS becomes actuated. With the actuation of limit switch **20**–LS, at T–**160**, contacts **20**–LS–B (line **358**) close, without further effect, while contacts **20**–LS–A (line **394**) open, thereby de-energizing let-off forward motor control relay **4**–MF (line **396**) at T–**161**. The de-energization of motor control relay **4**–MF causes its contacts **4**–MF (lines **127**, **128** and **129**) to open, thereby de-energizing let-off motor MTR–**4** (line **128**).

In the meantime, time-delay contacts **63**–TR (line **365**), which had previously started their time-delay period, remain open. At the end of the approximately one second timing period (T–**168**, FIG. 107) contacts **63**–TR (line **365**) close and, in turn, cause bias-cutter saw traverse forward motor control relay **5**–MF (line **365**) to become energized at T–**169**. With the energization of motor control relay **5**–MF, its contacts **5**–MF in lines **131**, **132** and **133** close, thereby energizing bias-cutter saw traverse motor MTR–**5** (line **132**) and releasing the integral brake of this motor. Referring to FIG. 75, when saw traverse motor MTR–**5** becomes energized, fabric cutting unit **200** begins its cutting stroke, during which saw **222** cuts the metered fabric into a wide width rhomboidal section.

At the start of the cutting stroke (T–**170**), limit switch **17**–LS becomes de-actuated, and its contacts **17**–LS–B (line **366**) close, while its contacts **17**–LS–A (line **364**) open. However, no immediate sequential action occurs as a result of this. When bias-cutter saw **222** reaches the far side of its cutting stroke, limit switch **16**–LS becomes actuated for a brief period of time (commencing at T–**174** and ending at T–**176**), and thus contacts **16**–LS–B (line **365**) open, while contact **16**–LS–A (line **363**) close. With the closing of contact **16**–LS–A (line **363**) valve solenoid **14**–SOL–D (line **363**) becomes energized at T–**175**. Accordingly, referring to FIG. 75, cutting position stop assembly 295 starts to move down.

The initial downward movement of stop assembly 295 causes limit switch contacts 14–LS–U (line 352) to open at T–176, without further effect, and also causes low voltage switch contacts 12–LVS–F (line 379) to open at T–176. The opening of low voltage switch contacts 12–LVS–F, in turn, causes sensing relay 66–SR (line 378) to become deenergized (at T–177). However, no further sequential action results at this time from the de-energization of this sensing relay.

Concurrently with the foregoing, bias-cutter saw 222 starts moving back on the return portion of its cutting stroke. Hence, at T–176, contacts 16–LS–A (line 363) open, while contacts 16–LS–B (line 365) close. The opening of contacts 16–LS–A (line 363) causes valve solenoid 14–SOL–D (line 363) to become de-energized, at T–177, without further effect. The closing of contacts 16–LS–B (line 365) provides an alternate energization source (via line 366) for valve solenoid 13–SOL–VO (line 361) and timing relay 63–TR (line 362).

Remembering that cutting position stop assembly 295 is moving down during the foregoing, it soon reaches its lower position and causes contacts 14–LS–D (line 351) to close at T–178. This results in the energizing of control relay 61–CR (line 351) at T–179. When control relay 61–CR energizes, its contacts 61–CR (line 355) close and complete a circuit to valve solenoid 12–SOL–F (line 358), thereby energizing this solenoid at T–180. In addition, the closing of contacts 61–CR (line 355) causes solenoid 11–SOL–R (line 353) to become energized at T–180, without further effect.

At about the same time that valve solenoid 12–SOL–F (line 358) becomes energized by contacts 61–CR (line 355), bias-cutter saw 222 (FIG. 75) completes the return portion of its cutting stroke and actuates limit switch 17–LS. This causes contacts 17–LS–A (line 364) to close (with no further effect) and causes contacts 17–LS–B (line 366) to open, the latter resulting in the de-energization of timing relay 63–TR (line 362) and valve solenoid 13–SOL–VO (line 361), at T–181, without further effect. The opening of contacts 17–LS–B also results in the de-energization of bias-cutter saw forward motor control relay 5–MF (line 365) at T–181. With the de-energization of motor control relay 5–MF, its contacts in lines 131, 132 and 133 open, thereby de-energizing bias-cutter saw traverse motor MTR–5 (line 132) and causing its integral brake to become engaged. Thus, motor MTR–5 quickly comes to a stop with saw 222 in its home position.

Returning to a consideration of valve solenoid 12–SOL–F (line 358), the energization of this solenoid at T–180 causes fabric pull out carriage 55 (FIG. 75), to start moving forward, past the now lowered cutting position stop assembly 295, towards dropping position stop assembly 320. When metallic bumper 276 of carriage 55 contacts stop assembly 320, low voltage switch contacts 12–LVS–F (line 379) close (at T–182). The closing of low voltage switch contacts 12–LVS–F causes sensing relay 66–SR (line 378) to become energized at T–183. As a result of this, contacts 66–SR (line 355) open, thereby de-energizing valve solenoid 12–SOL–F (line 358) at T–184. These contacts also cause valve solenoid 11–SOL–R (line 353) to de-energize at the same time. In addition, contacts 66–SR (line 371) close, thereby energizing valve solenoid 15–SOL–U (line 371) at T–184.

With the energization of valve solenoid 15–SOL–U (FIG. 75) fabric gripping bar 91 begins to raise, and, in addition, conduit 1150 bleeds to atmosphere. The latter action causes actuator 1151 to shift solenoid valve 1152, thereby releasing the vacuum in vacuum chamber 94 of fabric gripping bar 91. Thus, as fabric gripping bar 91 starts to raise, the vacuum in vacuum chamber 94 is released and a stripping action occurs, causing the newly cut, wide width, rhomboidal section of fabric to drop to main conveyor belt 400.

It will be recalled that fabric width and drop control unit 275 is in its wide width position. Accordingly, dropping position stop assembly 320 stopped the movement of fabric pull out carriage 55 with the center line of the cut section of fabric short of reference line X—X of FIG. 1A. Thus, the fabric being stripped from fabric gripping bar 91 drops onto main conveyor belt 400 at a position that is short of the reference line. When the fabric gripping bar 91 started raising, contacts 15–LS–D (line 375) opened (T–185), without further effect. When fabric gripping bar 91 reaches its raised position, and the section of fabric has been stripped therefrom, contacts 15–LS–U (line 372) close (T–187), thereby energizing, at T–188, control relay 64–CR (line 372) and the unlatching coil 62–CRU (line 373) of the dual coil latching relay.

Before discussing the sequential actions resulting from the energization of control relay 64–CR at T–188, the effects of unlatching coil 62–CRU will be considered. As previously described, the energization of unlatching coil 62–CRU (line 373) causes contacts 62–CRL (line 353) and contacts 62–CRL (line 359) to open, without further effect. Also, contacts 62–CRL (line 369) close, causing valve solenoid 12–SOL–R (line 369) to become energized at T–190.

Referring to FIG. 75, when valve solenoid 12–SOL–R becomes energized, fabric pull out carriage 55 begins moving from its forward position, adjacent stop assembly 320, to its home position, adjacent fabric cutting unit 200. Thus, at T–191, low voltage switch contacts 12–LVS–F (line 379) open, thereby de-energizing sensing relay 66–SR (line 378) at T–192. This, in turn, causes valve solenoid 11–SOL–R (line 353) to become energized at T–193 by virtue of the closing of contacts 66–SR (line 352). However, no further action results from this because fabric width and drop control unit 275 is already at its wide width setting.

When fabric pull out carriage 55 reaches its home position, metallic bumpers 260 and 261 (FIG. 75) contact rail 202, thereby closing low voltage switch contacts 12–LVS–R (line 381) at T–194. This causes sensing relay 67–SR (line 380) to become energized at T–195. However, no further action results therefrom, and the bias-cutter control circuits await a signal from the remaining electrical control circuits before commencing further action. This signal occurs at T–221, when control relay 53–CR subsequently becomes de-energized. As in similar earlier cases, the waiting period has been emphasized by the omission of "time lines" lines between T–197 and T–219.

The sequence of actions that begins with the energization of control relay 64–CR (line 372) at T–188 will now be considered. This sequence involves the moving of the newly cut, wide width, section of fabric to the splicing mechanism D. The electrical action line starting when control relay 64–CR becomes energized at T–188 and extending upwardly out of the top of the chart in FIG. 107 serves to indicate that a signal from control relay 64–CR is directed to the sequential action diagrams of FIGS. 91 through 105 and, in this case, indicates that control relay 33–CR becomes de-energized at T–189 in FIG. 94. The energization of control relay 64–CR at T–188 has been duplicated in FIG. 94, while the de-energization of control relay 33–CR at T–189 has been duplicated in FIG. 107, in order to better illustrate the correlation between FIGS. 94 and 107. Thus, at T–188, control relay 64–CR is shown as becoming energized, while, at T–189, control relay 33–CR is indicated as becoming de-energized by the electrical action line from control relay 64–CR.

Referring to FIG. 83, the electrical circuits that cause the foregoing have been illustrated. Contacts 64–CR (line 273) open when control relay 64–CR (line 372) becomes energized at T–188. This, in turn causes control relay 33–CR (line 273) to become de-energized at T–189. With the de-energization of control relay 33–CR, its contacts in line 310 open, thereby de-energizing valve solenoid 2–SOL–VO (line 309), without further effect. In addition, contacts 33–CR (line 195) open, thereby de-energizing timing relay 13–TR (line 195) at T–190. After about a 0.2 second time delay, contacts 13–TR (line 180) close, thereby energizing control relay 11–CR (line 182) at T–193.

When control relay 11–CR (line 182) becomes energized, its contacts in line 218 close, thereby energizing conveyor high speed motor control relay 7–MH (line 224) at T–194. The energization circuit for motor control relay 7–MH includes the following contacts: 11–CR (line 218); 12–CR (line 218); 26–CR (line 220); 64–CR (line 220); 56–CR (line 220); 53–CR (line 220); 33–CR (line 220); 41–SR (line 225); 64–CR (line 225); and 27–CR (line 223). Hence, contacts 7–MH (line 230) open, thereby de-energizing control relay 24–CR (line 231) at T–195 without further effect, and contacts 7–MH (line 213) close, thereby energizing timing relay 18–TR (line 213) at T–195 without further effect. In addition to the foregoing, contacts 7–MH in lines 147, 148 and 149 close, thereby energizing the high speed windings of main conveyor drive motor MTR–7 (line 145).

When main conveyor drive motor MTR–7 starts driving in a forward direction, the newly cut, wide width, rhomboidal section of fabric carried on main conveyor belt 400 starts moving downstream towards splicing mechanism D. Shortly thereafter, the leading edge of the new rhomboidal section of fabric intercepts the light beam between lamp 842 (line 282) and splice slow down photocell 1–EYE (line 281). This causes sensing relay 41–SR (line 280) to become de-energized at T–196. When sensing relay 41–SR (line 280) de-energizes, its contacts in line 240 open, thereby de-energizing control relay 41–CR (line 239) without further effect at T–197. In addition, its contacts 41–SR (line 227) close, causing timing relay 22–TR (line 227) to energize without further effect at T–197. Also, contacts 41–SR (line 225) open with the de-energization of sensing relay 41–SR, causing conveyor high speed motor control relay 7–MH (line 224) to become de-energized at T–197.

The de-energization of motor control relay 7–MH causes its contacts in line 213 to open, thereby de-energizing timing relay 18–TR (line 213) without further effect at T–198. In addition, contacts 7–MH (line 228) close, thereby concurrently energizing conveyor low speed motor control relay 7–ML (line 228) and timing relay 23–TR (line 229) at T–198. Time-delay contacts 23–TR (line 230) immediately close with the energization of timing relay 23–TR and, in turn, energize conveyor brake control relay 7–MB (line 230) at T–199.

The foregoing sequence of action causes main conveyor drive motor MTR–7 (line 145) to shift from high speed to low speed operation. After a short period of time at low speed operation, the leading edge of the new rhomboidal section of fabric on main conveyor belt 400 intercepts the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284), thereby de-energizing sensing relay 42–SR (line 283) at T–200. When this happens, contacts 42–SR (line 276) open to de-energize control relay 42–CR (line 276) at T–201. The de-energization of control relay 42–CR, in turn, causes its contacts in line 264 to close, thereby energizing control relay 32–CR at T–202.

When control relay 32–CR becomes energized, its contacts in line 192 open, de-energizing control relay 12–CR (line 190) at T–203. Thus, contacts 12–CR (line 218) open and cause the concurrent de-energization at T–204 of timing relay 22–TR (line 227), conveyor low speed motor control relay 7–ML (line 228) and timing relay 23–TR (line 229), all at T–204. With the de-energization of motor control relay 7–ML, its contacts in lines 144, 145 and 146 open to remove A.C. excitation from the low speed windings of main conveyor drive motor MTR–7 (line 145). Since a D.C. voltage remains applied to the high speed windings of main conveyor drive motor MTR–7 via contacts 7–MB in lines 152, 153 and 154, the motor is dynamically braked and main conveyor belt 400 quickly comes to a stop with the leading edge of the new rhomboidal section of fabric positioned beneath the trailing edge of the remnant piece of fabric from ply 1.

Immediately thereafter, at T–206, time-delay contacts 23–TR (line 230) open, thereby de-energizing conveyor braking relay 7–MB (line 230) at T–207. Thus contacts 7–MB in lines 152, 153 and 154 open, removing the D.C. voltage from the high speed windings of main conveyor drive motor MTR–7 (line 145). Also, time-delay contacts 23–TR (line 231) close and cause control relay 24–CR (line 231) to become energized at T–207. The energization of control relay 24–CR initiates the next sequence of actions, involving the splicing of the trailing edge of the remnant piece of fabric from ply 1 to the leading edge of the new rhomboidal section of fabric.

With the energization of control relay 24–CR, its contacts in line 314 close, thereby concurrently energizing valve solenoids 2–SOL–VR (line 315), 5–SOL–D (line 314), and 3–SOL–D (line 310) at T–208. The energization circuit for valve solenoid 2–SOL–VR (line 315) includes the following contacts: 42–CR (line 314); 33–CR (line 314); 64–CR (line 314); 52–CR (line 314); and 24–CR (line 314). The same energization circuit is employed in energizing valve solenoid 5–SOL–D (line 314) with the exception that an additional set of contacts, 27–CR (line 314), are added thereto. Similarly, the same energization circuit is employed in energizing valve solenoid 3–SOL–D (line 310) with the exception that the energization circuit for this valve solenoid includes, in addition, the following contacts: 15–CR (line 311); 58–CR (line 311); 33–CR (line 311); the normally closed contacts of selector switch 5–SS in line 310; and 52–CR (line 310).

Referring to FIG. 77, as a result of the foregoing, vacuum is released from vacuum lifter chamber 783 (due to solenoid 2–SOL–VR being energized), vacuum lifter 780 starts moving down (since valve solenoid 3–SOL–D is energized), and mechanical lifter frame 960 starts moving down (because valve solenoid 5–SOL–D is energized). This causes two separate, concurrent, series of sequential actions to take place.

In the first series of actions, initiated by the downward movement of frame 960, contacts 5–LS–U (line 327) open at T–209, thereby de-energizing control relay 56–CR (line 327) without further effect at T–210. When mechanical lifter frame 960 reaches its lower position, contacts 5–LS–D (line 328) close, thereby energizing control relay 57–CR (line 328) at T–212. This causes contacts 57–CR (line 196) to close, thereby energizing timing relay 13–TR (line 195) at T–213. As a result of this, time-delay contacts 13–TR (line 180) immediately open, de-energizing control relay 11–CR (line 182) without further effect at T–214.

In the second series of sequential actions, initiated by the downward movement of vacuum lifter 780, contacts 3–LS–U (line 326) open at T–209, thereby deenergizing control relay 55–CR (line 326) at T–210. Contacts 55–CR (line 321) of this relay, in turn, open to de-energize valve solenoid 4–SOL–U (line 321) without further effect at T–211. When vacuum lifter 780 reaches its lower position at T–211, contacts 3–LS–D (line 325) close, thereby energizing control relay 54–CR (line 325) at T–212. With the energization of control relay 54–CR, its contacts in line 313 close, thereby energizing valve solenoid 4–SOL–D (line 313) at T–213.

Referring to FIG. 77, when valve solenoid 4–SOL–D becomes energized, it actuates the operating mechanism of stripper 800, causing this mechanism to start moving down to its lower position. At the start of this movement, contacts 4–LS–U (line 181) open (T–214) without further effect. When the operating mechanism of stripper 800 reaches its lower position at T–216, contacts 4–LS–D (line 320) close, thereby energizing control relay 52–CR (line 320) at T–27 (FIG. 95).

With the energization of control relay 52–CR at T–217, its contacts 52–CR (line 314) open, thereby concurrently de-energizing, at T–218, valve solenoids 2–SOL–VR (line 315), 3–SOL–D (line 310), 4–SOL–D (line 313), and 5–SOL–D (line 314). No further actions result at this time from the de-energization of the foregoing valve solenoids. In addition, the two sets of normally open contacts 52–CR in line 316 close, thereby energizing valve solenoid 3–SOL–U (line 316), at T–218, via a circuit including the following contacts: 52–CR (two sets in line 316), 26–CR (line 315), and the normally closed contacts of selector switch 5–SS in line 316. Thus, referring to FIG. 77, vacuum lifter 780 starts to raise, while stripper 800 remains held down.

The initial raising of vacuum lifter 780 causes contacts 3–LS–D (line 325) to open (at T–219), thereby de-energizing control relay 54–CR (line 325) at T–220. As a result of this, contacts 54–CR (line 322) open, deenergizing control relay 53–CR (line 322) at T–221. The de-energization of control relay 53–CR signals the bias-cutter electrical circuits to become active again, as indicated by the electrical action line directed to FIG. 107. Before going into a discussion of the actions which take place when vacuum lifter 780 reaches its raised position, the following description relative to the bias-cutter actions will be considered.

Referring to FIGS. 75 and 107, the de-energization of control relay 53–CR at T–221 results in the initiation of a sequence of actions in the bias-cutter involving the lowering of fabric gripping bar 91, the application of a vacuum to vacuum chamber 94 of fabric gripping bar 91, and the directing of high pressure air to table chamber 264 for air blast purposes. When control relay 53–CR de-energizes at T–221, its contacts in line 372 open and concurrently de-energize valve solenoid 15–SOL–U (line 371), control relay 64–CR (line 372), and unlatching coil 62–CRU (line 373) at T–222, the first and third of these components causing no further actions.

The de-energization of control relay 64–CR, on the other hand, causes its contacts in line 374 to close, thereby energizing valve solenoid 15–SOL–D (line 374) at T–223, while its contacts 64–CR in line 196 open and its contacts 64–CR in line 193 close. Thus, timing relay 13–TR (line 195) becomes de-energized at T–223 (FIG. 95) without further effect, while control relay 12–CR (line 190) becomes energized at T–223 (FIG. 95) without further effect. As before, an electrical action line directed upwardly out of the chart (of FIG. 107) is employed to illustrate that control relay 64–CR controls an action relative to another sequential action chart (FIG. 95).

Referring to FIGS. 75 and 107, when valve solenoid 15–SOL–D (line 374) becomes energized at T–223, fabric gripping bar 91 starts lowering. Initially, contacts 15–LS–U (line 372) open without further effect at T–224. However, when fabric gripping bar 91 reaches its lower position, contacts 15–LS–D (line 375) close, thereby concurrently energizing timing relay 65–TR (line 375) and valve solenoid 14–SOL–U (line 377) at T–227. Since contacts 65–TR (line 376) have approximately a one second time-delay prior to closing after timing relay 65–TR has been energized, no immediate action occurs upon energization of this relay.

The energization of valve solenoid 14–SOL–U (line 377), on the other hand, causes cutting position stop assembly 295 (FIG. 75) to start raising. Thus, initially, contacts 14–LS–D (line 351) open, thereby de-energizing control relay 61–CR (line 351) at T–229. This, in turn, causes contacts 61–CR (line 355) to open, thereby de-energizing valve solenoid 11–SOL–R (line 353), without further effect, at T–230. When cutting position stop assembly 295 reaches its raised position, contacts 14–LS–U (line 352) close (T–230) and cause valve solenoid 11–SOL–R (line 353) to become energized at T–231; however, no further action results therefrom.

When the time-delay period of time-delay contacts 65–TR expires, these contacts close (T–237 FIG. 108), thereby energizing valve solenoid 13–SOL–AO (line 376) at T–238 and, referring to FIG. 75, causing blast air to be directed to table chamber 274. The reason for delaying the start of the table air blast is to allow time for the vacuum in chamber 94 of fabric gripping bar 91 to build up so that the gripping bar will have a firm hold on the fabric by the time the air blast begins. The purpose of the air blast, on the other hand, is to prevent the tacky fabric on the bias-cutter table from sticking to the table and, also, to provide a friction reducing layer of air to facilitate subsequent metering of a new section of fabric past fabric cutting unit 200.

With the energization of valve solenoid 13–SOL–AO (line 376) at T–238, all activity in the bias-cutter circuits ceases and these circuits await a new signal from the remainder of the electrical circuits. This waiting period has been denoted in FIG. 108 by the absence of vertical "time" lines between T–240 and T–332.

Referring now to FIGS. 77 and 95, the actions occurring when vacuum lifter 780 reaches its upper position at T–221 will now be considered. When the vacuum lifter reaches its upper position, contacts 3–LS–U (line 326) close, thereby energizing control relay 55–CR (line 326) at T–222. As a result of this, contacts 55–CR (line 321) close and energize valve solenoid 4–SOL–U (line 321) at T–223.

Referring to FIG. 77, the energization of valve solenoid 4–SOL–U causes stripper 800 to start raising, the stripping action thereof having been completed and the spliced strip of fabric resting at this time on main conveyor belt 400. When stripper 800 starts to raise, contacts 4–LS–D (line 320) open (T–224), thereby de-energizing control relay 52–CR at T–225. This, in turn, causes both sets of contacts 52–CR in line 316 to open, thereby de-energizing valve solenoid 3–SOL–U (line 316) without further effect at T–226.

When stripper 800 reaches its upper position, contacts 4–LS–U (line 181) close (T–226), thereby energizing control relay 11–CR (line 182) at T–227 and initiating the next sequence of actions. These actions involve the moving of the spliced strip of fabric into position under the cut-to-length unit preparatory to cutting ply 1 to length.

The energization of control relay 11–CR (line 182) at T–227 causes its contacts in line 218 to close, thereby concurrently energizing conveyor high speed motor control relay 7–MH (line 224), and timing relay 22–TR (line 227) at T–228, the latter being without further effect. As a result of this, contacts 7–MH (line 230) open, de-energizing control relay 24–CR (line 231) without further effect at T–229, and contacts 7–MH (line 213) close, causing timing relay 18–TR (line 213) to energize without further effect at T–229.

As before, with the energization of conveyor high speed motor control relay 7–MH, its contacts in lines 147, 148 and 149 close, causing main conveyor drive motor MTR–7 to begin driving main conveyor belt 400 in a forward direction at high speed. Accordingly, the leading edge of the spliced strip of fabric starts moving downstream towards slow down photocell 3–EYE. When the leading edge of the spliced strip of fabric intercepts the light beam between lamp 1052 (line 289) and photocell 3–EYE (line 288), sensing relay 43–SR (line 286) becomes de-energized (T–230). Contacts 43–SR (line 300) thus open, de-energizing control relay 43–CR (line 300) at T–231, while contacts 43–SR (line 223) open, de-energizing conveyor high speed motor control relay 7–MH (line 224) at T–231.

With the de-energization of control relay 43–CR, its contacts in line 232 open, thereby de-energizing timing relay 25–TR (line 233) at T–232. Time-delay contacts 25–TR in line 224 thereafter remain open without further effect for a timing period of approximately three seconds.

The de-energization of conveyor high speed motor control relay 7–MH (line 224) at T–231 causes its contacts in line 213 to open, thereby de-energizing timing relay 18–TR (line 213) at T–232 without further effect. Similarly, contacts 7–MH (line 228) close upon de-energization of motor control relay 7–MH. As a result of this, conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) become energized at T–232. The energization of timing relay 23–TR, in turn, causes time delay contacts 23–TR in line 230 to immediately close, thereby energizing conveyor brake relay 7–MB (line 230) at T–233.

Referring to FIG. 79, the de-energization of motor control relay 7–MH, plus the subsequent energization of motor control relay 7–ML and conveyor braking relay 7–MB, causes main conveyor drive motor MTR–7 (line 145) to shift from high to low speed operation. Hence, the movement of the leading edge of the strip of spliced fabric slows down and this edge begins "inching" towards stop photocell 4–EYE.

Shortly thereafter, the leading edge of the spliced strip of fabric intercepts the light beam between lamp 1053 (line 293) and stop photocell 4–EYE (line 292), thereby de-energizing sensing relay 44–SR (line 290) at T–234. This causes contacts 44–SR (line 302) to open, de-energizing control relay 44–CR (line 302) at T–235.

With the de-energization of control relay 44–CR, its contacts in line 248 close, energizing revolution counter assembly drive clutch 4–CLU (line 251), at T–226, through a bridge rectifier 6–REC (line 250). This causes revolution counter 2–RVC (line 207), which had previously been energized at T–121, to become mechanically coupled to main conveyor drive motor MTR–7. Accordingly, the counting period of this revolution counter begins at T–237. Contacts 2–RVC (line 184) which were previously open, close at T–237; contacts 2–RVC (line 191), which were previously closed, remain closed at T–227; and contacts 2–RVC (line 255), which were previously open, remain open at T–237. As main conveyor drive motor MTR–7 (FIG. 77) continues driving main conveyor belt 400 at low speed, revolution counter 2–RVC is mechanically driven through its counting period. When this revolution counter "counts out," at T–239, contacts 2–RVC (line 184) open, contacts 2–RVC (line 191) open, and contacts 2–RVC (line 255) close. The opening of contacts 2–RVC (line 191) causes control relay 12–CR (line 190) to de-energize at T–240, while the closing of contacts 2–RVC (line 255) causes an indexing voltage to become available at the indexing terminal of line 253, the indexing voltage to be subsequently used in stepping operation selector stepping relay CR–OS (line 165) from position 4 to position 5.

The de-energization of control relay 12–CR (line 190) at T–240 causes its contacts in line 248 to open thereby de-energizing revolution counter assembly drive clutch 4–CLU (line 251) at T–241, which, in turn, disengages revolution counter 2–RVC from main conveyor drive motor MTR–7. Also, contacts 12–CR (line 218) open with the de-energization of control relay 12–CR to thereby de-energize, at T–241, timing relays 22–TR (line 227) and 23–TR (line 229) and conveyor low speed motor control relay 7–ML (line 228).

With the de-energization of timing relay 22–TR, its time-delay contacts in line 224 remain open for a time-delay period of approximately 3 seconds; however, no further action results therefrom. The de-energization of conveyor low speed motor control relay 7–ML (line 228) causes its contacts in lines 144, 145 and 146 to open and remove the A.C. excitation from the low speed windings of main conveyor drive motor MTR–7 (line 145), while the de-energization of conveyor brake timing relay 23–TR (line 229) causes its time-delay contacts 23–TR (line 230) to start their time-delay period of about 0.2 second prior to opening. During this period, main conveyor drive motor MTR–7 is dynamically braked and stops. Subsequently, at T–243, contacts 23–TR (line 230) open, de-energizing conveyor braking relay 7–MB (line 230) at T–244, while time-delay contacts 23–TR (line 231) close, energizing control relay 24–CR (line 231) at T–244.

Accordingly, by T–244, main conveyor belt 400 (FIG. 77) has stopped with the leading edge of the spliced strip of fabric slightly downstream of stop photocell 4–EYE, the additional distance downstream being sufficient to allow ply 2 to be subsequently wound about tire building drum 1060 (over ply 1) with an adequate overlap between its ends.

With the energization of control relay 24–CR (line 231) at T–244, its contacts in line 165 close, thereby energizing operation selector stepping relay CR–OS (line 165) at T–245 from the previously energized indexing terminal in line 253. Accordingly, operation selector stepping relay CR–OS begins indexing from position 4 to position 5. During the indexing of this relay from position 4 to position 5, control relay 10–CR (line 170) becomes de-energized and then re-energized at T–246 and T–248, respectively, in the same manner as described in connection with the indexing of stepping relay CR–OS from position 1 to 2 at T–33 and T–35. Similarly, control relay 11–CR (line 182), timing relay 14–TR (line 197), and control relay 15–CR (line 203) go through a sequence of actions between T–247 and T–256 that is the same as previously described in connection with the indexing of stepping relay CR–OS from position 1 to position 2. Hence, the description of these actions will not be repeated at this time.

F. Stepping Relay CR–OS in Position 5: Referring to FIG. 90 in conjunction with FIGS. 78 through 88, when stepping relay CR–OS (line 165) indexes to position 5 the following changes occur. Contacts CR–OS–4 (line 207) open, thereby: de-energizing revolution counter 2–RVC (line 206) without further effect; de-energizing control relay 17–CR (line 207) without further effect; and de-energizing position 4 lamp 1193 (line 208). Contacts CR–OS–5 (line 402) close, thereby energizing position 5 lamp 1194 (line 402). Contacts CR–OS–1A (line 234) open, thereby removing from the indexing terminal of line 253 the voltage which indexed stepping relay CR–OS to position 5. Contacts CR–OS–1A (line 234), in addition, cause conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235) to become de-energized, the latter, in turn, de-energizing control relay 32–CR (line 264) at T–249 when contacts 26–CR (line 263) open. And finally, contacts CR–OS–14A (line 337) close, thereby energizing control relay 58–CR (line 337) at T–248 to begin the next sequence of actions involving the cutting of ply 2 to length.

The actions involved in cutting ply 2 to length occur between T–248 and T–283, at which time stepping relay CR–OS shifts from position 5 to position 6, and are almost an exact duplicate of the actions that occurred between T–35 (FIG. 91) and T–72 (FIG. 92), at which time stepping relay CR–OS shifted from position 2 to position 3. The only difference between these two series of actions is that the time-delay period of timing relay 51–TR (line 319), between T–257 and T–263, has been shown as extending for only six vertical "time" lines, while the time-delay period for timing relay 51–TR, between times T–44 and T–52, was shown as extending for a period of eight vertical "time" lines. In actuality, these two time-delay periods are exactly the same.

In view of the foregoing, a detailed description of the actions that take place between T–248 and T–283 is omitted at this time, and only the following cursory, functional description will be presented. Initially, referring to FIG. 77, a vacuum is introduced to vacuum chamber

783 (2–SOL–VO is energized) and vacuum lifter 780 is lowered (3–SOL–D is energized). With the vacuum lifter 780 down, an approximately 0.8 second time-delay is introduced to allow time for the spliced strip of fabric on main conveyor belt 400 to be grasped by vacuum lifter 780 (due to the vacuum building up in chamber 783). Thereafter, vacuum lifter 780 is raised (3–SOL–U is energized) and lifts the upstream portion of the spliced strip of fabric above main conveyor belt 400.

Next, mechanical lifter frame 960 is raised (5–SOL–U is energized). Then, fabric clamping means 900 is raised (7–SOL–U energized); and finally, cut-to-length knife traverse motor MTR–6 becomes energized to start knife 873 on the cutting stroke in which ply 2 is cut-to-length. At T–283 (FIG. 96), while motor MTR–6 is still moving knife 873 through its cutting stroke, operation selector stepping relay CR–OS (line 165) indexes from position 5 to position 6, preparatory to sending the soon to be remnant piece of fabric from ply 2 to lower storage area 500 (FIG. 76).

G. Stepping Relay CR–OS in Position 6: Referring to FIG. 90 in conjunction with FIGS. 78 through 88, when operation selector stepping relay CR–OS shifts to position 6 the following changes take place. Contacts CR–OS–5 (line 402) open, thereby de-energizing position 5 lamp 1194 (line 402). Contacts CR–OS–6 (line 403) close, thereby energizing position 6 lamp 1195 (line 403). Contacts CR–OS–2A (line 236) close, thereby energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237) without further effect. Contacts CR–OS–12A (line 185) close without further effect. Contacts CR–OS–14A (line 337) open, causing control relay 58–CR (line 337) to de-energize at T–284 and, also, removing indexing voltage from the indexing terminal in line 333. The de-energization of control relay 58–CR, in turn, causes its contacts in line 311 to open, thereby de-energizing valve solenoid 2–SOL–VO (line 309) without further effect at T–285. Finally, the stepping of operation selector stepping relay CR–OS to position 6 causes contacts CR–OS–17A (line 265) to close, thereby pre-conditioning the indexing terminal in line 265 for the subsequent indexing of stepping relay CR–OS from position 6 to position 7.

Recalling that cut-to-length knife traverse motor MTR–6 (FIG. 77) was moving knife 873 through a cutting stroke when stepping relay CR–OS started indexing from position 5 to position 6, upon completion of indexing knife 873 will still be moving in this cutting stroke. When knife 873 finishes the return portion of the cutting stroke, limit switch 8–LS becomes actuated (T–291), and its contacts in line 348 close, thereby energizing control relay 59–CR (line 348) at T–292.

The energization of control relay 59–CR causes its contacts in line 340 to open, de-energizing valve solenoid 7–SOL–U (line 338) and knife traverse motor control relay 6–MF (line 345) at T–293, the latter causing motor MTR–6 (line 139) to quickly come to a stop when contacts 6–MF in lines 138, 139 and 140 open.

In addition to stopping motor MTR–6, the de-energization of motor control relay 6–MF (line 345) causes its contacts in line 198 to open, thereby de-energizing timing relay 14–TR (line 197) at T–294, and causes its contacts 6–MF in line 203 to close, thereby energizing control relay 15–CR (line 203) at T–294. Time-delay contacts 14–TR (line 202) remain closed for approximately 0.6 seconds after the de-energization of timing relay 14–TR and, subsequently, at T–300, open to de-energize control relay 15–CR (line 203) at T–301.

Before this, however, with the energization of control relay 15–CR at T–294, contacts 15–CR in line 185 close, thereby energizing control relay 12–CR (line 190), at T–295, without further effect. In addition, contacts 15–CR in line 315 close, causing valve solenoids 2–SOL–VR (line 315) and 3–SOL–D (line 310) to become energized at T–295. Referring to FIG. 77 valve solenoid 2–SOL–VR releases the vacuum in vacuum lifter chamber 783, while solenoid 3–SOL–D causes vacuum lifter 780 to start moving down.

In addition to initiating the foregoing actions, when motor control relay 6–MF (line 345) became de-energized at T–293 its contacts in line 346 closed to thereby energize valve solenoid 7–SOL–D (line 346) at T–294. This, in turn, caused fabric clamping means 900 (FIG. 77) to start unclamping and, initially, contacts 7–LS–U (line 345) opened at T–295, without further effect, and then, subsequently, contacts 7–LS–D (line 181) closed at T–297, without further effect.

Remembering that valve solenoid 3–SOL–D (line 310) energized at T–295 and started moving vacuum lifter 780 down, it will be seen that contacts 3–LS–U (line 326) open at T–296, thereby de-energizing control relay 55–CR (line 326) at T–297. This, in turn, causes contacts 55–CR (line 321) to open, de-energizing solenoid valve 4–SOL–U (line 321), at T–298, without further effect.

When vacuum lifter 780 reaches its lower position, contacts 3–LS–D (line 325) close (T–298), thereby energizing control relay 54–CR (line 325) at T–299. Contacts 54–CR (line 313) thus close, energizing valve solenoid 4–SOL–D (line 313) at T–300. Referring to FIG. 77, the energization of valve solenoid 4–SOL–D causes the operating mechanism of stripper 800 to start moving down. As a result of this, contacts 4–LS–U (line 181) open at T–301, without further effect, and contacts 4–LS–D (line 320) close at T–303, thereby energizing control relay 52–CR (line 320) at T–304.

In the meantime, time-delay contacts 14–TR (line 202) end their timing period and open at T–300, de-energizing control relay 15–CR (line 203) at T–301. Accordingly, contacts 15–CR in line 315 open, thereby concurrently de-energizing valve solenoids 2-SOL–VR (line 315), 3–SOL–D (line 310), and 4–SOL–D (line 313), at T–302, without further effect.

Returning to the energization of control relay 52–CR at T–304, the two sets of contacts 52–CR in line 316 close at this time, thereby energizing valve solenoid 3–SOL–U (line 316) at T–305. This causes vacuum lifter 780 (FIG. 77) to start moving up, and, since stripper 800 is being held down, the remnant piece of fabric from ply 2, which was previously held by vacuum lifter 780, is stripped from the vacuum lifter and deposited on main conveyor belt 400. In addition, as vacuum lifter 780 starts moving up, contacts 3–LS–D (line 325) open (T–306), thereby de-energizing control relay 54–CR (line 325) at T–307. This, in turn, causes contacts 54–CR (line 322) to open, de-energizing control relay 53–CR (line 323), at T–308, without further effect.

When vacuum lifter 780 reaches its raised position (T–308), contacts 3–LS–U (line 326) close, thereby energizing control relay 55–CR (line 326) at T–309. As a result of this, contacts 55–CR (line 321) close, causing valve solenoid 4–SOL–U (line 321) to energize at T–310. Referring to FIG. 77, when valve solenoid 4–SOL–U becomes energized, stripper 800 starts moving up. Thus, at T–311, contacts 4–LS–D (line 320) open, de-energizing control relay 52–CR (line 320) at T–312. When this relay de-energizes, its two sets of contacts 52–CR in line 316 open and de-energize valve solenoid 3–SOL–U (line 316) without further effect at T–313.

When stripper 800 reaches its raised position (T–313), contacts 4–LS–U (line 181) close and complete an energization circuit to control relay 11–CR (line 182), this relay becoming energized at T–314. With the energization of control relay 11–CR, the next phase of operation begins, during which the remnant piece of fabric from ply 2 is returned to lower storage area 500 (FIG. 76), while ply 2 remains raised above main conveyor belt 400 by means of mechanical lifter frame 960 (FIG. 77).

When control relay 11–CR energizes at T–314, its contacts in line 218 close, thereby concurrently energizing conveyor high speed motor control relay 7–MH (line 224) and timing relay 27–CR (line 225) at T–315. As a result of this, contacts 7–MH (line 230) open, de-energizing control relay 24–CR (line 231) at T–316, without further effect. Similarly, contacts 7–MH (lines 147, 148 and 149) close to energize the high speed windings of main conveyor drive motor MTR–7 (line 145). Since conveyor reverse control relay 7–MR (line 236) is energized at this time, main conveyor belt 400 (FIG. 77) starts moving in an upstream direction at high speed, carrying the remnant piece of fabric from ply 2 along with it. In addition, since clutch 1–CLU (line 175) is energized at this time, lower storage conveyor belt 520 (FIG. 76) is also driven in an upstream direction at high speed. As the remnant of ply 2 starts moving upstream, its downstream edge uncovers the light beam between lamp 843 (line 285) and stop photocell 2–EYE (line 285), thereby causing sensing relay 42–SR (line 283) to become energized at T–317. Contacts 42–SR (line 276) thus close, causing control relay 42–CR (line 276) to become energized at T–318, without further effect.

Shortly thereafter, the downstream edge of the remnant of ply 2 uncovers the light beam between lamp 842 (line 282) and slow down photocell 1–EYE (line 281), thereby causing sensing relay 41–SR (line 280) to become energized at T–318. This causes contacts 41–SR (line 240) to close, resulting in the energization of control relay 41–CR (line 239) at T–319, without further effect.

As the remnant of ply 2 continues its upstream movement, it shifts from main conveyor belt 400 to lower storage conveyor belt 520 and, shortly thereafter, the upstream edge of the remnant intercepts the light beam between lamp 1185 (line 296) and photocell 5–EYE (line 295). This causes sensing relay 45–SR (line 294) to become de-energized at T–322. When this happens, contacts 45–SR (line 304) open to de-energize control relay 45–CR (line 304) at T–323. As a result of this, contacts 45–CR (line 262) close, causing control relay 31–CR (line 261) to become energized at T–324; however, no further action results from this.

As the upstream movement of the remnant of ply 2 continues, the downstream edge thereof eventually uncovers the light beam between lamp 1185 (line 296) and photocell 5–EYE (line 295). Thus, at T–324, sensing relay 45–SR (line 294) becomes energized at its contacts 45–SR (line 304) close to energize control relay 45–CR (line 304) at T–325, without further effect. Similarly, contacts 45–SR (line 191) open, and since contacts 31–CR (line 192) are open at this time also, control relay 12–CR (line 190) becomes de-energized at T–325.

Referring to FIG. 97 in conjunction with FIGS. 78 to 88, with the de-energization of control relay 12–CR at T–325, contacts 12–CR (line 218) open, causing the concurrent de-energization of conveyor high speed motor control relay 7–MH (line 224) and timing relay 21–TR (line 225) at T–326. The time-delay contacts of timing relay 21–TR in lines 228 and 229 remain in their actuated conditions during a timing period of approximately 0.3 second which follows the de-energization of the relay. With the de-energization of control relay 7–MH, its contacts in line 228 close, thereby concurrently energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–327, through the still closed time-delay contacts 21–TR (line 229). When conveyor brake timing relay 23–TR (line 229) becomes energized, its time-delay contacts in line 230 immediately close, thereby energizing conveyor brake control relay 7–MB (line 230) at T–328.

As a result of the foregoing, and in the same manner as previously described, main conveyor drive motor MTR–7 (line 145) slows to low speed operation. Shortly thereafter, with the opening of time-delay contacts 21–TR (line 229) at T–229, conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) become de-energized at T–330. Time-delay contacts 23–TR (line 230) remain closed during a brief (approximately 0.2 second) time-delay period following the de-energization of timing relay 23–TR (line 229), while time-delay contacts 23–TR (line 231) remain open during this period. Consequently, main conveyor drive motor MTR–7 (line 145) quickly comes to a stop, in the same manner as has been previously described, with the remnant piece of fabric from ply 2 completely supported within lower storage area 500 (FIG. 76).

When the above time-delay period ends at T–332, time-delay contacts 23–TR (line 230) open, thereby de-energizing conveyor brake control relay 7–MB (line 228), at T–333, and time-delay contacts 23–TR (line 231) close, thereby energizing control relay 24–CR (line 231), at T–333. This action causes operation selector stepping relay CR–OS (line 165) to energize and begin indexing from position 6 to position 7 at T–334, due to the closing of contacts 24–CR in line 165. Stepping relay CR–OS is energized at this time from the indexing terminal in line 265, the indexing voltage reaching this terminal via a circuit which includes the following contacts: 31–CR (line 271); 27–CR (line 271); 45–CR (line 267); 46–CR (line 267); 30–CR (line 267); and CR–OS–17A (line 265.)

As in earlier stepping operations, when stepping relay CR–OS (line 165) becomes energized, contacts CR–OS (line 170) open, thereby de-energizing control relay 10–CR (line 170) at T–335. As a result of this contacts 10–CR in line 165 open to de-energize stepping relay CR–OS at T–336 and complete the indexing sequence. In addition, contacts 10–CR (line 180) open, thereby de-energizing control relay 11–CR (line 182) at T–336, without further effect. Similarly, contacts 10–CR (line 197) close, thereby energizing timing relay 14–TR (line 197) at T–336, without further effect.

When operation selector stepping relay CR–OS (line 165) de-energizes after indexing into position 7, its contacts CR–OS (line 170) close, thereby re-energizing control relay 10–CR (line 170) at T–337. The sequential actions which follow from the energization of control relay 10–CR will be discussed in the following section, after the effects of shifting stepping relay CR–OS to position 7 have been described.

H. Stepping Relay CR–OS in Position 7: In position 7, the contacts of stepping relay CR–OS set the electrical control system for preparation of ply 3. Referring to FIG. 90 in conjunction with FIGS. 78 to 88, the following changes in the condition of the contacts of stepping relay CR–OS take place when this relay indexes from position 6 to position 7: contacts CR–OS–6 (line 403) open; contacts CR–OS–7 (line 209) close; contacts CR–OS–1A (line 234) close; contacts CR–OS–2A (line 236) open; contacts CR–OS–3A (line 171) open; contacts CR–OS–4A (line 175) close; contacts CR–OS–5A (line 353) open; contacts CR–OS–6A (line 355) close; contacts CR–OS–12A (line 185) open; and contacts CR–OS–17A (line 265) open.

The opening and closing of the various contacts of operation selector relay CR–OS enumerated above cause the following listed actions to occur, each of which starts at T–337: (1) With the opening of contacts CR–OS–6 (line 403), position 6 lamp 1195 (line 403) becomes de-energized. (2) With the closing of contacts CR–OS–7 (line 209), revolution counter 3–RVC (line 209) becomes energized and position 7 lamp 1196 (line 210) becomes illuminated. (3) With the closing of contacts CR–OS–1A (line 234), conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235) become energized. (4) With the opening of contacts CR–OS–2A (line 236), conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237) become de-energized, the de-energization of the latter in turn, causing control relay 31–CR (line 261) to become de-energized at T–338 by virtue of the opening of contacts 27–CR in line 261. (5) With the opening of contacts CR–OS–3A (line 171), valve solenoid 1–SOL–U (line 172) and clutch 1–CLU (line 175) become de-energized. (6) With the closing of contacts CR–OS–4A, valve solenoid 1–SOL–D (line 176) and clutch 2–CLU (line 179) become energized, the latter via a bridge rectifier 3–REC (line 178).

The energization of valve solenoid 1–SOL–D (line 176) causes upper storage conveyor belt 575 (FIG. 76) to start moving down into engagement with main conveyor belt 400. Similarly, the energization of clutch 2–CLU (line 179) causes upper storage conveyor belt 575 to become coupled to main conveyor belt 400 for subsequent driving thereby, while the de-energization of clutch 1–CLU (line 179) causes lower storage conveyor belt 520 to become uncoupled from main conveyor belt 400. Also, as upper storage conveyor belt 575 starts moving down, contacts 1–LS–U (line 171) open at T–338, without further effect. Similarly, when upper storage conveyor belt 575, reaches its lower position, contacts 1–LS–D (line 175) close (T–340), thereby energizing control relay 11–CR (line 182) at T–341.

In addition to the foregoing, when operation selector stepping relay CR–OS (line 165) shifts to position 7, its contacts CR–OS–12A (line 185) open, without further effect, and its contacts CR–OS–17A (line 265) open, without further effect. Also, contacts CR–OS–5A (line 353) open, thereby causing valve solenoid 11–SOL–R (line 353) to become de-energized at T–337 (see FIG. 108). Finally, contacts CR–OS–6A (line 355) close, causing valve solenoid 11–SOL–F (line 355) to become energized at T–337. Referring to FIG. 75, this results in the movement of fabric width and drop control unit 275 towards its narrow width setting and in the shifting of dropping position stop assembly 320 to remove the offset previously introduced by this assembly. When control unit 275 starts moving, limit switch 11–LS–R de-actuates and its contacts 11–LS–RA (line 354) open, while its contacts 11–LS–RB (line 356) close, at T–338. Similarly, when control unit 275 reaches its narrow width setting, limit switch 11–LS–F actuates and its contacts 11–LS–FA (line 354) open, while its contacts 11–LS–FB (line 356) close, at T–340. As a result of the foregoing, the bias-cutter controls are in condition to be subsequently cycled to cut narrow width, rhomboidal sections of fabric and deposit such sections of fabric onto main conveyor belt 400 with their centerlines in alignment with reference line X—X of FIG. 1A.

Remembering that control relay 10–CR (line 170) became energized at T–337 when stepping relay CR–OS completed indexing, this discussion will now continue with a description of the events occurring due to the energization of that relay. With the energization of control relay 10–CR, its contacts 10–CR (line 197) open, thereby de-energizing timing relay 14–TR (line 197) at T–338 (FIG. 97). However, time-delay contacts 14–TR (line 202) remain closed for an additional timing period of approximately 0.6 second thereafter, and, since contacts 10–CR (line 203) also close with the energization of control relay 10–CR, control relay 15–CR (line 203) becomes energized at T–338.

The energization of control relay 15–CR causes its contacts 15–CR in line 315 to close, resulting in the energization of valve solenoids 2–SOL–VR (line 315) and 5–SOL–D (line 314) at T–339. Referring to FIG. 77, since the vacuum in chamber 783 of vacuum lifter 780 had previously been released, the energization of valve solenoid 2–SOL–VR causes no follow-up action. The energization of valve solenoid 5–SOL–D, on the other hand, causes mechanical lifter frame 960 to start moving down to deposit ply 2 onto main conveyor belt 400. When frame 960 starts moving down, contacts 5–LS–U (line 327) open (T–340), thereby de-energizing control relay 56–CR (line 327) at T–341, without further effect. When frame 960 reaches its lower position, contacts 5–LS–D (line 328) close (T–342), thereby energizing control relay 57–CR (line 328) at T–343, without further effect.

Thereafter, time-delay contacts 14–TR (line 202) open (T–344) upon completing their time-delay period. Control relay 15–CR (line 203) thus becomes de-energized at T–345, and its contacts in line 315 open causing valve solenoids 2–SOL–VR (line 315) and 5–SOL–D (line 314) to become de-energized without further effect at T–346. At this time, all sequential actions of the electrical control system have stopped, and the system awaits a signal from the operator at tire building station J prior to beginning further automatic operation.

The status of the tire building apparatus at this time is as follows: Ply 1, which had previously been cut-to-length, lowered onto main conveyor belt 400, and transferred to applicator conveyor belt 1061 (FIG. 77), is resting at the upstream end of the applicator conveyor belt; ply 2, which also has been cut-to-length and lowered onto main conveyor belt 400, is resting at the downstream end thereof; upper storage conveyor belt 575 (FIG. 76) is in its lower position and is coupled to main conveyor belt 400 so that the narrow width section of fabric in upper storage area 501 is ready to be moved downstream toward splicing mechanism D and cut-to-length unit E (FIG. 77); and, finally, the controls of bias-cutter A (FIG. 75) have been set so that subsequent cycling of the bias-cutter will result in the cutting of narrow width rhomboidal sections of fabric and the depositing of these sections on main conveyor belt 400 with their centerlines in alignment with reference line X—X of FIG. 1A.

As described earlier, applicator conveyor belt 1061 may be independently driven by motor 1092 (FIG. 77) which is under the manual control of the operator at tire building station J. In the time period denoted by the absence of a vertical "time" line in FIG. 97, between T–348 and T–350, the operator concurrently energizes motor 1092, extends first applicating means 1063 into contact with drum 1060, and starts the drum rotating counterclockwise. Accordingly, during the waiting period between T–348 and T–350, ply 1 is delivered to and wrapped about tire building drum 1060. When this operation is completed, first applicating means 1063 is retracted and drum 1060 is stopped. Thereafter, the operator concurrently extends second applicating means 1064 into contact with drum 1060 and starts the drum rotating in a clockwise direction, the motor 1092 still being energized.

At this time, applicator conveyor belt 1061 is ready to receive ply 2 from main conveyor belt 400, and the operator is ready to signal the electrical control system to begin preparing plies 3 and 4. Referring to FIG. 97, pushbutton switch PB–8 (line 186) is depressed at T–350 to signal the electrical control system to begin automatic operation. When pushbutton PB–8 is depressed, its contacts in line 186 close, while its contacts in line 246 open. The closing of contacts PB–8 in line 186 causes control relay 12–CR (line 190) to become energized at T–351, and this relay locks itself in an energized condition via contacts 12–CR in line 188. The opening of contacts PB–8 in line 246 insures that applicator conveyor brake 3–BRK (line 245) will remain de-energized during the transfer of ply 2 from main conveyor belt 400 to tire building drum 1060.

With the energization of control relay 12–CR at T–351, its contacts in line 218 close, thereby energizing conveyor high speed motor control relay 7–MH (line 224) at T–352. This, in turn, causes main conveyor drive motor MTR–7 (line 145) to start rotating at high speed due to the closing of contact 7–MH in lines 147, 148 and 149. In addition contacts 7–MH (line 240) close, thereby concurrently energizing timing relay 28–TR (line 240) and applicator conveyor clutch 3–CLU (line 243), the applicator conveyor clutch being energized by a D.C. voltage derived from bridge rectifier 4–REC (line 242). Thus, main conveyor belt 400 and upper storage conveyor belt 575 start moving downstream at high speed, and control over the movement of applicator conveyor belt 1061 shifts to the electrical control system, the operator manually de-energizing motor 1092 (FIG. 77) at this time. Accordingly, ply 2 begins transferring to applicator conveyor belt 1061, and the section of fabric in upper storage area 501 starts transferring to main conveyor belt 400. The energization of motor control relay 7–MH at T–352 also causes its contacts in line 230 to open, de-energizing control relay 24–CR (line 231), without further effect, at T–353.

As upper storage conveyor belt 575 starts moving downstream, the leading edge of fabric carried thereon intercepts the light beam between lamp 610 (line 299) and photocell 6–EYE (line 298), thereby de-energizing sensing relay 46–SR (line 297) at T–353. This, in turn, causes contacts 46–SR (line 306) to open, de-energizing control relay 46–CR (line 306) at T–354, without further effect.

Similarly, the downstream movement of ply 2 in transferring from main conveyor belt 400 to applicator conveyor belt 1061 causes the trailing edge of ply 2 to move clear of the light beam between lamp 1052 (line 289) and cut-to-length slow down photocell 3–EYE (line 288), resulting in the energization of sensing relay 43–SR (line 286) at T–355. When sensing relay 43–SR becomes energized, its contacts in line 300 close, thereby energizing control relay 43–CR (line 300) at T–356. This, in turn, causes contact 43–CR (line 232) to close, thereby energizing timing relay 25–TR (line 233) at T–357, without further effect.

The continuing movement of ply 2 on main conveyor belt 400 also causes the trailing edge of ply 2 to uncover the light beam between lamp 1053 (line 293) and cut-to-length stop photocell 4–EYE (line 292). Hence, sensing relay 44–SR (line 290) becomes energized at T–356. As a result of this, contacts 44–SR (line 302) close, causing control relay 44–CR (line 302) to become energized, without further effect, at T–357.

Similarly, the continuing movement of upper storage conveyor belt 575 causes the section of fabric which it carries to transfer to main conveyor belt 400, and, during the transferring procedure, the trailing edge of this section of fabric uncovers the light beam between lamp 610 (line 299) and photocell 6–EYE (line 298), thereby energizing sensing relay 46–SR (line 297) at T–356.5. This causes control relay 46–CR (line 306) to become energized at T–357.5 due to the closing of contacts 46–SR (line 306). However, no further sequential action results from the energization of control relay 46–CR at this time.

As the high speed forward movement of main conveyor belt 400 continues, the leading edge of the narrow width section of fabric proceeds downstream towards splicing mechanism D and, eventually, blocks the light beam between lamp 842 (line 282) and splice slow down photocell 1–EYE (line 281), thereby de-energizing sensing relay 41–SR (line 280) at T–358. By the time this has happened, however, ply 2 has been wound about tire building drum 1060, the operator has started to manually retract second applicating means 1064, and applicator conveyor belt 1061 is ready to be stopped.

With the de-energization of sensing relay 41–SR (line 280), its contacts in line 240 open, thereby concurrently de-energizing applicator conveyor clutch 3–CLU (line 243), timing relay 28–TR (line 240), and control relay 41–CR (line 239) at T–359. As a result of this, time-delay contacts 28–TR (line 246) begin their time-delay period of approximately one second, remaining closed during this period; and, applicator conveyor clutch 3–CLU (line 243) removes the driving power from applicator conveyor belt 1061. In addition to the foregoing, the de-energization of control relay 41–SR at T–359 causes its contacts 41–SR in line 227 to close, thereby energizing timing relay 22–TR (line 227) without further effect at T–359.

The continuing movement of main conveyor belt 400 causes the leading edge of the section of fabric on the belt to intercept the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284). This results in the de-energization of sensing relay 42–SR (line 283) at T–359. With the de-energization of this relay, its contacts 42–SR (line 276) open, de-energizing control relay 42–CR (line 275) at T–360. This, in turn, causes contacts 42–CR in line 264 to close, thereby energizing control relay 32–CR (line 263) without further effect at T–361.

Remembering that the section of fabric moving on main conveyor belt 400 is sufficiently long to cut ply 3 to length, its leading edge will intercept the light beam between lamp 1052 (line 289) and cut-to-length slow down photocell 3–EYE (line 288) before its trailing edge uncovers splice slow down photocell 1–EYE. Hence, at T–361, sensing relay 43–SR (line 286) becomes de-energized. This causes contacts 43–SR (line 300) to open, de-energizing control relay 43–CR (line 300) at T–362. In turn, contacts 43–CR (line 232) open, causing timing relay 25–TR (line 233) to de-energize at T–363, its time-delay contacts 25–TR (line 224) remaining open for approximately a three second time-delay period without further effect.

At about the same time (T–362), the pushbutton switch PB–8 (line 186), which had previously been depressed by the operator, is released, and its contacts in line 246 close. Since time-delay contacts 28–TR (line 246) are still closed in their timing period and contacts 41–CR (line 246) are closed due to control relay 41–CR (line 239) being de-energized, applicator conveyor brake 3–BRK (line 245) becomes energized at T–363 with D.C. voltage supplied through a bridge rectifier 5–REC (line 246). This causes applicator conveyor belt 1061 (FIG. 77) to quickly come to a stop. Thereafter, when time-delay contacts 28–TR (line 246) open at the end of their timing period, applicator conveyor brake 3–BRK (line 245) becomes de-energized at T–370.

Resuming a consideration of the sequential actions following the de-energization of sensing relay 43–SR (line 286) at T–361, the de-energization of this relay also causes contacts 43–SR in line 223 to open. Since time-delay contacts 25–TR (line 224) are open at this time, conveyor high speed motor control relay 7–MH (line 224) becomes de-energized at T–362. This causes contacts 7–MH (line 228) to close thereby concurrently energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–363. The energization of conveyor brake timing relay 23–TR (line 229), in turn, causes its time-delay contacts 23–TR (line 230) to immediately close, thereby energizing conveyor brake control relay 7–MB (line 230) at T–364.

As a result of the foregoing, main conveyor drive motor MTR–7 (line 145) shifts from high speed operation to low speed operation in the same manner as described earlier herein, and the leading edge of the fabric on main conveyor belt 400 starts inching towards cut-to-length stop photocell 4–EYE.

When the leading edge of the fabric intercepts the light beam between lamp 1053 (line 293) and cut-to-length stop photocell 4–EYE (line 292), sensing relay 44–SR (line 290) de-energizes (T–365). This causes contacts 44–SR (line 302) to open, de-energizing control relay 44–CR (line 302) at T–366. With the de-energization of control relay 44–CR, contacts 44–CR in line 248 close, thereby energizing revolution counter assembly drive clutch 4–CLU (line 251) through bridge rectifier 6–REC (line 250) at T–367.

Since clutch 4–CLU (line 251) and revolution counter 3–RVC (line 209) are both energized and main conveyor belt 400 is moving, the counting period of revolution counter 3–RVC begins. Hence its contacts in lines 191 and 256 will soon reach their "count out" positions. This occurs when ply 3 has been metered to proper length past cut-to-length unit E. Accordingly, at T–370, "count out" is reached and contacts 3–RVC (line 191) open, while contacts 3–RVC (line 256) close.

The opening of contacts 3–RVC (line 191) cause control relay 12–CR (line 190) to become de-energized at T–371. Thus, contacts 12–CR (line 248) open, de-energizing revolution counter assembly drive clutch 4–CLU (line 251) at T–372. Also, contacts 12–CR (line 218) open, concurrently de-energizing timing relay 22–TR (line 227), conveyor low speed motor control relay 7–ML (line 228), and conveyor brake timing relay 23–TR (line 229), at T–372. Accordingly, main conveyor drive motor MTR–7 (line 145) comes to a stop through a sequence of actions that are the same as has been described earlier in this specification, and the section of fabric on main conveyor belt 400 is in position to be cut to the length of ply 3.

At the completion of the above-mentioned stopping sequence, control relay 24–CR (line 231) becomes energized (at T–375), causing its contacts in line 165 to close. This, in turn, applies an indexing voltage to operation selector stepping relay CR–OS (line 165), causing this relay to become energized at T–376 and start indexing from position 7 to position 8. The indexing voltage for this action comes from the indexing terminal in line 253. It reaches this terminal via, among other things, the now closed revolution counter contacts 3–RVC in line 256.

With the energization of stepping relay CR–OS (line 165) at T–376, its contacts CR–OS in line 170 open, thereby de-energizing control relay 10–CR (line 170) at T–377. Hence, contacts 10–CR (line 180) open, de-energizing control relay 11–CR (line 182) without further effect at T–378, and contacts 10–CR (line 197) close, energizing timing relay 14–TR (line 197) without further effect at T–378. In addition, contacts 10–CR (line 165) open, de-energizing operation selector stepping relay CR–OS (line 165) at T–378 and completing the stepping of this relay into position 8.

I. Stepping Relay CR–OS in Position 8: With the indexing of stepping relay CR–OS (line 165) into position 8, the following actions take place to set the electrical control system up for cutting ply 3 to length: Contacts CR–OS–7 (line 209) open, de-energizing revolution counter 3–RVC (line 209) and position 7 lamp 1196 (line 210); contacts CR–OS–8 (line 404) close, energizing position 8 lamp 1197 (line 404); contacts CR–OS–1A (line 234) open, concurrently de-energizing the indexing terminal of line 253, conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235), the latter, in turn, de-energizing control relay 32–CR (line 263) at T–380 by virtue of the opening of its contacts 26–CR in line 263; and, finally, contacts CR–OS–14A (line 337) close, causing control relay 58–CR (line 337) to become energized to start a new sequence of events.

In addition to the foregoing, when stepping relay CR–OS de-energizes upon completion of indexing into position 8, its contacts CR–OS (line 170) close, thereby energizing control relay 10–CR (line 170) at T–379. Thus, contacts 10–CR (line 197) open, de-energizing timing relay 14–TR at T–380; however, time-delay contacts 14–TR in line 202 remain closed during the timing period that follows this. In addition, contacts 10–CR (line 203) close, thereby energizing control relay 15–CR (line 203) at T–380. Control relay 15–CR thereafter remains energized until time-delay contacts 14–TR (line 202) open at the completion of their timing period (at T–386, FIG. 98). Also, contacts 10–CR (line 180) close with the energization of control relay 10–CR and, this, in turn, causes control relay 11–CR (line 182) to become energized at T–380.

It will be remembered that when stepping relay CR–OS indexed into position 8, control relay 58–CR (line 337) became energized to begin the next sequence of events in the electrical control system. This sequence of events relates to cutting the metered length of fabric on main conveyor belt 400 to the length of ply 3.

Since a cut-to-length sequence has previously been described in connection with ply 1 during times T–35 through T–70, and, since the cut-to-length sequence between times T–379 and T–412 is almost an exact duplicate of the aforementioned sequence, only a brief functional description of the actions occurring between T–379 and T–412 will be given at this time, the reader being referred to the description between T–35 and T–70 for a more detailed analysis of the cut-to-length sequence. Referring to FIG. 77, after control relay 58–CR (line 337) becomes energized at T–379 to begin the cut-to-length sequence, vacuum lifter 780 starts moving down (3–SOL–D is energized) and vacuum is applied to vacuum chamber 783 (2–SOL–VO is energized). A short time-delay period then follows during which vacuum lifter 780 is held down and the vacuum in vacuum chamber 783 builds up, gripping the fabric on main conveyor belt 400. Thereafter, vacuum lifter 780 starts going up (3–SOL–U is energized). When vacuum lifter 780 reaches its upper position, mechanical lifter frame 960 starts to move up (5–SOL–U is energized), and, when frame 960 reaches its raised position, fabric clamping means 900 starts raising to clamp the fabric (7–SOL–U is energized).

When the fabric at cut-to-length unit E has been clamped by fabric clamping 900, knife traverse motor MTR–6 becomes energized and begins moving knife 873 through a cutting stroke. Shortly thereafter, while knife 873 is in the early portion of its cutting stroke, operation selector stepping relay CR–OS receives an indexing signal from line 333 and begins indexing from position 8 to position 9 at T–412. Accordingly, stepping relay CR–OS (line 165) indexes into position 9 during the time period in which knife 873 of cut-to-length unit E is proceeding through its cutting stroke.

As in earlier stepping sequences, the energization of stepping relay CR–OS (line 165) causes its contacts in line 170 to open, thereby de-energizing control relay 10–CR (line 170) at T–413. This, in turn, causes contacts 10–CR in line 165 to open, thereby de-energizing stepping relay CR–OS at T–414. Its contacts CR–OS (line 170) thus close, thereby re-energizing control relay 10–CR (line 170) at T–415 and completing the indexing sequence in which stepping relay CR–OS shifts from position 8 to position 9.

J. Stepping Relay CR–OS in Position 9: The indexing of stepping relay CR–OS (line 165) to position 9 causes the following changes to occur, with respect to its contacts, in preparation for moving the soon to be remnant piece of fabric from ply 3 to the back-up position: Contacts CR–OS–8 (line 404) open, de-energizing position 8 lamp 1197 (line 404); contacts CR–OS–9 (line 405) close, energizing position 9 lamp 1198 (line 405); contacts CR–OS–2A (line 236) close, concurrently energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237); contacts CR–OS–12A (line 185) close without further effect; contacts CR–OS–13A (line 259) close, energizing control relay 30–CR (line 260); contacts CR–OS–14A (line 337) open, de-energizing control relay 58–CR (line 337) and removing the indexing voltage from the indexing terminal of line 333, the de-energization of control relay 58–CR (line 337), in turn, causing valve solenoid 2–SOL–VO (line 309) to become de-energized at T–416 due to the opening of contacts 58–CR (line 311); and, finally, contacts CR–OS–17A (line 265) close, pre-conditioning the indexing terminal of line 265 for subsequent energization in connection with indexing stepping relay CR–OS from position 9 to position 10.

Shortly after the indexing to position 9 is completed, knife 873 of cut-to-length unit E completes the return portion of its cutting stroke, causing the contacts of limit switch 8–LS in line 348 to close at T–420. This institutes the next sequence of events during which the remnant piece of fabric from ply 3 is lowered to main conveyor belt 400, deposited thereon, and moved upstream to the backup position of main conveyor belt 400. This sequence of events, which begins at T–420 with the closing of the contacts of limit switch 8–LS in line 348 and ends with the energization of control relay 24–CR (line 231) at T–459, is quite similar to the previously described sequence of events commencing at T–78 and ending at T–117. Accordingly, after first pointing out the differences between the earlier and later sequences, only a brief functional discussion of the actions occurring between T–420 and T–459 will be given, the reader being referred to the description of the earlier sequence for a more detailed analysis of the later sequence. One of the differences between the two sequences under consideration is that the section of fabric from which ply 3 was cut has been treated as being of sufficient length for its upstream edge not to uncover photocell 1–EYE (FIG. 77) when its downstream edge is positioned the length of ply 3 downstream of knife 873. On the other hand, the section of fabric from which ply 1 was cut was treated as being slightly shorter in length than the total distance separating photocells 1–EYE and 4–EYE. Thus, during the earlier sequence of T–78 through T–117, sensing relay 41–SR line 280) and control relay 41–CR (line 239) were energized, while, during the later sequence of T–420 through T–459, these two components are de-energized.

A second difference between the later sequence of T–420 to T–459 and the earlier sequence of T–78 to T–117 is that the later sequence omits the actions by which ply 1 is offset (involving the energization of valve solenoid 6–SOL–F, line 330, at T–87). The omission is due to operation selector stepping relay CR–OS being in position 9, causing its contacts CR–OS–3 in line 329 to be open. This precludes valve solenoid 6–SOL–F (line 330) from becoming energized during the sequence of T–420 to T–459. In addition, since mechanical lifter frame 960 is not offset during the later sequence, limit switch contacts 6–LS–F (line 219) and 6–LS–R (line 317) do not shift condition during this sequence, as they did in the earlier one.

The final difference to be mentioned relative to the two time periods under consideration is that during the later period, upper storage area 501 (FIG. 76) is down, and clutch 2–CLU (line 179) is energized, while in the earlier time period upper storage area 501 was raised, and clutch 1–CLU (line 175) was energized. Thus, the two time periods differ in this regard and also by virtue of the fact that contacts 1–LS–U (line 171) were closed during the earlier period, while contacts 1–LS–D (line 175) are closed during the later period.

Returning to the functional description of the actions which follow when limit switch contacts 8–LS (line 348) close at T–420, knife traverse motor MTR–6 (FIG. 77) becomes de-energized at this time to stop the cutting stroke of knife 873 with the knife at its home position. Then, fabric clamping means 900 starts lowering (7–SOL–D is energized) to unclamp the fabric. Next, the vacuum in vacuum chamber 783 is released (2–SOL–VR is energized), and vacuum lifter 780 starts to lower (3–SOL–D is energized). Thereafter, the operating mechanism for stripper 800 is lowered (4–SOL–D is energized), following which, vacuum lifter 780 is raised (3–SOL–U is energized), while stripper 800 remains down. This causes the remnant of ply 3 to be stripped from vacuum lifter 780 and deposited on main conveyor belt 400. Next, stripper 800 is raised (4–SOL–U is energized), and, following this, main conveyor drive motor MTR–7 becomes energized to move the remnant of ply 3 upstream at high speed. When the backup position of main conveyor belt 400 is reached (1–RVC counts out), main conveyor drive motor MTR–7 is stopped, and, following this, control relay 24–CR (line 231) becomes energized at T–459 to complete the sequence under consideration.

The energization of control relay 24–CR (line 231) at T–459 causes its contacts in line 165 to close, thereby energizing operation selector stepping relay CR–OS (line 165) at T–460 to index this relay from position 9 to position 10. The indexing voltage to stepping relay CR–OS comes from the indexing terminal in line 265 and reaches this terminal via a circuit which includes the following contacts: CR–OS–17A (line 265); 14–TR (line 272); the contacts of selector switch 2–SS in line 272, which are normally in the position shown; the two sets of contacts 30–CR in line 272; 53–CR (line 272); 1–RVC (line 272); and 27–CR (line 271).

When operation selector stepping relay CR–OS (line 165) becomes energized at T–460, its contacts CR–OS in line 170 open, thereby de-energizing control relay 10–CR (line 170) at T–461. Contacts 10–CR (line 180) thus open, de-energizing control relay 11–CR (line 182) without further effect, at T–462, and contacts 10–CR (line 197) close, energizing timing relay 14–TR (line 197) without further effect at T–462. Also, contacts 10–CR (line 165) open, thereby de-energizing stepping relay CR–OS (line 165) at T–462 and completing the indexing of this relay to position 10.

K. Stepping Relay CR–OS in Position 10: With the indexing of stepping relay CR–OS (line 165) into position 10, the following actions take place to set the electrical control system up for subsequent preparation of ply 4: Contacts CR–OS–9 (line 405) open, de-energizing position 9 lamp 1198 (line 405); contacts CR–OS–10 (line 211) close, concurrently energizing position 10 lamp 1199 (line 212) and revolution counter 4–RVC (line 211); contacts CR–OS–1A (line 234) close, concurrently energizing conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235); contacts CR–OS–2A (line 236) open, concurrently de-energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237); contacts CR–OS–13A (line 259) open, concurrently de-energizing control relay 29–CR (line 258), which is not listed in the sequential action diagrams of FIGURES 91 through 111, revolution counter 1–RVC (line 259), and control relay 30–CR (line 260); and, finally, contacts CR–OS–17A (line 265) open, removing the indexing voltage from the indexing terminal of line 265 to prevent premature stepping of relay CR–OS from position 10 to position 11.

In addition to the foregoing, when stepping relay CR–OS de-energizes at T–462 to complete its indexing into position 10, contacts CR–OS in line 170 close, thereby energizing control relay 10–CR (line 170) at T–463. As a result of this, contacts 10–CR in line 180 close, energizing control relay 11–CR (line 182) without further effect at T–464. In addition, contacts 10–CR (line 197) open, de-energizing timing relay 14–TR (line 197) at T–464, the time-delay contacts 14–TR in line 202 remaining closed during the timing period that follows. Also, contacts 10–CR (line 203) close, thereby energizing control relay 15–CR (line 203) through the closed time-delay contacts 14–TR in line 202. Control relay 15–CR thus remains energized until time-delay contacts 14–TR (line 202) open at T–470.

With the energization of control relay 15–CR at T–464 its contacts in line 185 close, thereby energizing control relay 12–CR (line 190) without further effect at T–465. In addition, contacts 15–CR (line 315) close, thereby concurrently energizing valve solenoids 2–SOL–VR (line 315) and 5–SOL–D (line 314) through a circuit including the following contacts: 15–CR (line 315); 26–CR (line 315); 52–CR (line 314); 24–CR (line 314); and, in the case of valve solenoid 5–SOL–D only, 27–CR (line 314). The energization of valve solenoid 2–SOL–VR results in no further action since the vacuum in vacuum chamber 783 (FIG. 77) had previously been released. The energization of valve solenoid 5–SOL–D (line 314), on the other hand, causes mechanical lifter frame 960 (FIG. 77) to start lowering ply 3 onto main conveyor belt 400.

When frame 960 starts lowering, contacts 5–LS–U (line 327) open (T–466), thereby de-energizing control relay 56–CR (line 327) without further effect at T–467. When frame 960 reaches its lower position and ply 3 is resting on main conveyor belt 400, contacts 5–LS–D (line 328) close (T–468), thereby energizing control relay 57–CR (line 328) at T–469. This, in turn, causes contacts 57–CR (line 221) to close, thereby energizing conveyor high speed motor control relay 7–MH (line 224), at T–470, through a circuit including the following contacts: 11–CR (line 218); 12–CR (line 218); 26–CR (line 220); 64–CR (line 221); 57–CR (line 221); 22–TR (line 224); 64–CR (line 223); 25–TR (line 224); and 27–CR (line 223).

The energization of conveyor high speed motor control relay 7–MH (line 224) at T–470 causes main conveyor drive motor MTR–7 (line 145) to start driving in a high speed forward direction by virtue of the closing of contacts 7–MH in lines 147, 148 and 149. In addition, contact 7–MH (line 240) close, concurrently energizing timing relay 28–TR (line 240) and applicator conveyor drive clutch 3–CLU (line 244) at T–471. Referring to FIG. 77, since applicator conveyor drive clutch 3–CLU and main conveyor drive motor MTR–7 are both energized, applicator conveyor belt 1061 and main conveyor belt 400 both begin moving in a downstream direction at high speed. This causes ply 3 to start transferring from the downstream end of main conveyor belt 400 to the upstream end of applicator conveyor belt 1061 and, also, causes the remnant piece of fabric from ply 3 to start moving downstream from the backup position towards splice slow down photocell 1–EYE.

In addition to the foregoing, the energization of conveyor high speed motor control relay 7–MH (line 224) at T–470 causes its contacts in line 230 to open, de-energizing control relay 24–CR (line 231) without further effect at T–471. Similarly, contacts 7–MH (line 213) close at this time, thereby energizing timing relay 18–TR (line 213) from line 211 at T–471. With the energization of timing relay 18–TR, its contacts in line 245 remain open during an approximately 0.6 second time-delay period following the energization of this relay. Similarly, time-delay contacts 18–TR (line 240) remain closed during this 0.6 second-time delay period.

As indicated earlier, time-delay contacts 14–TR in line 202 open when their timing period ends at T–470. As a result of this, control relay 15–CR (line 203) de-energizes at T–471. Accordingly, contacts 15–CR (line 315) open, concurrently de-energizing valve solenoids 2–SOL–VR (line 315) and 5–SOL–D (line 314) without further effect at T–472.

Remembering that applicator conveyor belt 1061 and main conveyor belt 400 (FIG. 77) are moving downstream at high speed, it will be seen that the trailing edge of ply 3 uncovers the light beam between lamp 1052 (line 289) and cut-to-length slow down photocell 3–EYE (line 288), thereby energizing sensing relay 43–SR (line 286) at T–473. As a result of this, contacts 43–SR (line 300) close, energizing control relay 43–CR (line 300) at T–474. With the energization of control relay 43–CR, its contacts in line 232 close and, in turn, cause the energization of timing relay 25–TR (line 233) without further effect at T–475.

The downstream movement of ply 3 also causes its trailing edge to uncover the light beam between lamp 1053 (line 293) and the cut-to-length stop photocell 4–EYE (line 292), thereby energizing sensing relay 44–SR (line 290) at T–474. This causes contacts 44–SR (line 302) to close, energizing control relay 44–CR (line 302) without further effect at T–475.

In the meantime, the remnant piece of fabric from ply 3 is being carried downstream by main conveyor belt 400 (FIG. 77). When the leading edge of the remnant reaches splice slow down photocell 1–EYE, it intercepts the light beam between lamp 842 (line 282) and photocell 1–EYE (line 281), thereby de-energizing sensing relay 41–SR (line 280) at T–475. By this time, ply 3 has been completely transferred from main conveyor belt 400 to applicator conveyor belt 1061, and the latter is ready to be stopped in the following manner.

When sensing relay 41–SR (line 280) de-energizes at T–475, its contacts 41–SR (line 227) close, energizing timing relay 22–TR (line 227) without further effect at T–476. In addition, contacts 41–SR (line 240) open, thereby concurrently de-energizing timing relay 28–TR (line 240), applicator conveyor clutch 3–CLU (line 243), and control relay 41–CR (line 239), at T–476. The de-energization of timing relay 28–TR causes its time-delay contacts in line 246 to begin their time-delay period of approximately 1 second, during which they remain closed; the de-energization of clutch 3–CLU disconnects applicator conveyor belt 1061 from main conveyor drive motor MTR–6; and the de-energization of control relay 41–CR causes its contacts 41–CR in line 246 to close, thereby energizing applicator conveyor brake 3–BRK (line 245) at T–477, via bridge rectifier 5–REC (line 246).

Accordingly at T–477, applicator conveyor belt 1061 is braked to a stop with ply 3 completely supported by the conveyor, at the upstream end thereof. In addition to the foregoing, time-delay contacts 18–TR (line 245) also close at T–477 (their time-delay period having ended) to insure that applicator conveyor brake 3–BRK (line 245) becomes energized at this time.

In the meantime, the continuing downstream movement of main conveyor belt 400 causes the leading edge of the remnant of ply 3 to intercept the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284). As a result of this, sensing relay 42–SR (line 283) becomes de-energized at T–476. With the de-energization of this relay, contacts 42–SR (line 276) open, de-energizing control relay 42–CR (line 276) at T–477. Accordingly, contacts 42–CR (line 264) close, causing control relay 32–CR (line 263) to become energized without further effect at T–478.

The next sequence of events occurs when the trailing edge of the remnant of ply 3 uncovers the light beam between lamp 842 (line 282) and splice slow-down photocell 1–EYE (line 281). This causes sensing relay 41–SR (line 280) to become energized at T–477. Contacts 41–SR (line 227) thus open, de-energizing timing relay 22–TR (line 227) at T–478, its time-delay contacts in line 224 remaining open during the timing period that follows this. In addition, contacts 41–SR (line 240) close, causing control relay 41–CR (line 239) to become energized at T–478.

The energization of control relay 41–CR at T–478 causes its contacts 41–CR in line 223 to open, and, since time-delay contacts 22–TR (line 224) are still open during their approximately 3.0 seconds time-delay period, conveyor high speed motor control relay 7–MH (line 224) becomes de-energized at T–479.

The de-energization of motor control relay 7–MH causes its contacts in line 213 to open, de-energizing timing relay 18–TR (line 213) at T–480. Consequently, time-delay contacts 18–TR in line 245 immediately open, de-energizing applicator conveyor brake 3–BRK (line 245) at T–481. Similarly, contacts 7–MH in lines 147, 148 and 149 open, de-energizing the high speed windings of main conveyor drive motor MTR–7 (line 145). In addition, contacts 7–MH (line 228) close, thereby concurrently energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–480. The energization of the latter, in turn, causes its time-delay contacts in line 230 to immediately close, thereby energizing conveyor brake control relay 7–MB (line 230) at T–481.

As a result of the foregoing, the low speed windings of main conveyor drive motor MTR–7 (line 145) become energized with A.C. voltage via contacts 7–ML (lines 144, 145 and 146), while one leg of the high speed windings of motor MTR–7 become energized with D.C. voltage via contacts 7–MB (lines 151, 152 and 153). Thus, main conveyor drive motor MTR–7 slows down, and the trailing edge of the remnant of ply 3 starts inching towards splice stop photocell 2–EYE (FIG. 77).

When the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284) becomes uncovered, sensing relay 42–SR (line 283) becomes energized (T–482). Accordingly, its contacts 42–SR (line

276) close, energizing control relay 42–CR (line 276) at T–483, while its contacts 42–SR (line 193) open, de-energizing control relay 12–CR (line 190) at T–483.

The energization of control relay 42–CR (line 276) at T–483 causes its contacts in line 273 to close, energizing control relay 33–CR (line 273) at T–484. This, in turn, causes contacts 33–CR (line 265) to open, de-energizing control relay 32–CR (line 263) without further effect at T–485.

The de-energization of control relay 12–CR (line 190) at T–483 causes its contacts 12–CR (line 218) to open, thereby concurrently de-energizing low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–484. The former action results in the opening of contacts 7–ML (lines 144, 145 and 146) and consequent de-energization of the low speed windings of main conveyor drive motor MTR–7 (line 145), while the latter action starts the timing period of timing relay 23–TR running, the time-delay contacts 23–TR (line 230) remaining closed during this period. Accordingly, conveyor brake control relay 7–MB (line 230) remains energized and its contacts in lines 151, 152 and 153 continue to apply a D.C. voltage to one leg of the high speed windings of main conveyor drive motor MTR–7 (line 145). Since all A.C. excitation has previously been disconnected from motor MTR–7, it is dynamically braked during the timing period of time-delay contacts 23–TR (line 230) and quickly stops. As a result of this, main conveyor belt 400 also stops, with the trailing edge of the remnant of ply 3 positioned beneath vacuum lifter 780.

When the timing period of timing relay 23–TR (line 229) is completed (T–486), time-delay contacts 23–TR in line 230 open, thereby de-energizing conveyor brake control relay 7–MB (line 230) at T–487. This causes contacts 7–MB (lines 151, 152 and 153) to open, thereby removing D.C. voltage from the high speed winding of main conveyor drive MTR–7 (line 145). Concurrently therewith, time-delay contacts 23–TR in line 231 complete their timing period and close. This causes control relay 24–CR (line 231) to become energized at T–487.

The energization of control relay 24–CR at T–487 initiates the start of two concurrent series of actions. In the first series of actions, the remnant of ply 3 is raised by vacuum lifter 780 and mechanical lifter frame 960 to a position above main conveyor belt 400 (FIG. 77), while in the second series of actions, bias cutter A (FIG. 75) goes through a bias-cutting cycle in which a new, narrow width, rhomboidal section of fabric is cut and deposited onto main conveyor belt 400, the main conveyor belt thereafter delivering this new section of fabric to splicing mechanism D (FIG. 77) for splicing this section to the remnant of ply 3.

These two series of actions, which take place between the time that control relay 24–CR becomes energized at T–487 and the time that this same relay again becomes energized at T–545, are essentially similar to the two series of actions that occurred between the time that control relay 24–CR become energized at T–149 and the time that this relay again became energized at T–207. Accordingly, a detailed description of these two series of actions will not be repeated at this time. Instead, a brief discussion of the functional steps which occur from T–487 to T–545 will be provided.

The only major difference between the earlier and the later time periods under consideration is that in the later period (T–487 to T–545, FIGS. 108 and 109) the bias cutter controls are set for cutting a narrow width section of fabric, rather than one of wide width. As a result of this, certain of the electrical components which were involved in the earlier cycling of the bias cutter are not involved in the later cycling of the bias cutter, and vice versa. Thus, referring to FIG. 106, at T–149 valve solenoid 11–SOL–R was energized, contacts 11–LS–RA were closed, and contacts 11–LS–FA were closed, while referring to FIG. 108 at T–487 the following electrical components, respectively, are energized or closed in their stead: valve solenoid 11–SOL–F, contacts 11–LS–RB, and contacts 11–LS–FB. As a result of this, any actions involving the three first-mentioned components during times T–149 through T–207 occur in a corresponding manner to the three second mentioned components during times T–487 through T–545.

The brief description of the functional steps which occur from T–487 to T–545 will now be given. Referring to FIG. 77, a vacuum is drawn on vacuum chamber 783 of vacuum lifter 780, and the vacuum lifter is lowered into contact with the trailing edge of the remnant piece of fabric from ply 3. Then, after a slight time-delay period during which the vacuum builds up in chamber 783, vacuum lifter 780 raises, carrying the upstream edge of the remnant piece of fabric from ply 3 along with it. Immediately thereafter, mechanical lifter frame 960 raises to lift the downstream portion of the remnant of ply 3 above main conveyor belt 400. When both the vacuum lifter 780 and the mechanical lifter frame 960 have been raised, all action at the splicing mechanism D and mechanical lifter unit F stops to await the arrival of a new, narrow width, rhomboidal section of fabric from bias cutter A (FIG. 75).

In the meantime, concurrently with the foregoing, bias cutter A goes through a cutting cycle in which it cuts a new, narrow width, rhomboidal section of fabric and deposits this section of fabric onto main conveyor belt 400 with its center line aligned with reference line X—X of FIG. 1–A. Then the main conveyor belt starts moving at high speed to bring the leading edge of this new section of fabric to splicing mechanism D (FIG. 77). When the leading edge of this section of fabric reaches splice slow-down photocell 1–EYE, main conveyor belt 400 slows to crawl speed. Thereafter, when the leading edge of this section of fabric blocks the light beam to splice stop photocell 2–EYE, main conveyor belt 400 comes to a stop with the leading edge of the new section of fabric positioned beneath and overlapped by the trailing edge of the remnant of ply 3. At this time (T–545), control relay 24–CR (line 231) becomes energized to initiate the next sequence of events, during which the trailing edge of the remnant of ply 3 is lowered onto the leading edge of the new section of fabric to splice the edges together and create a new strip of spliced fabric from which ply 4 may be cut to length.

Since this sequence of events, which occurs between T–545 and T–565, is essentially the same as the sequence of events occurring between T–207 and T–227, only a brief functional discussion of the events which take place will be given at this time, the reader being referred to the earlier description for a more detailed analysis of the circuits involved. Following the energization of control relay 24–CR at T–545, the vacuum in chamber 783 (FIG. 77) is released and vacuum lifter 780 and stripper 800 move to their lower positions. Concurrently therewith, mechanical lifter frame 960 is also moved to its lower position. Thereafter, stripper 800 is held in its lower position while vacuum lifter 780 is raised, thereby causing the strip of spliced fabric to be stripped from the vacuum lifter and deposited on main conveyor belt 400. Then stripper 800 is raised, and, when the stripper reaches its upper position, contacts 4–LS–U (line 181) close, thereby energizing control relay 11–CR (line 182) at T–565 and completing the sequence of events under consideration. The energization of control relay 11–CR at this time also marks the beginning of a new sequence of events during which the strip of spliced fabric on main conveyor belt 400 is moved downstream and metered to the length of ply 4, preparatory to cutting ply 4 to length.

The new sequence of events, involving the metering of the strip of spliced fabric to the length of ply 4, occurs between T–565 (upon energization of control relay

11–CR) and T–582 (when main conveyor belt 400 comes to a stop and control relay 24–CR in line 231 becomes energized). The description of this sequence of events is essentially similar to that of the sequence of events occurring between T–227 and T–244 (described earlier in connection with the metering to length of the strip of spliced fabric used in making ply 2), and, hence, it will not be repeated at this time. The only substantial difference between the two sequences under discussion is that revolution counter 4–RVC (line 211) controls the stopping point of main conveyor belt 400 during the later sequence of events, while revolution counter 2–RVC (line 206) controlled the stopping point of main conveyor belt 400 during the earlier sequence of events. Accordingly, when main conveyor belt 400 comes to a stop with the new strip of spliced fabric metered to the proper length from which to cut ply 4, control relay 24–CR (line 231) becomes energized (T–582).

With the energization of control relay 24–CR (line 231) at T–582, its contacts in line 165 close, thereby energizing operation selector stepping relay CR–OS (line 165) at T–583 to begin indexing this relay from position 10 to position 11. The indexing voltage to stepping relay CR–OS is supplied by the indexing terminal in line 253 which, in turn, is energized via contacts 4–RVC (line 257), these contacts being closed at this time due to their being in their "count out" position.

With the energization of stepping relay CR–OS (line 165) at T–583, its contacts in line 170 open, de-energizing control relay 10–CR (line 170) at T–584. This causes contacts 10–CR in line 180 to open, de-energizing control relay 11–CR (line 182) without further effect at T–585. It also causes contacts 10–CR in line 197 to close, energizing timing relay 14–TR (line 197) without further effect at T–585. In addition, contacts 10–CR in line 165 open, de-energizing stepping relay CR–OS (line 165) at T–585. Accordingly, contacts CR–OS in line 170 close, again energizing control relay 10–CR (line 170), at T–586. As with various earlier indexing sequences, the energization of control relay 10–CR (line 170) at T–586 causes its contacts 10–CR in line 180 to close, energizing control relay 11–CR (line 182) without further effect at T–587. It also causes contacts 10–CR in line 197 to open, de-energizing timing relay 14–TR (line 197) at T–587, the time-delay contacts 14–TR in line 202 remaining closed during the timing period that follows. In addition, contacts 10–CR in line 203 close, energizing control relay 15–CR (line 203) without further effect at T–587. At this time the indexing sequence during which stepping relay CR–OS (line 165) shifts from position 10 to position 11 is completed.

L. Stepping Relay CR–OS in Position 11: With the indexing of stepping relay CR–OS into position 11, the following actions take place to set the electrical control system up for subsequent cutting of ply 4 to length: Contacts CR–OS–10 (line 211) open, thereby concurrently de-energizing revolution counter 4–RVC (line 211) and position 10 lamp 1199 (line 212); contacts CR–OS–11 (line 406) close, causing position 11 lamp 1200 (line 406) to become illuminated; contacts CR–OS–1A (line 234) open, thereby concurrently de-energizing conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235), the de-energization of the latter, in turn, causing its contacts 26–CR in line 263 to open, de-energizing control relay 32–CR (line 264) without further effect at T–587; contacts CR–OS–12A (line 185) open without further effect; contacts CR–OS–14A (line 337) close, thereby energizing control relay 58–CR (line 337).

With the energization of control relay 58–CR (line 337) at T–586, a new sequence of events involving the cutting of ply 4 to length begins. This sequence of events starts at T–586 with the energization of control relay 58–CR and ends at T–619 with the energization of operation selector stepping relay CR–OS (while knife 873 in FIG. 77 is going through its cutting stroke). It is essentially the same as the sequenc of events commencing at T–35 and ending at T–70, and, therefore, only a brief discussion of the events occurring in the later period will be presented, the reader being referred to the earlier description for a detailed discussion of the sequential actions involved. In essence, the only difference between the sequence of T–586 through T–619 from that of T–35 through T-70 is that the time-delay period of timing relay 51–TR (line 319) in the later sequence is illustrated (in FIG. 101) as being six vertical "time" lines in length (T–595 through T–601), while in the earlier sequence the timing period of this relay was illustrated (in FIGS. 91 and 92) as being eight vertical "time" lines in length (T–44 through T–52). However, in actuality, the timing periods are exactly the same. Referring to FIG. 77, the actions which occur during the period T–586 through T–619 will now be briefly set forth.

Initially, a vacuum is drawn on chamber 783 of vacuum lifter 780 and, concurrently, the vacuum lifter is lowered to its down position. Then, after a short time-delay period in which the vacuum in chamber 783 builds up, vacuum lifter 780 is raised and, in turn, raises the upstream portion of the spliced fabric strip above main conveyor belt 400. Thereafter, mechanical lifter frame 960 moves to its upper position, raising the downstream portion of the spliced fabric strip above main conveyor belt 400. At this time, fabric clamping means 900 is raised in order to clamp the spliced fabric strip adjacent the point where the cut is to be made. When the fabric has been clamped securely, knife traverse motor MTR–6 becomes energized to start driving knife 873 through its cutting stroke. Immediately after the cutting stroke starts, operation selector stepping relay CR–OS (line 165) becomes energized (T–619) and starts indexing from position 11 to position 12.

With the energization of stepping relay CR–OS, its contacts in line 170 open, de-energizing control relay 10–CR (line 170) at T–620. This causes contacts 10–CR (line 165) to open, thereby de-energizing stepping relay CR–OS (line 165) at T–621. Contacts CR–OS in line 170 thus close, re-energizing control relay 10–CR (line 170) at T–623 and completing the indexing sequence in which stepping relay CR–OS shifts from position 11 to position 12.

M. Stepping Relay CR–OS in Position 12: The indexing of operation selector stepping relay CR–OS into position 12 causes the following actions to take place relative to setting up the electrical control system for moving the soon to be remnant of ply 4 to the backup position: Contacts CR–OS–11 (line 406) open, de-energizing position 11 lamp 1200 (line 406); contacts CR–OS–12 (line 407) close, causing position 12 lamp 1201 (line 407) to become illuminated; contacts CR–OS–2A (line 236) close, thereby concurrently energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237); contacts CR–OS–12A (line 185) close without further effect; contacts CR–OS–13A (line 259) close, energizing control relay 30–CR (line 260); contacts CR–OS–14A (line 337) open, de-energizing control relay 58–CR (line 337), this, in turn, causing contacts 58–CR in line 311 to open and de-energize valve solenoid 2–SOL–VO without further effect at T–623; and, finally, contacts CR–OS–17A (line 265) close, thereby preconditioning the indexing terminal of line 265 for subsequent application of an indexing voltage to operation selector stepping relay CR–OS.

It will be recalled that the above indexing of stepping relay CR–OS takes place while knife 873 (FIG. 77) is going through its cutting stroke (cutting ply 4 to length). When the indexing is completed, the electrical control system awaits the return of knife 873 to its home position before beginning a new sequence of actions. Accordingly, when knife 873 reaches its home position (at T–627) the new sequence of actions begins.

The new sequence of actions involves the stopping of knife traverse motor MTR–6, the lowering of the remnant of ply 4 onto main conveyor belt 400, and the moving of the remnant of ply 4 upstream to the backup position of the main conveyor belt. It takes place between T-627 (when limit switch contacts 8-LS in line 348 close) and T-667 (when stepping relay CR-OS in line 165 becomes energized to step from position 12 to position 13).

The sequence of actions occurring between T-627 and T-667 is essentially similar to the sequence of actions that occurred between T-78 and T-118, described earlier. The only significant differences between the earlier and the later sequences involve sensing relay 41-SR (line 280) and control relay 41-CR (line 239). These two relays were energized at the start of the earlier sequence, while they are de-energized at the start of the later sequence. The reason for this is that the remnant of ply 1 in the earlier sequence was arbitrarily assumed to be shorter than the distance between knife 873 and splice stop photocell 1-EYE, while the remnant of ply 4 in the later sequence is arbitrarily assumed to be longer than the distance between knife 873 and splice stop photocell 1-EYE. However, in neither case does the length of the remnant change the basic operation of the electrical control system in the two periods under consideration. Accordingly, since the earlier sequence of actions (T-78 through T-118) has been described in detail heretofore, the later sequence of actions (T-627 through T-667) will only be briefly alluded to at this time, the reader being referred to the earlier description for a detailed analysis of the sequential actions involved.

When knife 873 returns to its starting position at T-627, knife traverse motor MTR-6 stops. Then, fabric clamping means 900 is lowered to unclamp the fabric pieces. Thereafter, a vacuum is applied to vacuum chamber 783, and vacuum lifter 780 is lowered. Next, the operating mechanism of stripper 800 is lowered, and, while stripper 800 is held down, vacuum lifter 780 is raised. This causes the remnant of ply 4 to be stripped from vacuum lifter 780 and deposited on main conveyor belt 400. Subsequently, stripper 800 is raised to its upper position, and then main conveyor belt 400 starts moving the remnant of ply 4 upstream at high speed.

When main conveyor belt 400 has moved approximately six feet upstream to the backup position, revolution counter 1-RVC (line 259) counts out, causing main conveyor drive motor MTR-7 to begin braking to a stop. When the braking action is over, at T-666, control relay 24-CR (line 231) becomes energized. This, in turn, causes its contacts 24-CR in line 165 to close, energizing operation selector stepping relay CR-OS (line 165) at T-667 from the indexing terminal in line 265. Accordingly, stepping relay CR-OS begins indexing from position 12 to position 13, the indexing sequence being similar to that described earlier in connection with the indexing of this relay, for example, from position 10 to position 11 (T-583 through T-587). Hence, control relays 15-CR (line 203) and 11-CR (line 182) become energized at T-671, while timing relay 14-TR (line 197) becomes de-energized at that time.

N. Stepping Relay CR-OS in Position 13: The indexing of operation selector stepping relay CR-OS (line 165) to position 13 causes the following actions to occur relative to setting the electrical control system up to prepare another narrow width section of fabric and splice this section to the remnant of ply 4. Contacts CR-OS-12 (line 407) open, de-energizing position 12 lamp 1201 (line 407). Contacts CR-OS-13 (line 408) close, causing position 13 lamp 1202 (line 408) to become illuminated. Contacts CR-OS-1A (line 234) close, thereby concurrently energizing conveyor forward control relay 7-MF (line 234) and control relay 26-CR (line 235). Contacts CR-OS-2A (line 236) open, thereby concurrently de-energizing conveyor reverse control relay 7-MR (line 236) and control relay 27-CR (line 237). Contacts CR-OS-11A (line 214) close, thereby energizing control relay 19-CR (line 214). This causes further sequential action which will be considered in the next paragraph. Contacts CR-OS-12A (line 185) open, but no further action results therefrom. Contacts CR-OS-13A (line 259) open, thereby concurrently de-energizing revolution counter 1-RVC (line 259), control relay 30-CR (line 260), and control relay 29-CR (line 258), the latter relay action not being indicated in the sequential action diagrams of FIGS. 91 through 111. And, finally, contacts CR-OS-17A (line 265) open, de-energizing the indexing terminal of line 265 to prevent premature indexing of stepping relay CR-OS from position 13 to position 14.

The energization of control relay 19-CR (line 214) at T-670, due to the closing of contacts CR-OS-11A in line 214, causes the following additional actions to occur. Contacts 19-CR (line 287) close, thereby shorting together terminals 8 and 11 of sensing relay 43-SR (line 286). This causes sensing relay 43-SR to become energized at T-671, the sensing relay thereafter remaining energized whether or not the light beam from lamp 1052 (line 289) illuminates cut-to-length slow-down photocell 3-EYE (line 288). In turn, contacts 43-SR (line 300) close, thereby energizing control relay 43-CR (line 300) at T-672. Contacts 42-CR in line 232 thus close, energizing timing relay 25-TR (line 233) without further effect at T-673.

Similarly, contacts 19-CR (line 291) close with the energization of control relay 19-CR (line 214) at T-670, and this causes sensing relay 44-SR (line 290) to become energized at T-671, the sensing relay thereafter remaining energized whether or not the light beam from lamp 1053 (line 293) illuminates the cut-to-length stop photocell 4-EYE (line 292). In turn, contacts 44-SR (line 302) close, thereby energizing control relay 44-CR (line 302) without further effect at T-672.

Remembering that control relay 15-CR (line 203) became energized, at T-671, when stepping relay CR-OS finished indexing into position 13, it will be seen that its contacts 15-CR in line 315 thus close, thereby concurrently energizing valve solenoids 2-SOL-VR (line 315) and 5-SOL-D (line 314) at T-672. Since the vacuum in chamber 783 (FIG. 77) has previously been broken, the energization of valve solenoid 2-SOL-VR causes no further action to occur at this time. The energization of valve solenoid 5-SOL-D, however, causes mechanical lifter frame 960 to start moving down. Thus, contacts 5-LS-U (line 327) open (T-673), thereby de-energizing control relay 56-CR (line 327) without further effect at T-674. When frame 960 reaches its lower position, contacts 5-LS-D (line 328) close (T-675), thereby energizing control relay 57-CR (line 328) without further effect at T-676.

At T-677, time-delay contacts 14-TR (line 202) complete their time-delay period and open. This causes control relay 15-CR (line 203) to become de-energized at T-678. With the de-energization of control relay 15-CR, its contacts in line 315 open, thereby concurrently de-energizing valve solenoids 2-SOL-VR (line 315) and 5-SOL-D (line 314) without further effect at T-679.

At this time all sequential actions of the electrical control system stop, and the system awaits a signal from the operator at tire building station J (FIG. 77) before resuming automatic operation. This waiting period has been indicated by the absence of a vertical "time" line between T-680 and T-682. The condition of the tire building apparatus at T-680 is summarized in the following paragraph.

Plies 1 and 2 have been wound on tire building drum 1060 (FIG. 77) and the operator at tire building station J is involved in applying and setting bead rings thereto. Ply 3, which was previously cut to length, lowered to main conveyor belt 400, and shifted to applicator conveyor belt 1061, is resting on the upstream end of the applicator conveyor belt. Ply 4, which also was cut-to-length and lowered onto main conveyor belt 400, is now resting at the downstream end of the main conveyor belt. In addition, the remnant piece of fabric from ply 4 is resting on main conveyor belt 400, at its backup position, approximately six feet upstream of splice slow-down photocell 1–EYE.

When the operator at tire building station J finishes setting the beads on plies 1 and 2 of the partially completed carcass, he concurrently starts drum 1060 rotating in a counterclockwise direction, energizes the independent applicator conveyor drive motor 1092, and extends first applicating means 1063 into contact with the lower surface of drum 1060. Hence, ply 3 is carried by applicator conveyor belt 1061 into contact with drum 1060, and, consequently, the ply is wound about the drum. When this operation is completed, first applicating means 1063 is retracted, the direction of rotation of drum 1060 is reversed, and second applicating means 1064 is extended. Accordingly, applicator conveyor belt 1061 is now ready to receive ply 4 from main conveyor belt 400, and, therefore, the operator now signals the electrical control circuits to again begin automatic operation.

Referring to FIGS. 81 and 103, the operator's signal is given at T–683 by the depression of push-button switch PB–8 (line 186). At this time contacts PB–8 in line 186 close, and contacts PB–8 in line 246 open. The closing of contacts PB–8 in line 186 causes control relay 12–CR (line 190) to become energized at T–684. As a result of this, contacts 12–CR (line 218) close, thereby energizing conveyor high speed motor control relay 7–MH (line 224) at T–685 through a circuit including the following contacts: 11–CR (line 218); 12–CR (line 218); 26–CR (line 220); 64–CR (line 221); 57–CR (line 221); 22–TR (line 224); 64–CR (line 223); 43–SR (line 223); and 27–CR (line 223). In addition, contacts 7–MH (line 240) close, thereby concurrently energizing timing relay 28–TR line 240) and applicator conveyor drive clutch 3–CLU line 243) at T–686. Also, contacts 7–MH (line 230) open, thereby de-energizing control relay 24–CR (line 231) without further effect at T–686.

As a result of the foregoing, main conveyor drive motor MTR–7 starts rotating at high speed in a forward direction, driving main conveyor belt 400 downstream at high speed. Also, applicator conveyor belt 1061, which formerly was driven by motor 1092, is now being driven by motor MTS–7, the overruning clutch 1090 allowing this shift in driving source to occur. According, ply 4 begins transferring to applicator conveyor belt 1061, while the remnant of ply 4 starts moving downstream towards splice slow-down photocell 1–EYE.

As indicated earlier, terminals 8 and 11 of sensing relays 43–SR (line 286) and 44–SR (line 290) are shunted by the contacts of control relay 19–CR in lines 287 and 291, respectively. Hence, when main conveyor belt 400 carries the trailing edge of ply 4 beyond photocells 3–EYE (line 288) and 4–EYE (line 292), sensing relays 43–SR (line 286) and 44–SR (line 290) remain unaffected. However, with the continuing downstream movement of main conveyor belt 400, the leading edge of the remnant of ply 4 intercepts the light beam between lamp 842 (line 282) and splice slow-down photocell 1–EYE (line 281), thereby de-energizing sensing relay 41–SR (line 280) at T–690. As a result of this, contacts 41–SR (line 240) open, thereby concurrently de-energizing control relay 41–CR (line 239), timing relay 28–TR (line 240), and applicator conveyor drive clutch 3–CLU (line 243) at T–691. Also, contacts 41–SR in line 227 close, energizing timing relay 22–TR without further effect at T–691.

The de-energization of control relay 41–CR (line 239) at T–691 does not result in any further sequential action. The de-energization of timing relay 28–TR (line 240) at T–691 starts its time-delay period running, its contacts 28–TR in line 246 remaining closed during the approximately one second long timing period of this relay. The de-energization of applicator conveyor clutch 3–CLU (line 243) at T–691 causes driving control over applicator conveyor belt 1061 to shift back to the independent, manually controlled, drive motor 1092.

As the downstream movement of main conveyor belt 400 continues, the leading edge of the remnant of ply 4 intercepts the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284), de-energizing sensing relay 42–SR (line 283) at T–691. Hence, contacts 42–SR (line 276) open, de-energizing control relay 42–CR (line 276) at T–692. This, in turn, causes contacts 42–CR (line 264) to close, energizing control relay 32–CR (line 263) without further effect at T–693.

The next sequential action occurs when the trailing edge of the remnant of ply 4 uncovers the light beam between lamp 842 (line 282) and splice slow-down photocell 1–EYE (line 281). This causes sensing relay 41–SR (line 280) to become energized at T–692. Thus, contacts 41–SR (line 240) close, thereby energizing control relay 41–CR (line 239), timing relay 28–TR (line 240), and applicator conveyor drive clutch 3–CLU (line 243) at T–693, the latter shifting driving control over applicator conveyor belt 1061 back to main conveyor drive motor MTR–7. In addition, contacts 41–SR (line 227) open, thereby de-energizing timing relay 22–TR (line 227) and starting its contacts in line 224 on their three second time-delay period, during which they remain open.

The foregoing energization of control relay 41–CR at T–693 institutes the next sequence of actions when its contacts in line 223 open, de-energizing conveyor high speed motor control relay 7–MH (line 224) at T–694. This causes contacts 7–MH (line 228) to close, thereby concurrently energizing conveyor low-speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–695 the latter causing time-delay contacts 23–TR (line 230) to close and energize conveyor brake control relay 7–MB (line 230) at T–696.

As with similar sequences described earlier, the foregoing actions result in the shifting of main conveyor drive motor MTR–7 (line 145) from high speed forward operation to low speed forward operation, and, thus, the trailing edge of the remnant of ply 4 starts inching towards splice stop photocell 2–EYE.

The de-energization of conveyor high speed motor control relay 7–MH at T–694 also causes its contacts in line 240 to open, thereby de-energizing timing relay 28–TR (line 240) and applicator conveyor clutch 3–CLU (line 243) at the same time that main conveyor belt 400 begins to slow down. The de-energization of timing relay 28–TR causes its contacts 28–TR (line 246) to again start their timing period, and, thus, these contacts remain closed for approximately 1.0 second thereafter. The de-energization of applicator conveyor drive clutch 3–CLU (line 243) causes driving control over applicator conveyor belt 1061 to again be shifted to the independent, manually controlled, drive motor 1092.

In addition to the foregoing, when the operator at tire building station J sees main conveyor belt 400 begin to slow down he releases push-button switch PB–8 (line 186), and, therefore, at T–695, contacts PB–8 (line 186) open, while contacts PB–8 (line 246) close. Since contacts 41–CR (line 246) have previously opened, the closing of contacts PB–8 (line 246) has no effect on applicator conveyor brake 3–BRK (line 245), and, therefore, ply 4 continues on to tire building drum 1060 under the manual control of the operator.

As the forward low speed movement of main conveyor belt 400 continues, the trailing edge of the remnant of ply 4 moves into position beneath vacuum lifter 780 and uncovers the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284). This causes sensing relay 42–SR (line 283) to become energized at T–697. Accordingly, contacts 42–SR (line 276) close, energizing control relay 42–CR (line 276) at T–698. When this happens, contacts 42–CR (line 273) close, energizing control relay 33–CR (line 273) at T–699. The energization of control relay 33–CR, in turn, causes its contacts 33–CR in line 216 to close, thereby energizing control relay 20–CR (line 216) without further effect at T–700. Also, contacts 33–CR (line 265) open, de-energizing control relay 32–CR (line 263) at T–700 without further effect.

In addition to the foregoing, with the energization of sensing relay 42–SR (line 283) at T–697 its contacts 42–SR in line 193 open, de-energizing control relay 12–CR (line 190) at T–698. As a result of this, contacts 12–CR (line 218) open, thereby simultaneously de-energizing low-speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–699.

With the de-energization of timing relay 23–TR, its contacts in lines 230 and 231 start their approximately 0.2 second time-delay period. Contacts 23–TR (line 230) remain closed during this period, keeping conveyor brake control relay 7–MB (line 230) energized, while contacts 23–TR (line 231) remain open during this period keeping control relay 24–CR (line 231) de-energized. As a result of the foregoing, main conveyor drive motor MTR–7 (line 145) has a D.C. voltage applied to one leg of its high speed windings after all A.C excitation voltage has been removed. Consequently, main conveyor drive motor MTR–7 is dynamically braked to a halt during the time delay period of relay 23–TR, the remnant of ply 4 stopping with its trailing edge in line with vacuum lifter 780.

At the end of the time-delay period of timing relay 23–TR (line 229), contacts 23–TR (line 230) open, de-energizing conveyor brake control relay 7–MB (line 230) at T–702. Contacts 7–MB in lines 151, 152 and 153, in turn, open and remove the D.C. voltage from motor MTR–7 (line 145). Also, time-delay contacts 23–TR (line 231) close, energizing control relay 24–CR (line 231) at T–702 to begin the next phase of operation.

The energization of control relay 24–CR at T–702 marks the beginning of two separate, concurrent, sequences of actions. One of these sequences involves the raising of the remnant of ply 4 by vacuum lifter 780 and mechanical lifter frame 960 (FIG. 77), while the other of these sequences involves the cutting of a new, narrow width, rhomboidal section of fabric by bias cutter A (FIG. 75) and the depositing of this section of fabric onto main conveyor belt 400.

Considering first the sequence involving the raising of the remnant play of ply 4, the energization of control relay 24–CR (line 231) at T–702 causes its contacts in line 310 to close, thereby concurrently energizing valve solenoid 2–SOL–VO (line 309) and valve solenoid 3–SOL–D (line 310) at T–703. Referring to FIG. 77, this causes a vacuum to be drawn on chamber 783 of vacuum lifter 780 and, also, causes vacuum lifter 780 to start lowering. As vacuum lifter 780 starts moving down, contacts 3–LS–U (line 326) open, de-energizing control relay 55–CR (line 326) at T–705. This causes contacts 55–CR (line 182) to open, thereby de-energizing control relay 11–CR (line 182) without further effect at T–706. Similarly, contacts 55–CR (line 321) open, de-energizing valve solenoid 4–SOL–U (line 321) without further effect at T–706.

When vacuum lifter 780 reaches its lower position, contacts 3–LS–D (line 325) close, thereby energizing control relay 54–CR (line 325) at T–707. Hence, contacts 54–CR (line 322) close, energizing control relay 53–CR (line 323) at T–708.

With the energization of control relay 53–CR, its contacts in line 310 open, de-energizing valve solenoid 3–SOL–D without further effect at T–709. In addition, contacts 53–CR (line 317) close, causing valve solenoid 6–SOL–R (line 318) and timing relay 51–TR (line 319) to become energized at T–709. The energization of valve solenoid 6–SOL–R does not result in any further sequential action since mechanical lifter frame 960 is already at its home position. However, the energization of timing relay 51–TR causes its contacts 51–TR (line 317) to start their timing period, and, thus they remain open for the next approximately 0.8 second. Accordingly, vacuum builds up in chamber 783 of vacuum lifter 780, and the vacuum lifter firmly grasps the trailing edge of the remnant of ply 4. At the end of the time-delay period, contacts 51–TR (line 317) close (T–718), energizing valve solenoid 3–SOL–U (line 316) at T–719. Hence, vacuum lifter 780 starts moving up to its raised position, carrying the trailing edge of the remnant of ply 4 along with it.

From this point T–719 through T–730, the sequence under discussion duplicates an earlier sequence that occurred between T–165 and T–176. Accordingly, only a brief description of the steps taking place during this period will be given, the reader being referred to the earlier description for a detailed analysis of the sequential actions involved. Referring to FIG. 77, when vacuum lifter 780 reaches its raised position, mechanical lifter frame 960 starts moving up (5–SOL–U is energized) to raise the downstream portion of the remnant of ply 4. By T–730, after frame 960 has reached its upper position, that portion of the electrical control system represented by FIG. 104 becomes inactive and awaits a signal from the bias cutter portion of the system indicating that a new, narrow width, rhomboidal section of fabric has been cut and deposited on main conveyor belt 400. The development of this signal, which occurs at T–741 when control relay 64–CR (line 372) become energized, will now be considered.

It will be recalled that when control relay 24–CR (line 231) became energized at T–702, it instituted, in addition to the foregoing sequence of events relative to the remnant of ply 4, a second sequence of events involving the cutting of a new, narrow width, rhomboidal section of fabric and the depositing of this section of fabric onto main conveyor belt 400. Referring to FIGS. 110 and 111, this sequence of events occurs between T–702 (when control relay 24–CR became energized) and T–741 (when control relay 64–CR in line 372 becomes energized). Since this sequence of events is exactly the same as an earlier sequence of events which occurred between T–487 and T–526 (FIGS. 108 and 109) and, in addition, is also quite similar to a still earlier sequence of events which occurred between T–149 and T–188 (FIGS. 106 and 107), a description of the later sequence will not be duplicated at this time, the reader's attention being directed to the earlier discussions for a detailed analysis of the sequential actions involved. Also, at the same time that control relay 64–CR becomes energized, unlatch coil 62–CRU (line 373) energizes at T–741 (FIG. 110) to institute a brief sequence of actions in the bias cutter circuits. This sequence involves the moving of fabric pull out carriage 55 (FIG. 75) back to its starting position (adjacent fabric cutting unit 200) and takes place between T–741 and T–748 (when sensing relay 67–SR in line 380 energizes). This sequence of events is exactly the same as an earlier sequence of events which occurred between T–526 and T–533 (FIG. 109) and, in addition, is also quite similar to a still earlier sequence of events which occurred between T–188 and T–195 (FIG. 107). Here, again, the reader is referred to the earlier sequences for a more detailed analysis of the sequential actions involved.

Referring back to FIG. 104, when control relay 64–CR (line 372) becomes energized at T–741, after the new, narrow width, rhomboidal section of fabric has been deposited on main conveyor belt 400, its contacts in line 273 open, thereby de-energizing control relay 33–CR (line 273) at T–742. With the de-energization of control relay 33–CR, its contacts in line 310 open, de-energizing valve solenoid 2–SOL–VO (line 309) without further effect at T–743. Similarly, contacts 33–CR (line 195) open, de-energizing timing relay 13–TR (line 195) at T–743. When timing relay 13–TR becomes de-energized, its time-delay contacts 13–TR (line 180), which had theretofore been open, remain open during the time-delay period of approximately 0.2 second that follows, and then they close

(T–745). When contacts 13–TR (line 180) close, control relay 11–CR (line 182) becomes energized at T–746.

As a result of the foregoing, contacts 11–CR (line 218) close, energizing conveyor high speed motor control relay 7–MH (line 224) at T–747. This causes main conveyor drive motor MTR–7 (line 145) to start driving main conveyor belt 400 (FIG. 77) at high speed in a forward direction so that the new, narrow width, section of fabric, which was previously deposited on the conveyor belt by bias cutter A, starts moving downstream toward splicing mechanism D. Also, contacts 7–MH (line 230) open with the energization of motor control relay 7–MH, thereby de-energizing control relay 24–CR (line 231) without further effect at T–748.

As the downstream movement of main conveyor belt 400 continues, the leading edge of the new section of fabric intercepts the light beam between lamp 842 (line 282) and the splice slow-down photocell 1-EYE (line 281), thereby de-energizing sensing relay 41–SR (line 280) at T–749. Contacts 41–SR (line 240) thus open, de-energizing control relay 41–CR (line 239) without further effect at T–750. Similarly, contacts 41–SR (line 227) close, energizing timing relay 22–TR (line 227) without further effect at T–750. Also, contacts 41–SR (line 225) open, de-energizing conveyor high speed motor control relay 7–MH (line 224) at T–750. This, in turn, removes the A.C. excitation from the high speed windings of main conveyor drive motor MTR–7 (line 145).

In addition to the foregoing, the de-energization of motor control relay 7–MH (line 224) at T–750 causes its contacts 7–MH in line 228 to close, thereby concurrently energizing conveyor low speed motor control relay 7–ML (line 228) and conveyor brake timing relay 23–TR (line 229) at T–751. The energization of motor control relay 7–ML causes contacts 7–ML in lines 144, 145 and 146 to close and energize the low speed windings of main conveyor drive motor MTR–7 (line 145) with A.C. voltage. The energization of timing relay 23–TR causes its time-delay contacts in line 230 to immediately close, thereby energizing conveyor brake control relay 7–MB (line 230) at T–752. When conveyor brake control relay 7–MB becomes energized, its contacts in lines 151, 152 and 153 close thereby applying a D.C. voltage to one leg of the high speed windings of main conveyor drive motor MTR–7 (line 145). Thus the main conveyor drive motor slows down to a crawling speed, and the leading edge of the new section of fabric inches towards splice stop photocell 2–EYE (FIG. 77).

When the leading edge of the fabric intercepts the light beam between lamp 843 (line 285) and splice stop photocell 2-EYE (line 284), sensing relay 42–SR (line 283) becomes de-energized at T–753, and, in turn, de-energizes control relay 42–CR (line 276) at T–754 due to the opening of contacts 42–SR (line 276). The de-energization of control relay 42–CR causes contacts 42–CR in line 264 to close, thereby energizing control relay 32–CR (line 263) at T–755. With the energization of control relay 32–CR, contacts 32–CR in line 192 open, de-energizing control relay 12–CR (line 190) at T–756.

The de-energization of control relay 12–CR opens contacts 12–CR in line 218 to concurrently de-energize timing relay 22–TR (line 227), conveyor motor control relay 7–ML (line 228), and conveyor brake timing relay 23–TR (line 229), at T–757. Time-delay contacts 23–TR (line 230), which were closed prior to the de-energization of timing relay 23–TR, thereafter remain closed for an approximately 0.2 second time-delay period. During this time conveyor brake control relay 7–MB (line 230) remains energized, and its contacts in line 151, 152 and 153 maintain the D.C. voltage to drive motor MTR–7 (line 145) after all A.C. voltage has been disconnected from the motor. Accordingly main conveyor drive motor MTR–7 stops main conveyor belt 400 with the leading edge of the new section of fabric positioned beneath the trailing edge of the remnant of ply 4.

When the time-delay period of timing relay 23–TR (line 229) expires, time-delay contacts 23–TR (line 230) open, de-energizing conveyor brake control relay 7–MB (line 230) at T–760. This causes contacts 7–MB in lines 151, 152 and 153 to open, removing the D.C. voltage from drive motor MTR–7 (line 145). In addition, time-delay contacts 23–TR (line 231) close at the end of the timing period, thereby energizing control relay 24–CR (line 231) at T–760. When control relay 24–CR becomes energized at T–760, it initiates a new sequence of actions during which the trailing edge of the remnant of ply 4 and the leading edge of the new section of fabric are spliced together.

With the energization of control relay 24–CR at T–760, its contacts in line 314 close, concurrently energizing valve solenoids 2–SOL–VR (line 315), 5–SOL–D (line 314) and 3–SOL–D (line 310) at T–761. The energization circuit for valve solenoid 2–SOL–VR comprises the following contacts: 42–CR (line 314); 33–CR (line 314); 64–CR (line 314); 52–CR (line 314); and 24–CR (line 314). The energization circuit for valve solenoids 5–SOL–D (line 314) includes the same contacts as those used in energizing valve solenoid 2–SOL–VR but further includes contacts 27–CR (line 314). Similarly, the energization circuit for valve solenoid 3–SOL–D (line 310) includes the same contacts as those used in energizing valve solenoid 2–SOL–VR but further includes contacts 15–CR (line 311), contacts 58–CR (line 311), contacts 33–CR (line 311), the normally closed contacts of selector switch 5–SS in line 310, and contacts 52–CR (line 310).

Accordingly, referring to FIG. 77, valve solenoid 2–SOL–VR causes the vacuum to be released in chamber 783, valve solenoid 3–SOL–D causes vacuum lifter 780 to start lowering, and valve solenoid 3–SOL–D causes mechanical lifter frame 960 to start lowering.

The initial downward movement of mechanical lifter frame 960 causes contacts 5–LS–U (line 327) to open, de-energizing control relay 56–CR (line 327) without further effect at T–763. Similarly, when frame 960 reaches its lower position, contacts 5–LS–D (line 328) close, energizing control relay 57–CR (line 328) without further effect at T–765.

The initial downward movement of vacuum lifter 780 causes contacts 3–LS–U (line 326) to open, de-energizing control relay 55–CR (line 326) at T–763. This causes contacts 55–CR in line 321 to open, thereby de-energizing valve solenoid 4–SOL–U (line 321) without further effect at T–764. When vacuum lifter 780 reaches its lower position, causing the training edge of the remnant of ply 4 to be spliced to the leading edge of the new section of fabric to form a new strip of spliced fabric, contacts 3–LS–D (line 325) close, thereby energizing control relay 54–CR (line 325) at T–765. The energization of control relay 54–CR causes its contact in line 313 to close, resulting in the energization of valve solenoid 4–SOL–D (line 313) at T–766.

Referring to FIG. 77, when valve solenoid 4–SOL–D becomes energized, the operating mechanism for stripper 800 starts moving down in order to hold stripper 800 down while vacuum lifter 780 subsequently moves up. At the start of this downward movement, contacts 4–LS–U (line 181) open, thereby de-energizing control relay 11–CR (line 182) without further effect at T–768. When the operating mechanism for stripper 800 reaches its lower position, contacts 4–LS–D (line 320) close, thereby energizing control relay 52–CR (line 320) at T–770. The energization of control relay 52–CR, in turn, causes its contacts 52–CR in line 314 to open, thereby concurrently de-energizing valve solenoids 2–SOL–VR (line 315), 5–SOL–D (line 314), 4–SOL–D (line 313), and 3–SOL–D (line 310) without further effect at T–771 (FIG. 105).

Additionally, the energization of control relay 52–CR causes its two sets of contacts in line 316 to close, and, since contacts 26–CR (line 315) are closed at this time also, valve solenoid 3–SOL–U (line 316) becomes energized at T–771. Accordingly, vacuum lifter 780 (FIG. 77) starts moving up, while stripper 800 remains down. Since the vacuum in chamber 783 has previously been released, the fabric formerly grasped by vacuum lifter 780 is stripped therefrom and, thus, is now supported by main conveyor belt 400.

At the beginning of the upward movement of vacuum lifter 780, contacts 3–LS–D (line 325) open, de-energizing control relay 54–CR (line 325) at T–773. This causes contacts 54–CR in line 322 to open, resulting in the de-energization of control relay 53–CR (line 323) at T–774. The de-energization of control relay 53–CR marks the starting point of a new series of sequential actions which will be discussed after the sequential actions due to vacuum lifter 780 reaching its upper position are presented.

When vacuum lifter 780 reaches its upper position, contacts 3–LS–U (line 326) close, causing control relay 55–CR (line 326) to become energized at T–775. This causes contacts 55–CR in line 321 to close, thereby energizing valve solenoid 4-SOL–U (line 321) at T–776. Referring to FIG. 77, the energization of valve solenoid 4-SOL–U causes stripper 800 to start raising, and, initially, contacts 4–LS–D (line 320) open, thereby de-energizing control relay 52–CR (line 320) at T–778. The two sets of contacts 52–CR in line 316 thus open, de-energizing valve solenoid 3–SOL–U (line 316) without further effect at T–779. When stripper 800 reaches its upper position, contacts 4–LS–U (line 181) close, without further effect at T–779.

Referring to FIG. 111 and resuming a consideration of the events following the de-energization of control relay 53–CR (line 323) at T–774, when this happens contacts 53–CR in line 372 open, thereby concurrently de-energizing valve solenoid 15–SOL–U (line 371) and unlatching coil 62–CRU (line 373) without further effect at T–775 and also de-energizing control relay 64–CR (line 372). The de-energization of control relay 64–CR at this time initiates a new sequence of actions in the bias cutter circuits covered by FIG. 111, which will be considered hereinafter, and also affects the remaining electric circuits represented by FIG. 105.

Referring to FIG. 105, the de-energization of control relay 64–CR (line 372) at T–775 causes its contacts 64–CR in line 248 to close, thereby energizing the indexing terminal of line 253, which, in turn, energizes operation selector stepping relay CR–OS (line 165) at T–776 and causes this relay to begin indexing from position 13 to position 14.

The energization of stepping relay CR–OS causes contacts CR–OS in line 170 to open, thereby de-energizing control relay 10–CR (line 170). Contacts 10–CR (line 197) thus close, energizing timing relay 14–TR (line 197) without further effect at T–778. In addition, contacts 10–CR (line 165) open, thereby de-energizing stepping relay CR–OS (line 165) at T–778. When stepping relay CR–OS de-energizes, contacts CR–OS in line 170 close, thereby re-energizing control relay 10–CR (line 170) at T–779 and completing the indexing sequence in which stepping relay CR–OS shifts to position 14. Further effects of the energization of control relay 10–CR at T–779 will be considered in the following section, entitled "Stepping Relay CR–OS in Position 14," after the changes brought on by the indexing of stepping relay CR–OS into position 14 have been considered. However, before starting the next section, the effects in the bias cutter circuits of the de-energization of control relay 64–CR (line 372) at T–775 (FIG. 111) will be considered.

Referring to FIG. 111, when control relay 64–CR de-energizes at T–775, contacts 64–CR in line 374 close, energizing valve solenoid 15–SOL–D (line 374) at T–776. Referring to FIG. 75, this causes a vacuum to be applied to chamber 94 and also causes fabric gripping bar 91 to start lowering, thereby opening contacts 15–LS–U (line 372) without further effect at T–777 and closing contacts 15–LS–D (line 375) at T–779. The closing of contacts 15–LS–D causes the concurrent energization of timing relay 65–TR (line 375) and valve solenoid 14–SOL–U (line 377) at T–780, the time-delay contacts 65–TR in line 376 remaining open for approximately one second after timing relay 65–TR becomes energized to allow time for the vacuum in chamber 94 to build up prior to starting the table air blast.

With the energization of valve solenoid 14–SOL–U (line 377) at T–780, cutting position stop assembly 295 starts moving up to prepare for a subsequent metering stroke by fabric pull-out carriage 55. Accordingly, contacts 14–LS–D (line 351) open, de-energizing control relay 61–CR (line 351) at T–782. This causes contacts 61–CR (line 355) to open, de-energizing valve solenoid 11–SOL–F (line 355) without further effect at T–783. When stop assembly 295 reaches its raised position, contacts 14–LS–U (line 352) close, thereby re-energizing valve solenoid 11–SOL–F (line 355) without further effect at T–784.

When the timing period of time-delay contacts 65–TR in line 376 expires at T–790, these contacts close, thereby energizing valve solenoid 13–SOL–AO (line 376) at T–791. Referring to FIG. 75, this causes high pressure air to be directed to table chamber 264, thereby providing an air blast between the fabric and the table to facilitate a subsequent metering stroke by carriage 55. The bias-cutter now awaits the arrival of a new signal before commencing further actions.

O. Stepping Relay CR–OS in Position 14: The indexing of stepping relay CR–OS (line 165) into position 14 at T–778 causes the following actions to take place relative to setting up the electrical control system to move the narrow width strip of spliced fabric on main conveyor 400 upstream to the upper storage area 501: Contacts CR–OS–13 (line 408) open, de-energizing position 13 lamp 1202 (line 408); contacts CR–OS–14 (line 409) close, energizing position 14 lamp 1203 (line 409); contacts CR–OS–1A (line 234) open, thereby concurrently de-energizing conveyor forward control relay 7–MF (line 234), the indexing terminal of line 253, and control relay 26–CR (line 235), the de-energization of control relay 26–CR causing its contacts 26–CR in line 263 to open and de-energize control relay 32–CR (line 263) without further effect at T–780; contacts CR–OS–2A (line 236) close, thereby concurrently energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237); contacts CR–OS–12A (line 185) close without further effect; and, finally, contacts CR–OS–17A (line 265) close, preconditioning the indexing terminal of line 265 for subsequent energization relative to indexing stepping relay CR–OS from position 14 to position 15.

Remembering that control relay 10–CR (line 170) became energized at T–779 (at the completion of the indexing sequence), contacts 10–CR (line 180) close, energizing control relay 11–CR (line 182) without further effect at T–780. In addition, contacts 10–CR (line 197) open, de-energizing timing relay 14–TR (line 197), the contacts 14–TR in line 202 remaining closed during the 0.6 second timing period that follows this. Also, contacts 10–CR (line 203) close, thereby energizing control relay 15–CR (line 203) at T–780 through the closed time-delay contacts 14–TR in line 202.

The energization of control relay 15–CR causes its contacts in line 185 to close, thereby energizing control relay 12–CR (line 190) at T–781. As a result of this, contacts 12–CR (line 188) close, providing an energization circuit to control relay 12–CR that bypasses contacts 15–CR in line 185. Accordingly, when control relay 15–CR (line 203) becomes de-energized at T–787, due to the opening of time-delay contacts 14–TR (line 202) at the end of their timing period, the opening of contacts 15–CR (line 185) has no effect on control relay 12–CR.

In addition to the foregoing the energization of control relay 12–CR causes its contacts in line 218 to close, thereby concurrently energizing conveyor high speed motor control relay 7–MH (line 224) and timing relay 21–TR (line 225) at T–782. As a result of the foregoing, contacts 7–MH (line 230) open, thereby de-energizing control relay 24–CR (line 231) without further effect at T–783. In addition, contacts 7–MH (line 147, 148 and 149) close, thereby energizing the high speed windings of main conveyor drive motor MTR–7 (line 145). This causes main conveyor belt 400 (FIG. 77) to start moving upstream at high speed, carrying the strip of spliced, narrow width, fabric back towards upper storage conveyor belt 575 (FIG. 76). Belt 575 is also being driven at high speed in an upstream direction at this time due to the fact that clutch 2–CLU (line 179) is energized. In addition, upper storage 501 is in its lower position (valve solenoid 1–SOL–D is energized), and, accordingly, the strands of belt 575 are in position to receive the strip of spliced fabric from main conveyor belt 400.

As the strip of spliced fabric moves upstream, its downstream edge uncovers the light beam between lamp 843 (line 285) and splice stop photocell 2–EYE (line 284), thereby causing sensing relay 42–SR (line 283) to become energized at T–783. As a result of this, contacts 42–SR (line 276) close, energizing control relay 42–CR (line 276) without further effect at T–784. Next, the downstream edge of the strip of spliced fabric uncovers the light beam between lamp 842 (line 282) and the splice slow-down photocell 1–EYE (line 281), resulting in the energization of sensing relay 41–SR (line 280) at T–784. When this happens, contacts 41–SR (line 240) close, thereby energizing control relay 41–CR (line 239) without further effect at T–785.

As the upstream movement of main conveyor belt 400 continues, the upstream edge of the strip of spliced fabric transfers to upper storage conveyor belt 575 (FIG. 76) and, shortly thereafter, intercepts the light beam between lamp 610 (line 299) and upper storage photocell 6–EYE (line 298), thereby causing sensing relay 46–SR (line 297) to become de-energized at T–786. The de-energization of sensing relay 46–SR causes its contacts in line 306 to open, thereby de-energizing control relay 46–CR (line 306) at T–787. As a result of this, contacts 46–CR (line 263) close, thereby energizing control relay 31–CR without further effect at T–788.

The continuing upstream movement of main conveyor belt 400 and upper storage conveyor belt 575 causes the strip of spliced fabric to move entirely into upper storage area 501 (FIG. 76), and accordingly, the light beam between lamp 610 (line 299) and upper storage photocell 6–EYE (line 298) becomes uncovered, thereby energizing sensing relay 46–SR (line 297) at T–789. When this happens, contacts 46–SR (line 306) close, energizing control relay 46–CR (line 306) without further effect at T–780. In addition, contacts 46–SD (line 190) open, de-energizing control relay 12–CR (line 190) at T–790. This, in turn, causes contacts 12–CR (line 218) to open, thereby concurrently de-energizing conveyor high speed motor control relay 7–MH (line 224) and timing relay 21–TR (line 225) at T–791.

When motor control relay 7–MH and timing relay 21–TR de-energize at T–791, a short sequence of actions begins in which main conveyor drive motor MTR–7 (line 145) is brought to a stop. This sequence, which ends at T–798 when control relay 24–CR (line 231) becomes energized, is essentially the same as the sequence of actions that occurred earlier between T–326 and T–333, during which main conveyor drive motor MTR–7 (line 145) was stopped after the remnant of ply 2 had been returned to the lower storage area 500 (FIG. 76). Accordingly, the reader is referred to the earlier description for a detailed discussion of this stopping sequence.

As indicated above, when the strip of spliced, narrow width fabric stops in proper position in upper storage area 501, control relay 24–CR (line 231) becomes energized at T–798. As a result of this, contacts 24–CR in line 165 close, thereby energizing operation selector stepping relay CR–OS (line 165) at T–799 with an indexing signal that comes from the indexing terminal in line 265. The energization circuit for stepping relay CR–OS at this time includes the following: Contacts 31–CR (line 271); contacts 27–CR (line 271); contacts 45–CR (line 267); contacts 46–CR (line 267); contacts 30–CR (line 267); contacts CR–OS–17A (line 265); the indexing terminal of line 265; the indexing terminal of line 165; contacts CR–A (line 165); the normally closed contacts of push-button switch PB–7 in line 165; contacts 10–CR (line 165); and the just closed contacts 24–CR (line 165). Thus, operation selector stepping relay CR–OS (line 165) begins indexing from position 14 to position 15 at T–799.

When stepping relay CR–OS begins indexing, its contacts in line 170 open, de-energizing control relay 10–CR (line 170) at T–800. Accordingly, contacts 10–CR (line 180) open, de-energizing control relay 11–CR (line 182) without further effect at T–801, and contacts 10–CR (line 197) close, energizing timing relay 14–TR (line 197) without further effect at T–801. Additionally, contacts 10–CR (line 165) open, de-energizing stepping relay CR–OS (line 165) at T–801 and completing the indexing sequence in which this relay shifts to position 15.

P. Steeping Relay CR–OS in Position 15: The indexing of operation selector stepping relay CR–OS into position 15 causes the following actions to take place relative to setting up the electrical control system (1) to later index stepping relay CR–OS to position 16 and (2) to prepare for subsequent forward driving of main conveyor drive motor MTR–7: Contacts CR–OS–14 (line 409) open, de-energizing position 14 lamp 1203 (line 409); contacts CR–OS–15 (line 168) close, thereby providing a new source of indexing voltage for stepping relay CR–OS via lines 168 and 169; contacts CR–OS–2A (line 236) open, thereby concurrently de-energizing conveyor reverse control relay 7–MR (line 236) and control relay 27–CR (line 237), the de-energization of the latter, in turn, causing contacts 27–CR in line 261 to open, de-energizing control relay 31–CR (line 261) without further effect at T–803; contacts CR–OS–11A (line 214) open, thereby de-energizing control relay 19–CR (line 214), the de-energization of which (1) causes contacts 19–CR in line 216 to open, de-energizing control relay 20–CR (line 216) without further effect at T–803, and (2) causes contacts 19–CR in lines 287 and 291 to open, removing the shunting circuit between terminals 8 and 11 of sensing relays 43–SR (line 286) and 44–SR (line 290), respectively, without further effect at this time; contacts CR–OS–12A (line 185) open, but no further action results therefrom; and, finally, contacts CR–OS–17A (line 265) open to remove indexing voltage from the indexing terminal in line 265.

In addition to the foregoing, with the de-energization of stepping relay CR–OS upon indexing into position 15, its contacts CR–OS (line 170) close, thereby energizing control relay 10–CR (line 170) at T–802. This causes contacts 10–CR (line 180) to close, energizing control relay 11–CR (line 182) without further effect at T–803. Similarly, contacts 10–CR (line 203) close, energizing control relay 15–CR (line 203) without further effect at T–803. Also, contacts 10–CR (line 197) open, thereby de-energizing timing relay 14–TR (line 197) at T–803, the time-delay contacts 14–TR in line 202 remaining closed during the timing period that follows this. In addition to the foregoing, contacts 10–CR in line 165 close, thereby re-energizing operation selector stepping relay CR–OS (line 165) at T–803 through a circuit including contacts CR–OS–15 (line 168), contacts 10–CR (line 165) and contacts 24–CR (line 165). Accordingly, stepping relay CR–OS begins a new indexing sequence in which it shifts from position 15 to position 16.

The new indexing sequence of stepping relay CR–OS is similar to the previous one insofar as the control relays 10–CR (line 170) and 15–CR (line 203) and the timing relay 14–TR (line 197) are concerned. Thus, these relays cycle in the same manner between T–804 and T–807 as they did between T–800 and T–803. As at T–800, control relay 11–CR (line 182) becomes de-energized at T–804 with the opening of contacts 10–CR in line 180. However, this relay does not become energized again at T–807, as it did at T–803, due to the fact that, as will appear shortly, contacts CR–OS–4A (line 175) open when stepping relay CR–OS shifts to position 16.

Q. Stepping Relay CR–OS in Position 16: The indexing of stepping relay CR–OS into position 16 causes the following changes to take place relative to setting up the electrical control system (1) to later index stepping relay CR–OS from position 16 to position 1 and (2) to prepare for subsequent raising of upper storage area 501: Contacts CR–OS–15 (line 168) open, removing the previous indexing voltage from stepping relay CR–OS; contacts CR–OS–16 (line 169) close, providing a new indexing voltage source via line 169 for subsequently indexing stepping relay CR–OS from position 16 to position 1; and, contacts CR–OS–4A (line 175) open, thereby concurrently de-energizing valve solenoid 1–SOL–D (line 176) and upper storage drive clutch 2–CLU (line 179) without further effect at T–806.

In addition to the foregoing, when operation selector stepping relay CR–OS (line 165) de-energizes at the completion of its indexing into position 16 (T–805), its contacts CR–OS (line 170) close, thereby energizing control relay 10–CR (line 170) at T–806, as indicated at the end of the previous section. This causes contacts 10–CR in line 165 to close, thereby energizing operation selector stepping relay CR–OS (line 165) via contacts CR–OS–16 (line 169). As a result of this, the stepping relay starts indexing from position 16 to position 1, the stepping relay CR–OS becoming energized for this purpose at T–807. Contacts CR–OS (line 170) thus open, thereby de-energizing control relay 10–CR (line 170) at T–808. Accordingly, contacts 10–CR in line 165 open to de-energize stepping relay CR–OS at T–809 and complete the shifting of this relay from position 16 to position 1. In addition, contacts 10–CR (line 197) close, energizing timing relay 14–TR (line 197) without further effect at T–809, and contacts 10–CR (line 203) open, de-energizing control relay 15–CR (line 203) without further effect at T–809.

R. Stepping Relay CR–OS Back in Position 1: With the indexing of stepping relay CR–OS into position 1, the following changes occur to the condition of its contacts preparatory to processing a new ply 1: Contacts CR–OS–16 (line 169) open, thereby removing the previous indexing voltage from the stepping relay; contacts CR–OS–1 (line 205) close, thereby concurrently energizing control relay 16–CR (line 205) and position 1 lamp 1190 (line 204); contacts CR–OS–1A (line 234) close, thereby concurrently energizing conveyor forward control relay 7–MF (line 234) and control relay 26–CR (line 235); contacts CR–OS–3A (line 171) close, thereby energizing lower storage drive clutch 1–CLU (line 175), without further effect, and, also, energizing valve solenoid 1–SOL–U (line 172), the effects of which will be considered hereinafter; contacts CR–OS–12A (line 185) close; and, finally, contacts CR–OS–6A (line 355) open, while contacts CR–OS–5A (line 353) close.

Referring to FIGS. 87 and 111, the simultaneous opening of contacts CR–OS–6A (line 355) and closing of contacts CR–OS–5A (line 353) causes the following sequence of actions to occur in the bias-cutter circuits. Initially, valve solenoid 11–SOL–F (line 355) de-energizes at T–810, and valve solenoid 11–SOL–R (line 353) energizes at T–810. The de-energization of valve solenoid 11–SOL–F (line 355) is without further effect, while, referring to FIG. 75, the energization of valve solenoid 11–SOL–R (line 353) causes fabric width and drop control unit 275 to start moving from its narrow width setting to its wide width setting. In addition, the energization of valve solenoid 11–SOL–R causes dropping position stop assembly 320 to shift position (piston rod 321 extending out of power cylinder 322) so that subsequent cycling of the bias-cutter will result both in the cutting of wide width, rhomboidal sections of fabric and in the dropping of these sections of fabric with their center lines offset from the reference line X—X of FIG. 1A.

At the start of the movement of fabric width and drop control unit 275 from its narrow width setting to its wide width setting, limit switch contacts 11–LS–FA (line 354) close and limit switch contacts 11–LS–FB (line 356) open without further effect at T–811. When fabric width and drop control unit 275 reaches its wide width setting, limit switch contacts 11–LS–RA (line 354) close and limit switch contacts 11–LS–RB (line 356) open at T–813; however no further sequential actions result from the foregoing. Thus, at T–813, the bias-cutter circuits of FIGS. 87 and 88 are back to exactly the same conditions that existed at T–20 (FIG. 106). Thereafter, these circuits remain inactive until a new signal is received calling for the bias-cutter to cycle through the cutting of a new, wide width, rhomboidal section of fabric.

Referring to FIGS. 80 and 105, it will be seen that when stepping relay CR–OS (line 165) becomes de-energized at T–809, while indexing into position 1, its contacts CR–OS in line 170 close, thereby energizing control relay 10–CR (line 170) at T–810. Contacts 10–CR (line 197) thus open, thereby de-energizing timing relay 14–TR (line 197) at T–811. This starts time-delay contacts 14–TR (line 202) on their approximately 0.6 second time-delay period, during which they remain closed. Additional, contacts 10–CR (line 203) close, energizing control relay 15–CR (line 203) at T–811. When this happens, contacts 15–CR (line 315) close, thereby concurrently energizing valve solenoids 2–SOL–VR (line 315) and 5–SOL–D (line 314) without further effects at T–812. Also, contacts 15–CR (line 185) close, energizing control relay 12–CR (line 190) without further effect at T–812.

Recalling that valve solenoid 1–SOL–U (line 172) became energized at T–810 when stepping relay CR–OS shifted to position 1, it will be seen (FIG. 76) that upper storage area 501 begins moving from its lower position to its upper position. Thus, at T–811, contacts 1–LS–D (line 175) open, but without further effect. When storage area 501 reaches its upper position, contacts 1–LS–U (line 171) close (T–813), thereby energizing control relay 11–CR (line 182) at T–814.

The energization of control relay 11–CR (line 182) at T–814 causes its contacts in line 218 to close, thereby energizing conveyor high speed motor control relay 7–MH (line 224) through a circuit including the following contacts: 11–CR (line 218); 12–CR (line 218); 26–CR (line 220); 64–CR (line 221); 57–CR (line 221); 22–TR (line 224); 64–CR (line 223); 43–SR (line 223); and 27–CR (line 223).

With the energization of conveyor high speed motor control relay 7–MH (line 224), its contacts in line 230 open, thereby de-energizing control relay 24–CR (line 231) at T–816. Similarly, contacts 7–MH (lines 147, 148 and 149) close, thereby energizing the high speed windings of main conveyor drive motor MTR–7 (line 145). Thus, the main conveyor drive motor begins rotating at high speed in a forward direction. Since upper storage area 501 (FIG. 76) is in its upper position, upper storage clutch 2–CLU is de-energized, and lower storage drive clutch 1–CLU is energized, the high speed forward rotation of the main conveyor drive motor results in the high speed forward movement both of main conveyor belt 400 and lower storage conveyor belt 520. Accordingly, the wide width remnant piece of fabric in lower storage area 500 starts moving downstream on lower storage belt 520 to be eventually transferred to main conveyor belt 400 and delivered to the splicing mechanism D (FIG. 77).

The initial downstream movement of the remnant piece of fabric causes its leading edge to intercept the light beam between lamp 1185 (line 296) and lower storage photocell 5–EYE (line 295). Thus, sensing relay 45–SR (line 294) becomes de-energized at T–816. As a result of this, contacts 45–SR (line 304) open, thereby de-energizing control relay 45–CR (line 304) at T–817.

Referring back to FIGS. 91 and 106, it will be seen that, at T–15, the components of the electrical control system were in exactly the same condition of operation as they are in at T–817 of FIGS. 105 and 111. Thus, a full cycle of the events which occur in the preparation of four plies for the building of one tire carcass has been described. However, one further point requires mention at this time with regard to a comparison between the cycle just completed and subsequent cycles to come.

When the electrical control system was initially started, it was assumed that the piece of wide width fabirc carried in lower storage area 500 (FIG. 76) was of sufficient length from which to cut ply 1. On the other hand, at T–817, the remnant piece of fabric in lower storage area 500 is a relatively short piece of fabric that is not long enough, by itself, to form a new play 1. Accordingly, the operation of the electrical control system between T–15 and T–32 (at which time stepping relay CR–OS begins stepping to position 2) will be different during the preparation of a new ply 1 than it was during the preparation of the original ply 1.

Since the remnant piece of fabric in lower storage area 500 at T–817 is much shorter than it was at T–15, sensing relay 41–SR (line 280), which in the first cycle of the apparatus became energized at T–22.5 after sensing relay 43–SR (line 286) had been de-energized at T–22, becomes energized prior to the energization of sensing relay 43–SR in the second cycle of the apparatus (e.g. at T–21). Accordingly, the sequence of events shown between T–22 and T–32 in FIG. 91 is delayed until a new sequence of actions takes place, between T–21 and T–22, during which a new, wide width, rhomboidal section of fabric is cut by bias-cutter A, the new section is deposited on main conveyor B, the new section is delivered to the splicing mechanism D, and the leading edge of the new section and the trailing edge of the old remnant are spliced together. The steps just mentioned take place during a sequence of actions which is essentially similar to the sequence of actions occurring between T–140 (at which time sensing relay 41–SR becomes energized as the trailing edge of a remnant piece of fabric uncovers splice slow down photocell 1–EYE) and T–230 (at which time sensing relay 43–SR becomes de-energized as the leading edge of a strip of spliced fabric covers cut-to-length photocell 3–EYE).

Accordingly, assuming the steps occuring between T–140 and T–230 also occur between T–21 and T–22, the actions of the electrical control system become repetitive and the system continues in the manner shown in FIGS. 91 through 111, as modified by the above discussion.

It will be understood that as the number of carcasses built on the machine increases, the length of the remnant piece of fabric stored in lower storage area 500 will increase, and, eventually, its length will become sufficient to omit between times T–21 and T–22 the additional actions (T–140 to T–230) just described.

Similarly, as the narrow width strip of spliced fabric in upper storage area 501 increases in length as more and more carcasses are built, this strip of fabric will become sufficiently long so that in addition to ply 3, ply 4 also will be able to be cut therefrom. When this occurs, the sequence of events beginning at T–463 (when stepping relay CR–OS finishes indexing into position 10, with the remnant of ply 3 stopped at the backup position) and ending at T–583 (when stepping relay CR–OS begins to index into position 11, with the strip of spliced fabric just having been metered to the length of ply 4), during which time period a new, narrow width, rhomboidal section of fabric is cut by the bias-cutter, spliced to the remnant of ply 3, and the new strip of fabric is metered to the length of ply 4, will be replaced by a sequence of events in which the remnant of ply 3 is directly metered to the length of ply 4 by moving from the backup position of main conveyor belt 400 directly to cut-to-length unit E without first stopping at the splicing mechanism D.

The foregoing completes the discussion relative to automatic operation of the electrical control system. A description of the manual electrical controls employed in the tire building apparatus follows.

MANUAL CONTROLS

Referring to FIG. 78, the manual controls of the electrical control system include a "master stop" pushbutton switch PB–1 (line 109) and an "emergency stop" pushbutton switch PB–2 (line 113). By depressing either of the foregoing pushbutton switches, the energization circuit for master control relay CR–M (line 113) is opened, thereby deenergizing this relay and stopping the automatic operation of this system by virtue of the opening of contacts CR–M (line 155).

A "machine start" pushbutton switch PB–3 (line 113) which was mentioned earlier, serves to complete the energization circuit to master control relay CR–M (line 113) to initially start the machine.

Referring to FIG. 80, a "cycle stop" pushbutton switch PB–4 (line 158) is employed in the event that it becomes desirable to interrupt the automatic operation of the electrical control system and still retain conductor L–5A (FIG. 80) energized for purposes of subsequent manual electrical control operations.

The function of "cycle start" pushbutton switch PB–5 (line 160), which serves to concurrently energize automatic control relay CR–A (line 158) and automatic bias-cutter control relay CR–B (line 162) has previously been discussed.

Similarly, cycle start pushbutton switch PB–6 (line 158) serves as an alternate means for energizing automatic control relay CR–A (line 158) from a location different from that of "cycle start" pushbutton switch PB–5 (line 160). When pushbutton switch PB–6 is depressed, automatic control relay CR–A (line 158) becomes energized prior to the energization of automatic bias-cutter control relay CR–B (line 162). However, contacts CR–A (line 163) become closed with the energization of control relay CR–A and, almost immediately thereafter, energize automatic bias-cutter control relay CR–B so that the function of each of the pushbutton switches PB–6 and PB–5 is essentially the same.

A "manual indexing" pushbutton switch PB–7 (line 165) is provided in the event it is desired to manually index operation selector stepping relay CR–OS (line 165). When this switch is depressed, indexing voltage is applied via line 166 (assuming contacts CR–H in line 166 are closed) to line 165 to initiate the indexing of stepping relay CR–OS (assuming contacts 24–CR in line 165 are closed).

Referring to FIG. 81, the operation of "conveyor start" pushbutton switch PB–8 (line 186), which has an additional set of contacts in line 246, has previously been discussed. This pushbutton switch is utilized in manually energizing control relay 12–CR (line 190) which, when other conditions are proper, in turn energizes conveyor high speed motor control relay 7–MH (line 224), thereby starting main conveyor drive motor MTR–7 (line 145).

Referring to FIG. 83, a "bias-cutter cycle start" pushbutton switch PB–9 (line 275) is employed to manually energize control relay 33–CR (line 273) from conductor L–8. The energization of this relay, in turn, causes its contacts in line 358 to initiate the start of a bias-cutter cycle (assuming certain other conditions are met). Thus, pushbutton switch PB–9 is employed to initiate a manual re-cycling of the bias-cutter while the remainder of the system is still in automatic operation.

Referring to FIG. 85 a "stripper down" pushbutton switch PB–10 (line 312) is employed to manually energize valve solenoid 4–SOL–D (line 313) from conductor L–7 (assuming contacts CR–H in line 168 are closed). When this solenoid is energized, it, in turn, causes stripper 800 (FIG. 77) to move down.

Similarly, a "ply offset" pushbutton switch PB–11 (line 331) is employed to manually energize valve solenoid 6–SOL–F (line 330) from conductor L–7 (assuming contacts CR–H in line 168 are closed and certain other conditions are met). This, in turn, causes mechanical lifter frame 960 to move to its offset position.

In order to provide a manual control by which the cutting position stop assembly 295 (FIG. 75) may be lowered, a pushbutton switch PB–12 (line 363) is provided. When this pushbutton switch is depressed, its contacts in line 364 close, and, assuming contacts CR–H in line 364 are closed and certain other conditions are met, valve solenoid 14–SOL–D (line 363) becomes energized. This, in turn, causes the cutting position stop assembly 295 to move down (FIG. 75).

Similarly, a pushbutton switch PB–13 (line 374) is provided in order to introduce into the system a manual means for lowering fabric gripping bar 91 (FIG. 75). When pushbutton switch PB–13 is depressed, its contacts in line 375 close, and, assuming conductor L–5 is energized via contacts CR–H (line 166), this causes valve solenoid 15–SOL–D (line 374) to become energized (assuming certain other conditions are met). The energization of valve solenoid 15–SOL–D, in turn, sends fabric gripping bar 91 down and initiates a brief sequence of events during which cutting position stop assembly 295 is raised and, thereafter, the table air blast from chamber 264 starts.

Referring to FIG. 75, when the roll of fabric in fabric let-off unit 21 is almost completely consumed, the trailing edge of this roll passes by photocell 7–EYE. Accordingly, the light beam from lamp 31 (line 388) strikes photocell 7–EYE (line 387) causing sensing relay 68–SR (line 386) to become energized. When sensing relay 68–SR becomes energized, its contacts in line 385 close, thereby shunting together terminals 8 and 11 of sensing relay 68–SR. This, in turn, prevents sensing relay 68–SR from subsequently becoming de-energized when the leading edge of a new roll of fabric is spliced to the trailing edge of the old roll of fabric in fabric let-off unit 21.

In addition to the foregoing, contacts 68–SR (line 394) open with the energization of sensing relay 68–SR (line 386), causing let-off forward motor control relay 4–MF (line 396) to become de-energized. This causes contacts 4–MF in lines 127, 128 and 129 to open, thereby de-energizing bias-cutter let-off motor MTR–4 (line 128). Also, contacts 68–SR (line 398) close, energizing valve solenoid 18–SOL–F (line 399) which, referring to FIG. 75, causes brake roller 43 to be moved down into engagement with the fabric moving on rollers 36 and 37, thereby applying a frictional drag on these rollers. This, in turn, brings let-off motor MTR–4 to a quick stop so that a new roll of fabric may be spliced to the old roll of fabric in let-off unit 21.

When brake roller 43 (FIG. 75) moves down, it actuates limit switch 18–LS, whose contacts 18–LS–B (line 394) open to insure that the energization circuit to motor control relay 4–MF (line 396) remains open until after brake roller 43 is subsequently raised to its "unbraking" position.

In order to reset sensing relay 68–SR (line 386) after a new roll of fabric has been spliced onto the preceding roll of fabric in fabric let-off unit 21, a pushbutton switch PB–14 (line 384) is provided. When this pushbutton switch is depressed, it shunts together terminals 3, 8 and 10 of sensing relay 68–SR and, recalling the earlier description with respect to the operation of the sensing relays, sensing relay 68–SR becomes de-energized. Thus, assuming a new roll of fabric has been spliced to the preceding roll of fabric in the fabric let-off unit, upon depressing pushbutton switch PB–14 sensing relay 68–SR becomes de-energized and is reset for subsequent normal operation.

Referring to FIG. 75, in the event it becomes desirable to manually cause brake roller 43 to be lowered, thereby applying a brake to fabric 28, pushbutton switch PB–15 (line 399) is provided. When this switch is depressed and other conditions are met, valve solenoid 18–SOL–F (line 399) becomes energized, causing brake roller 43 to be lowered into braking engagement with fabric 28.

After brake roller 43 has been lowered, either manually via pushbutton switch PB–15 (line 399) or automatically via contacts 68–SR in line 398 (due to sensing relay 68–SR in line 386 becoming energized when a roll of fabric is used up), a pushbutton switch PB–16 (line 399) is employed to raise brake roller 43 back to its "unbraking" position. Assuming that the leading edge of a new roll of fabric has been spliced to the trailing edge of a previous roll of fabric and that sensing relay 68–SR (line 396) has been reset (is de-energized), the let-off function of fabric let-off unit 21 is started up again in the following manner when pushbutton switch PB–16 is depressed. Initially, contacts PB–16 in line 400 close, thereby energizing valve solenoid 18–SOL–R (line 400). This causes brake roller 43 to raise to its unbraking position, thereby actuating limit switch 18–LS and causing contacts 18–LS–B (line 394) to close. When this happens, motor control relay 4–MF (line 396) becomes energized (assuming limit switch contacts 19–LS–B and 20–LS–A in line 394 are closed), and its contacts in lines 127, 128 and 129 close, energizing bias-cutter let-off motor MTR–4 (line 128) for rotation in a forward direction. Limit switch contacts 19–LS–B (line 394) are normally closed at all times except when there is a jam up in fabric let-off unit 21 (FIG. 75) that causes dancer roller 40 to rise to its top position and actuate limit switch 19–LS. Contacts 20–LS–A (line 394), it will be recalled, are closed whenever dancer roller 40 is above its bottom position.

In addition to the foregoing pushbutton switches 1 through 16, the manual control circuits of the electrical system include a plurality of selector switches (1–SS through 10–SS) which are utilized for various purposes. Referring to FIG. 80, a "mode control" selector switch 1–SS is provided. This selector switch is of the detent type and, thus, its contacts will remain in any one of the three positions into which they may be switched when a change in mode of operation is made. The three positions of selector switch 1–SS include: a normally used "automatic" position, which is the position in which switch 1–SS has been illustrated in FIG. 80; a "bias-cutter" position, in which the contacts of selector switch 1–SS are raised one notch from the position shown in FIG. 80; and, a "hand" position, in which the contacts of selector switch 1–SS are lowered one notch from the position in which they are shown in FIG. 80.

When selector switch 1–SS is shifted to its "bias-cutter" position, contacts 1–SS in line 159 open, thereby precluding energization of "automatic" control relay CR–A (line 158), while contacts 1–SS in line 161 close, thereby preconditioning "bias-cutter" control relay CR–B (line 162) for subsequent energization. In addition, contacts 1–SS in line 359 close. As a result of the foregoing, if "cycle start" pushbutton switch PB–5 (line 160) is depressed (its contacts in line 359 closing) bias-cutter A automatically goes through a complete cycle of operation while the remainder of the apparatus remains inactive.

When selector switch **1–SS** (FIG. 80) is moved to its "hand" position, contacts **1–SS** in line **157** close, thereby energizing hand control relay CR–H (line **157**), while contacts **1–SS** in lines **158** and **161** open, thereby de-energizing automatic control relay CR–A (line **158**) and bias-cutter control relay CR–B (line **162**). With the energization of hand control relay CR–H (line **157**), its contacts in lines **166**, **225**, **360**, **364**, **366** and **367** close while its contacts in line **368** open. This, in addition to energizing conductor L–**7** at line **166**, prepares various of the circuits in the electrical control system for subsequent manual energization.

Referring to FIG. 80, selector switch **2–SS** (line **155**) is provided for manually starting or stopping the movement of main conveyor belt **400** at desired times. Selector switch **2–SS** is a spring-biased, three-position switch that normally remains in its "automatic" position so long as it is not actuated. Upon raising selector switch **2–SS**, thereby shifting the switch into its "start" position, contacts **2–SS** in line **199** close, energizing timing relay **14–TR** (line **197**). Accordingly, when selector switch **2–SS** is released and shifts back to its "auto" position, time-delay contacts **14–TR** (line **202**) remain closed during the timing period that follows. In addition, assuming contacts **10–CR**, **59–CR**, and **6–MF** (all of which are in line **203**) are also closed, the shifting of selector switch **2–SS** back to its "auto" position (and concurrent closing of contacts **2–SS** in line **201**) causes control relay **15–CR** (line **203**) to become energized. With the energization of control relay **15–CR**, its contacts in line **185** close, and, assuming a circuit to control relay **12–CR** (line **190**) otherwise exists, control relay **12–CR** become energized. The energization of control relay **12–CR**, in turn, causes its contacts in line **218** to close, resulting (if the system is otherwise ready for operation of main conveyor belt **400**) in the energization of conveyor high speed motor control relay **7–MH** (line **224**).

Similarly, by depressing selector switch **2–SS** to its "stop" position, the contacts of this selector switch in line **158** open, thereby de-energizing "automatic" control relay CR–A (line **158**), and this, in turn, causes main conveyor belt **400** to stop running due to the fact that contacts CR–A (line **184**) open, thereby de-energizing conductor L–**8** which, in turn, either causes conveyor high speed motor control relay **7–MH** (line **224**) or conveyor low speed motor control relay **7–ML** (line **228**) to become de-energized, depending on which of the two had previously been energized.

Referring to FIG. 82, a conveyor drive selector switch **3–SS** (line **215**) is provided in the electrical control system. This selector switch is also a three-position switch and is spring-biased towards its "automatic" position. Assuming that "hand" control relay CR–H (line **157**) is energized and its contacts in line **166** have energized conductor L–**7**, when selector switch **3–SS** is shifted to its "forward" position, contacts **3–SS** in line **226** close, thereby concurrently energizing conveyor high speed motor control relay **7–MH** (line **224**) and timing relay **21–TR** (line **225**). Also, the two sets of contacts **3–SS** in line **235** close, thereby concurrently energizing conveyor forward control relay **7–MF** (line **234**) and control relay **26–CR** (line **235**), assuming that one or the other of contacts **56–CR** (line **235**) and **53–CR** (line **237**) are closed. Accordingly, main conveyor drive motor MTR–**7** (line **145**) begins driving at high speed in a forward direction.

Similarly, when selector switch **3–SS** is shifted to its "reverse" position, contacts **3–SS** in line **226** close, thereby concurrently energizing conveyor high speed motor control relay **7–MH** (line **224**) and timing relay **21–TR** (line **225**), and contacts **3–SS** in line **237** close, thereby concurrently energizing conveyor reverse control relay **7–MR** (line **236**) and control relay **27–CR** (line **237**), assuming that one or the other of contacts **53–CR** (line **237**) and **56–CR** (line **235**) are closed. Accordingly, main conveyor drive motor MTR–**7** (line **145**) begins driving at high speed in a reverse direction.

Referring to FIG. 85, a "vacuum lifter" selector switch **4–SS** (line **308**) is provided in order to be able to manually control the movement of vacuum lifter **780** (FIG. 77) between its upper and lower positions. This selector switch is also a three-position switch and is spring-biased towards its "automatic" position. Assuming "hand" control relay CR–H (line **157**) is energized, when selector switch **4–SS** is shifted to its "up" position, contacts **4–SS** in line **319** close, thereby causing timing relay **51–TR** line **319**) to become energized. After a brief time-delay period passes, time-delay contacts **51–TR** in line **317** close, thereby energizing valve solenoid **3–SOL–U** (line **316**) to send vacuum lifter **780** up to its raised position. Similarly, when selector switch **4–SS** is shifted to its "down" position, contacts **4–SS** in line **309** close, thereby providing an energization circuit for valve solenoid **3–SOL–D** (line **310**), assuming that the electrical control circuits of the system are in a condition that would allow vacuum lifter **780** to move downwardly. When this happens, vacuum lifter **780** starts moving down to its lower position.

A similar three-position, spring-biased, selector switch **5–SS** (line **308**) is provided for manually controlling the movement of mechanical lifter frame **960** (FIG. 77). Assuming "hand" control relay CR–H (line **157**) is energized, when selector switch **5–SS**, which is normally biased into its "auto" position, is shifted to its "up" position, contacts **5–SS** (line **318**) close, thereby providing an energization circuit for valve solenoid **5–SOL–U** in line **317** (assuming the electrical control system is in a condition to allow upward movement of frame **960**). This causes frame **960** to start moving up. Similarly, when selector switch **5–SS** is shifted to its "down" position, contacts **5–SS** in line **313** close, thereby providing an energization circuit to valve solenoid **5–SOL–D** in line **314** (assuming the electrical control circuits are in condition to allow downward movement of frame **960**). This causes frame **960** to start moving down.

Referring to FIG. 86, a three-position, spring-biased, selector switch **6–SS** (line **335**) is employed to manually control the movement of knife **873** (FIG. 77) of cut-to-length unit E. Assuming "hand" control relay CR–H (line **157**) is energized and knife **873** is at its home position (contacts **8–LS** in line **348** closed, control relay **59–CR** in line **348** energized, contacts **59–CR** in line **343** closed, and contacts **59–CR** in line **342** open), the shifting of selector switch **6–SS** (line **335**) to its "start" position causes valve solenoid **7–SOL–U** (line **338**) to become energized (assuming the remaining components of the electrical control system are in such condition as to complete a circuit to these components). This causes fabric clamping means **900** to start raising and, when it reaches its upper position, contacts **7–LS–U** (line **345**) close, energizing knife traverse motor control relay **6–MF** (line **345**). As a result, knife traverse motor MTR–**6** (line **139**) starts driving knife **873** through its cutting stroke. However, as soon as the knife moves out of its "home" position, contacts **8–LS** (line **348**) open, de-energizing control relay **59–CR** (line **348**). Accordingly, contacts **59–CR** (line **343**) open, concurrently de-energizing motor control relay **6–MF** (line **345**) and valve solenoid **7–SOL–U** (line **338**), the former stopping the movement of knife **873**, the latter being without further effect. Also, contacts **59–CR** in line **342** close, thereby allowing contacts **6–SS** in line **342** to concurrently re-energize motor control relay **6–MF** and valve solenoid **7–SOL–U** when selector switch **6–SS** is subsequently shifted to its "jog" position. From the foregoing it will be seen that to initially start knife **873** off on its cutting stroke, when it is in its home position, selector switch **6–SS** must be shifted to its "start" position. On the other hand, if knife **873** is stopped at some point other than its home position, selector switch **6–SS** must be shifted to its "jog" position in order to start the knife moving.

A three-position, spring-biased, selector switch 7-SS (line 332) is provided for manually controlling the movement of fabric clamping means 900 (FIG. 77). Assuming "hand" control relay CR-H (line 157) is energized, when this selector switch is shifted to its "clamp" position, contacts 7-SS in line 341 close, thereby providing an energization circuit for valve solenoid 7-SOL-U in line 338 (assuming the electrical control circuits are otherwise in condition to allow clamping). Referring to FIG. 77, when this solenoid is energized, it causes fabric clamping means 900 to clamp the fabric at the cut-to-length unit E. Similarly, when selector switch 7-SS is shifted to its "unclamp" position, contacts 7-SS in line 347 close, thereby energizing valve solenoid 7-SOL-D (line 346). This, in turn, causes fabric clamping means 900 (FIG. 77) to unclamp the fabric at cut-to-length unit E.

Referring to FIG. 87, a manually controlled, three-position, spring-biased, selector switch 8-SS (line 350) is employed for manually controlling the movement of fabric pull out carriage 55 (FIG. 75) of bias-cutter A. Assuming that "hand" control relay CR-H (line 157) is energized and the electrical control system is otherwise in a condition favorable to having carriage 55 moved forward, the shifting of selector switch 8-SS to its "forward" position causes its contacts 8-SS in line 360 to close. This causes valve solenoid 12-SOL-F (line 358) to become energized and, thus, carriage 55 starts moving forward (away from fabric cutting unit 200). Similarly, the shifting of selector switch 8-SS to its "return" position causes contacts 8-SS in line 369 to close, thereby energizing valve solenoid 12-SOL-R (line 369). This, in turn, causes carriage 55 to start moving in a reverse direction, back towards fabric cutting unit 200.

A three-position, spring-biased, selector switch 9-SS (line 350) is employed in manually controlling the traversing movement of bias-cutter saw 222 (FIG. 75). When selector switch 9-SS (line 350) is shifted to its "forward" position, its contacts in line 366 close, and, assuming "hand" control relay CR-H (line 157) is energized and the electrical control system is set up for this, saw traverse forward motor control relay 5-MF (line 365) becomes energized. When this happens, motor MTR-5 (line 132) starts driving in a forward direction to move saw 222 through its traversing cutting stroke. Similarly, when selector switch 9-SS is shifted to its "reverse" position, contacts 9-SS in line 367 close, thereby energizing saw traverse reverse motor control relay 5-MR (line 367). When this happens, motor MTR-5 (line 132) starts driving in a reverse direction to move bias-cutter saw 222 back towards its starting position (if the saw had not yet reached the far side of its cutting stroke). In the event that saw 222 had passed beyond the far side of its cutting stroke and was on its return stroke when reverse motor control relay 5-MR became energized, saw 222 would start moving back towards the far side of the bias-cutter.

The final selector switch to be considered in this discussion is selector switch 10-SS (line 385, FIG. 88). This selector switch, which is also a three-position, spring-biased selector switch, serves to control bias-cutter let-off motor MTR-4 (line 128). Referring to FIG. 88 and assuming contacts 18-LS-B (line 394) are closed (brake roller 43 is up), when selector switch 10-SS is shifted to its "forward" position, contacts 10-SS in lines 393 and 396 close, thereby energizing let-off forward motor control relay 4-MF (line 396). When this relay is energized, its contacts in lines 127, 128 and 129 close, thereby energizing bias-cutter let-off motor MTR-4 (line 128) to drive in a forward direction. Similarly, when selector switch 10-SS (line 385) is shifted to its "reverse" position, its contacts in lines 393 and 397 close, thereby energizing let-off reverse motor control relay 4-MR (line 397). When this relay becomes energized, its contacts in lines 124, 125 and 126 close, thereby energizing bias-cutter let-off motor MTR-4 (line 128) to drive in a reverse direction.

The foregoing concludes the detailed description of a particular embodiment of this invention. It will be obvious to those skilled in the art that various changes and modifications may be made without departing from this invention in its broader aspects, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of this invention.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. In a tire building machine having a tire building drum, a bias-cutter for supplying bias-cut sections of fabric from a web of tire cord fabric, and a conveyor for receiving the cut sections of fabric, means for lifting a first section of fabric from the conveyor so that a second section of fabric may be moved by the conveyor to a position underlying a portion of said first section of fabric, means for splicing together the overlapped portions of said sections of fabric to form strips of spliced fabric, means for cutting plies of proper length from the strips of spliced fabric, means for actuating said lifting means to laterally shift a cut ply to offset its side edges with respect to the side edges of an adjacent ply, and means for delivering successive plies to said building drum.

2. A machine according to claim 1 in which the conveyor includes a fabric conveying portion comprising a plurality of laterally spaced apart, horizontally disposed strands, and said lifting means comprises a plurality of vertically disposed lifter bars located between said conveyor strands, said lifter bars being movable vertically from a position below to a position above the level of said strands to lift a fabric ply off said conveyor and being movable laterally and downwardly to transversely shift said ply and deposit it on to said conveyor.

3. In a tire building machine having a bias-cutter for supplying bias-cut sections of fabric from a web of tire cord fabric and a conveyor to which the cut sections of fabric are delivered, a storage device at one end of said conveyor, a tire building drum at the other end of said conveyor, means cooperating with said conveyor to overlap the adjacent ends of two sections of fabric on said conveyor, means for splicing together the overlapped portions of said sections of fabric to form a strip of spliced fabric, means for cutting a ply of proper length from the strip of spliced fabric, means for delivering said ply to the building drum, and means for reversing the conveyor to deliver the remnant of said strip of spliced fabric to said storage device.

4. A machine according to claim 3 in which the storage device comprises at least two conveyors, at least one of which is movable into and out of operative position with respect to said first mentioned conveyor, whereby said storage device conveyors are adapted to selectively receive fabric pieces from said first mentioned conveyor.

5. A machine according to claim 4 in which the storage conveyors each are provided with means for selectively driving said conveyors in a forward or reverse direction at the same speed as and at selected times during the operation of said first mentioned conveyor.

6. In an automatic tire building machine, the combination with a conveyor, fabric splicing means and ply-length cutting means located intermediate the ends of said conveyor, and a tire building drum at one end of said conveyor, of a bias-cutter for cutting sections of fabric of different widths from a web of said material and delivering the same to said conveyor, said bias-cutter comprising a fabric pull-out device adapted to engage the end of the fabric web to pull the same out transversely of said conveyor, a cutting member for severing the pulled-out web of fabric into sections, and control means sequentially actuating said fabric pull-out device and cutting member

to successively (1) pull out a predetermined width of fabric, (2) cut the same into a section, (3) move said cut section of fabric transversely of said conveyor, and (4) deposit said section on said conveyor in a predetermined position with respect to the centerline of the drum.

7. In a machine for building multi-ply tire carcasses, a longitudinally extending conveyor provided with forward and reverse drive means, a tire building drum positioned crosswise to and at the forward end of said conveyor, the centerline of said drum being in longitudinal alignment with said conveyor and forming a reference line extending along the length of said conveyor, means for cutting a web of tire fabric on a bias to form a first bias-cut section of fabric having a predetermined width, means for depositing said first section of fabric on said conveyor with its longitudinal centerline laterally offset by a predetermined amount to one side of said reference line, means for splicing said first section of fabric to an aligned first remnant piece of fabric of similar width to form a first strip of spliced fabric, the first remnant piece of fabric having been left over from the building of a previous tire carcass on the machine, means for cutting said first strip of spliced fabric to proper ply length to form a first ply and a second remnant piece of fabric, means for cutting the web of tire cord fabric on a bias to form a second bias-cut section of fabric of similar width to said first section of fabric, means for depositing said second section of fabric on said conveyor with its longitudinal centerline laterally offset by said predetermined amount to said one side of said reference line, means for splicing said second remnant piece of fabric to said second section of fabric to form a second strip of spliced fabric, means for cutting said second strip of spliced fabric to proper ply length to form a second ply and a third remnant piece of fabric, means for laterally shifting one of said plies so that its centerline ends up said predetermined amount on the other side of said reference line, and means for delivering said first and second plies to said tire building drum while retaining their centerlines offset both from one another and from the centerline of the drum.

8. A machine as described in claim 7, and further including a storage device positioned at the rear end of said conveyor and in longitudinal alignment therewith, said storage device including a storage area for storing said third remnant piece of fabric for use in preparing the first ply of a subsequent tire carcass.

9. A machine as described in claim 8, said storage device further including a second storage area for storing a third strip of spliced fabric having a narrower width than the fabric stored in said first storage area, said narrow width third strip of spliced fabric having been prepared during the building of a previous tire carcass on the machine and being sufficiently long from which to cut a third ply to proper ply length, the longitudinal centerline of said third strip of spliced fabric being aligned with said reference line, means for cutting said third strip of spliced fabric to proper ply length to form a third ply and a fourth remnant piece of fabric, means for cutting the web of tire fabric on a bias to form a third bias-cut section of fabric having a narrow width similar to that of said fourth remnant piece of fabric, means for depositing said third section of fabric on said conveyor with its longitudinal centerline aligned with said reference line, means for splicing said third section of fabric with said fourth remnant piece of fabric to form a fourth strip of spliced fabric, means for cutting said fourth strip of spliced fabric to proper ply length to form a fourth ply and a fifth remnant piece of fabric, means for delivering said third and fourth plies to said tire building drum while retaining their centerlines in alignment both with one another and with the centerline of the drum, means for cutting the web of tire fabric on a bias to form a fourth bias-cut section of fabric having a narrow width similar to that of said third section of fabric, means for depositing said fourth section of fabric on said conveyor with its longitudinal centerline aligned with said reference line, means for splicing said fourth section of fabric with said fifth remnant piece of fabric to form a fifth strip of spliced fabric, means for transferring said fifth strip of spliced fabric to said second storage area of the storage device for use in preparing the third ply of a subsequent tire carcass, and circuit means interconnecting said storage device, said bias-cutting means, said splicing means, said ply-length cutting means and said delivery means for automatically correlating their operations with respect to sections of fabric of two different widths.

10. In an automatic tire building machine including a conveyor provided with forward and reverse driving means, a tire building drum positioned at the downstream end of and in alignment with the conveyor, and a bias-cutter positioned intermediate the ends of the conveyor for cutting a web of tire fabric on a bias into sections of fabric and delivering the same to the conveyor: a storage device positioned at the upstream end of and in alignment with the conveyor; splicing means, ply-length cutting means, and lifting means each positioned intermediate the bias-cutter and the downstream end of the conveyor, said splicing means being upstream of said ply-length cutting means and said lifting means being downstream of said ply-length cutting means; means for starting the forward drive means of the conveyor to deliver a remnant piece of fabric from said storage device to the conveyor; control means responsive to the length of said remnant piece of fabric for selectively positioning the trailing edge of said remnant piece of fabric at said splicing means if said remnant piece of fabric is less than a ply length and the leading edge of said remnant piece of fabric a ply-length downstream from said ply-length cutting means if said remnant piece is longer than a ply length; means for actuating said lifting means to lift said remnant piece of fabric above the conveyor irrespective of the positioning thereof by said control means; means responsive to the positioning of the trailing edge of a less than ply-length remnant piece of fabric at the splicing means to sequentially (1) actuate the bias-cutter to deliver a new section of fabric to the conveyor, (2) start the forward drive of the conveyor to move the new section of fabric into a position underlying a portion of the remnant piece, (3) actuate the splicing means to splice the remnant piece and new section together to form a strip of spliced fabric, (4) actuate the lifting means to deposit the strip of spliced fabric on the conveyor, (5) start the forward drive means on the conveyor to position the leading edge of the strip of spliced fabric a ply length downstream from said ply-length cutting means, and (6) actuate the lifting means to raise said strip of spliced fabric above the conveyor; means responsive to the rising of said lifting means when the leading edge of the fabric on said lifting means is spaced a ply-length downstream from said ply-length cutting means for actuating said ply-length cutting means to cut the fabric raised on said lifting means into a ply of proper length and a new remnant piece; means to lower said new remnant piece of fabric onto the conveyor while said ply remains raised on said lifting means; means to actuate the reverse drive means of the conveyor to position said new remnant piece of fabric upstream from said ply by a distance of at least one ply length; means to actuate said lifting means to thereafter lower said ply onto the conveyor; and means to actuate the forward drive means of the conveyor to thereafter concurrently move said ply toward the tire building drum and said new remnant piece of fabric toward said splicing means.

11. In a tire building machine, a bias-cutter for supplying bias-cut sections of fabric from a web of tire cord fabric, a conveyor for receiving the cut sections of fabric, means for arresting movement of a leading section of fabric on the conveyor to permit a trailing section of fabric to be moved by the conveyor into overlapped rela-

tion with said leading section of fabric, means for splicing together the overlapped portions of said sections of fabric to form elongated strips of spliced fabric, means for cutting plies of proper length from said strips of spliced fabric, a tire building drum, means for alternately rotating said drum in counter-clockwise and clockwise directions, means for successively applying said plies to said drum during said rotation of the latter, whereby the cords of adjacent plies as applied to the drum cross one another and extend angularly in opposite directions, and circuit means interconnecting said bias-cutter, said movement arresting means, said splicing means and said ply-length cutting means to correlate their operations with respect to one another.

12. Apparatus for bias-cutting a tire fabric, comprising: cutting means including a fixed support and a movable cutter assembly for cutting said fabric during a cutting stroke; fabric let-off means positioned adjacent one side of said cutting means and adapted to dispense fabric thereto; fabric pull-out means positioned adjacent the other side of said cutting means for gripping said fabric and pulling out said fabric past said cutting means; fabric width control means positioned in the path of movement of and engageable with said fabric pull-out means for selectively positioning said fabric pull-out means with a wide or narrow width of fabric pulled out past said cutting means and for signalling said cutting means to initiate a cutting stroke which cuts said width of pulled-out fabric into a rhomboidal section; and fabric drop control means engageable with said fabric pull-out means for selectively positioning said pull-out means after said cutting stroke takes place and signalling said pull-out means to release said cut section of fabric, whereby wide cut sections of fabric are released at one predetermined position of said pull-out means and narrow cut sections of fabric are released at another predetermined position of said pull-out means.

13. Apparatus for bias-cutting a tire fabric, comprising: a stationary frame; a moveable frame carried by said stationary frame and pivotal about a vertical axis with respect thereto; cutting means including a fixed track carried by said stationary frame and a cutter assembly moveable along said track during a cutting stroke; a fabric let-off unit carried by said moveable frame adjacent one side of said cutting means and adapted to receive and unwind the fabric to be cut; a fabric pull-out unit carried by said movable frame adjacent the other side of said cutting means, said fabric pull-out unit comprising a track and, moveable therealong, a fabric gripping mechanism for gripping the fabric unwound from said let-off unit and holding the fabric during movement of said gripping mechanism away from said cutting means; and fabric width control means carried by said stationary frame in the path of movement of said gripping mechanism and engageable thereby for selectively stopping the movement away from the cutting means of said gripping mechanism at one or another of at least two different positions and thereafter initiating a cutting stroke by said cutting means, whereby rhomboidal sections of fabric of at least two different widths may be bias-cut by said apparatus.

14. Apparatus as described in claim 13, and further including means for re-instituting movement of said gripping mechanism away from said cutting means after said cutting stroke; and fabric drop control means carried by said stationary frame in the path of movement of said gripping mechanism and engageable thereby for selectively stopping the movement away from said cutting means of said gripping mechanism at one or another of at least two different positions and thereafter actuating said gripping mechanism to release the cut section of fabric, whereby cut sections of fabric of one width are released at one predetermined position of said gripping mechanism and cut sections of fabric of another width are released at another predetermined position of said gripping mechanism.

15. For use in a tire building machine wherein sheet-like tire building materials are to be bodily moved without wrinkling or disorientation, a conveyor arrangement comprising a longitudinally extending frame; upstream roller means carried by said frame; downstream roller means carried by said frame; an endless belt, said belt being wound in the general form of a helix about said upstream and downstream roller means to form a plurality of laterally spaced apart strands on an upper level above the roller means and on a lower level below the roller means of said conveyor, all of the strands of said upper level being parallel to one another and to the longitudinal axis of said conveyor, all of the strands of said lower level being parallel to one another but at a slight angle to the longitudnial axis of said conveyor, there being a cross-over strand interconnecting the beginning strand and the end strand of the helix; and means for driving said endless belt, whereby the linear advance of each strand in the upper level is maintained exactly equal to the linear advance of every other strand in said upper level.

16. In a tire building machine, a conveyor adapted to receive thereon sections of tire building fabric of different lengths; splicing means cooperable with said conveyor for automatically splicing together adjacent ends of selected sections of fabric carried by said conveyor; ply-length cutting means cooperable with said conveyor for automatically cutting plies of predetermined length from fabric sections carried by said conveyor; means for driving said conveyor to deliver the fabric sections to said splicing means and said ply-length cutting means; and means in circuit with both said splicing means and said ply-length cutting means and responsive to the lengths of the fabric sections carried by said conveyor for selectively cycling said splicing means and said ply-length cutting means, whereby fabric sections initially shorter than said predetermined length are spliced to other fabric sections to increase their lengths at least to said predetermined length and then said sections are cut to said predetermined length, while fabric sections initially longer than said predetermined length are directly cut to said predetermined length.

17. In a time building machine, a longitudinally extending conveyor adapted to receive sections of tire fabric of different lengths at an upstream portion thereof; a tire building drum positioned adjacent the downstream end of said conveyor; means for driving said conveyor to move said sections of fabric toward said drum; splicing means positioned adjacent said conveyor, intermediate the upstream portion thereof and said drum, for automatically splicing together adjacent ends of sections of fabric on said conveyor; ply-length cutting means positioned adjacent said conveyor, intermediate said splicing means and said drum, for automatically cutting plies of predetermined length from sections of fabric having lengths greater than said predetermined length; and means selectively controlling the operation of said splicing means and said ply-length cutting means to cycle said splicing means when a section of fabric of less than a ply in length arrives at said splicing means and to omit a cycle of said splicing means and initiate a cycle of said ply-length cutting means when a section of fabric of more than a ply in length arrives at said splicing means.

18. In a tire building machine, a conveyor adapted to receive sections of tire fabric of different lengths at an upstream portion thereof; means for driving said conveyor; splicing means positioned above and cooperable with said conveyor for splicing together adjacent ends of preceding and succeeding sections of fabric on said conveyor; first fabric sensing means positioned upstream of said splicing means for determining the presence or absence of a section of fabric thereat; second fabric sensing means positioned downstream of said splicing means

for determining the presence or absence of a section of fabric thereat, the spacing between said first and second sensing means being at least as great as the length of a ply to be prepared by the machine; ply-length cutting means positioned adjacent said conveyor and between said splicing means and said second sensing means for cutting plies of predetermined lengths from sections of fabric having lengths greater than said predetermined length; and circuit means responsive to said sensing means and selectively controlling said splicing means and said ply-length cutting means for actuating said splicing means to join said preceding and succeeding sections of fabric when said preceding section of fabric is less than a ply in length and for actuating said ply-length cutting means to cut said preceding section of fabric to ply-length when said preceding section of fabric is greater than a ply in length.

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