United States Patent

[11] 3,552,252

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Continuation of application Ser. No. 552,940, May 25, 1966, now abandoned.

[54] **VENEER DEFECT DETECTOR AND CLIPPER CONTROL**
21 Claims, 16 Drawing Figs.

[52] U.S. Cl. 83/362, 83/363, 83/365, 83/369, 83/371
[51] Int. Cl. B26d 5/34
[50] Field of Search 83/76, 74, 362, 361, 364, 365, 370, 371, 369, 363; 144/2

[56] **References Cited**

UNITED STATES PATENTS

2,211,362	8/1940	Bennett	83/76UX
2,617,483	11/1952	Porter	83/365X
2,623,589	12/1952	Price et al.	83/365X
2,978,943	4/1961	Balint	83/362
3,120,861	2/1964	Finlay et al.	144/2
3,165,961	1/1965	Hammond	83/365
3,175,442	3/1965	Drenning et al.	83/76
3,183,950	5/1965	Sherman	83/364X

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Attorney—Marechal, Biebel, French & Bugg

ABSTRACT: Apparatus for providing actuating signals to a cutting device having asymmetrical actuation response characteristics in such a way that material is cut precisely at preselected locations includes manual or electronic means for generating cutting command signals, either as a result of a defect in the material or after predetermined lengths of material have moved through the cutting device, and means for introducing a time delay between the cutting command signals and those signals which actuate the cutting device. The magnitude of the time delay is determined by the speed at which the material moves through the cutting device and by the response characteristics of the cutting device to the actuating signals. If no defects are found in the material, the material will be cut automatically into predetermined standard lengths.

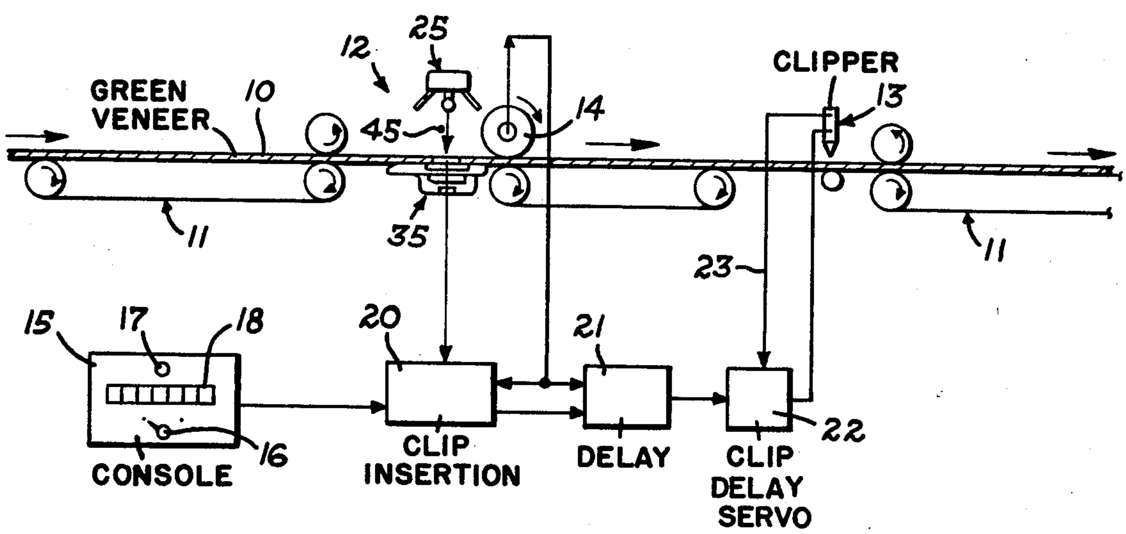

FIG-1

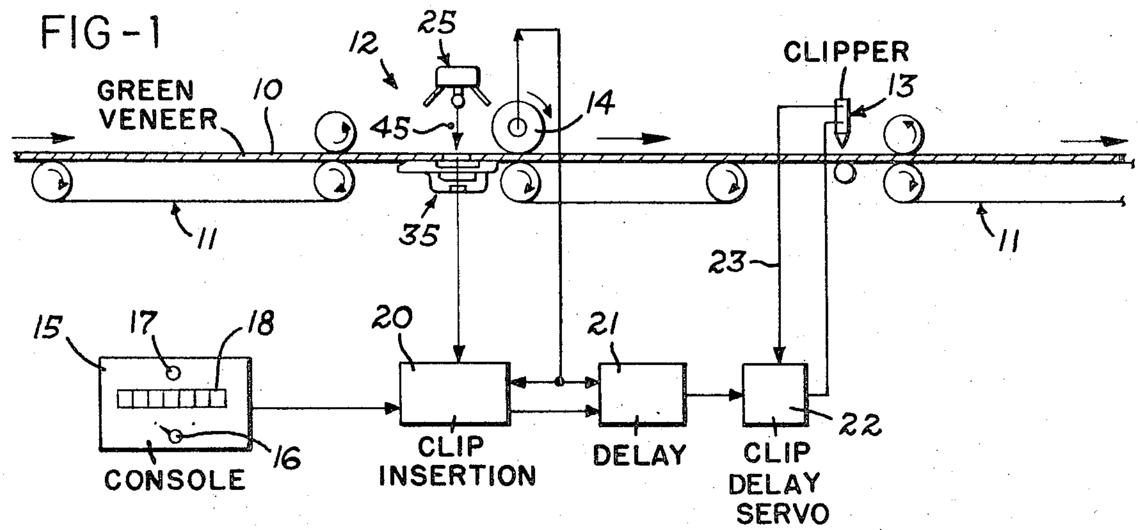

FIG-2

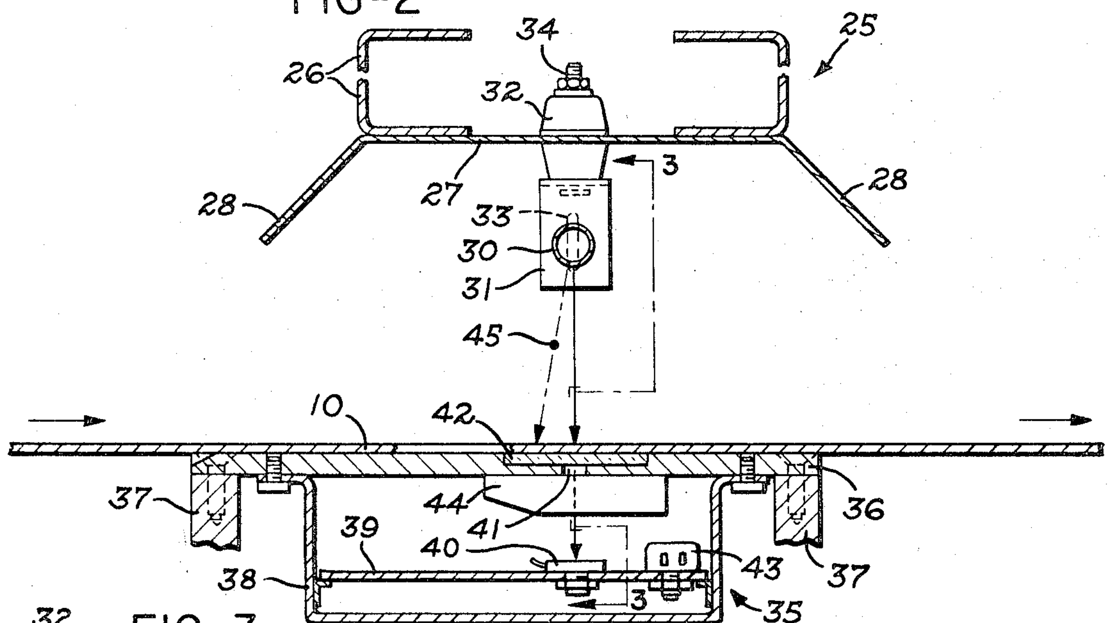

FIG-3

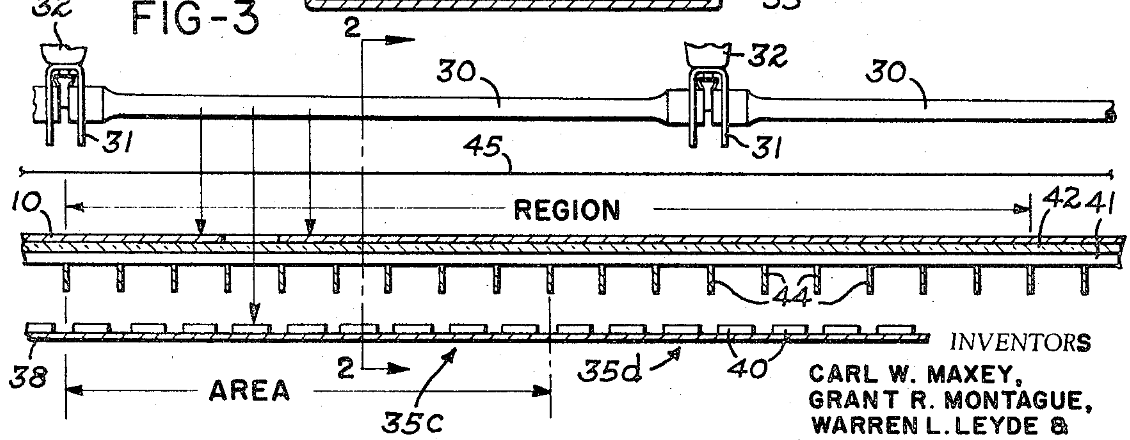

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FIG-4

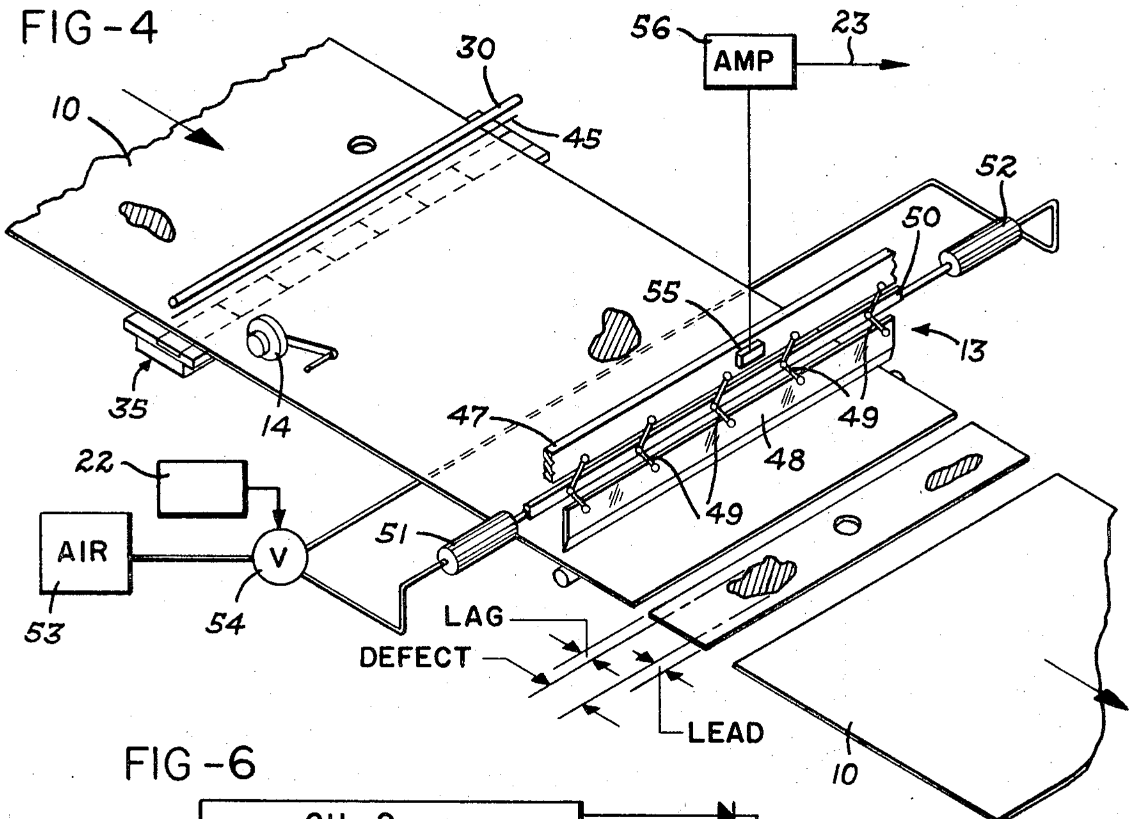
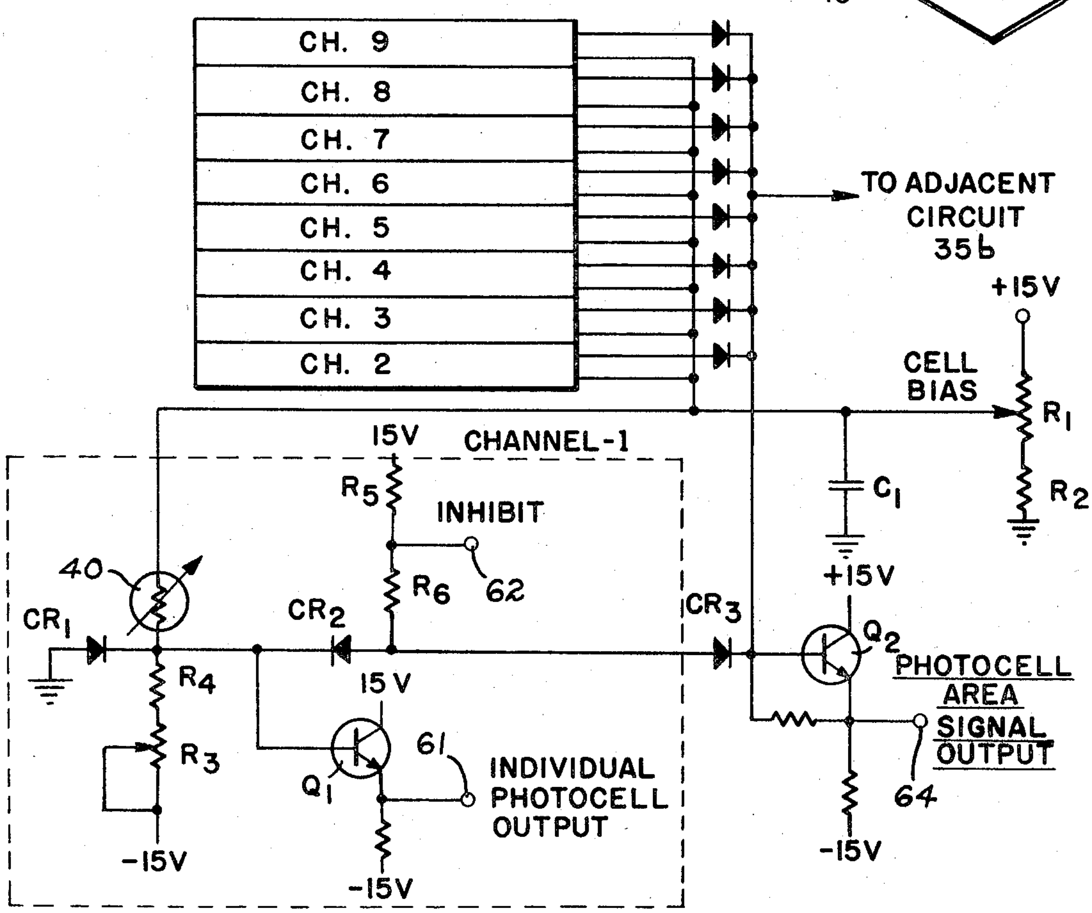

56
AMP
23
30
10
45
52
50
55
13
49
35
14
47
48
22
49
AIR
51
V
53
54
LAG
DEFECT
LEAD
10

FIG-6


CH. 9
CH. 8
CH. 7
CH. 6
CH. 5
CH. 4
CH. 3
CH. 2
TO ADJACENT CIRCUIT 35b
+15V
CELL BIAS
R_1
15V
CHANNEL-1
R_5
INHIBIT
C_1
R_2
40
62
R_6
+15V
CR_2
CR_3
CR_1
Q_2
PHOTOCELL AREA SIGNAL OUTPUT
R_4
15 V
61
R_3
Q_1
INDIVIDUAL PHOTOCELL OUTPUT
64
-15V
-15V
-15V

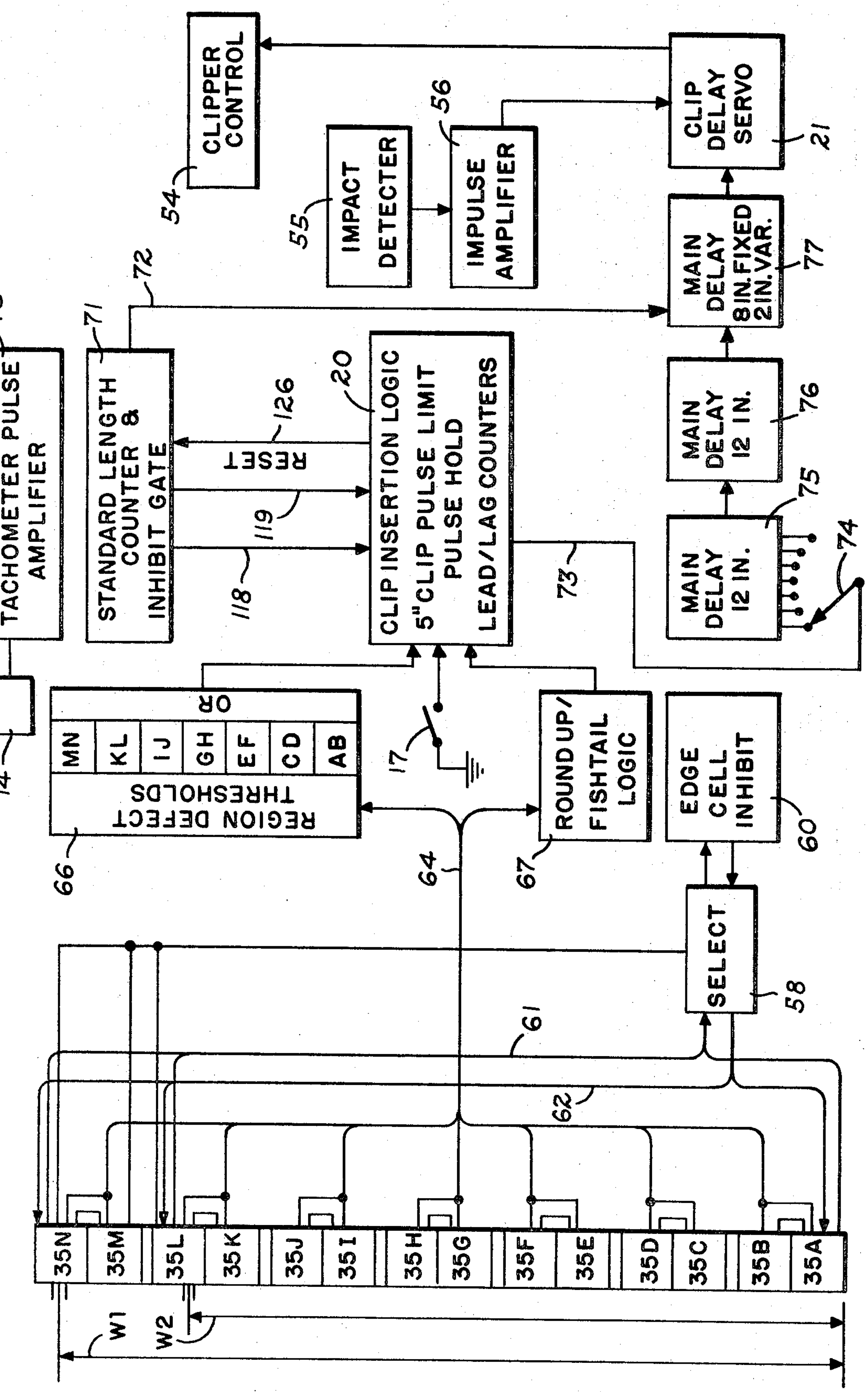

CLIPPER CONTROL
54
CLIP DELAY SERVO
21
IMPACT DETECTER
55
IMPULSE AMPLIFIER
56
MAIN DELAY 8IN. FIXED 2IN. VAR.
77
72
TACHOMETER PULSE AMPLIFIER
78
STANDARD LENGTH COUNTER & INHIBIT GATE
71
CLIP INSERTION LOGIC
5" CLIP PULSE LIMIT
PULSE HOLD
LEAD/LAG COUNTERS
20
RESET
126
119
118
MAIN DELAY 12 IN.
76
MAIN DELAY 12 IN.
75
74
73
14
REGION DEFECT THRESHOLDS
OR
MN
KL
IJ
GH
EF
CD
AB
66
17
ROUND UP/ FISHTAIL LOGIC
67
EDGE CELL INHIBIT
60
64
SELECT
58
61
62
35N
35M
35L
35K
35J
35I
35H
35G
35F
35E
35D
35C
35B
35A
W1
W2

FIG-5

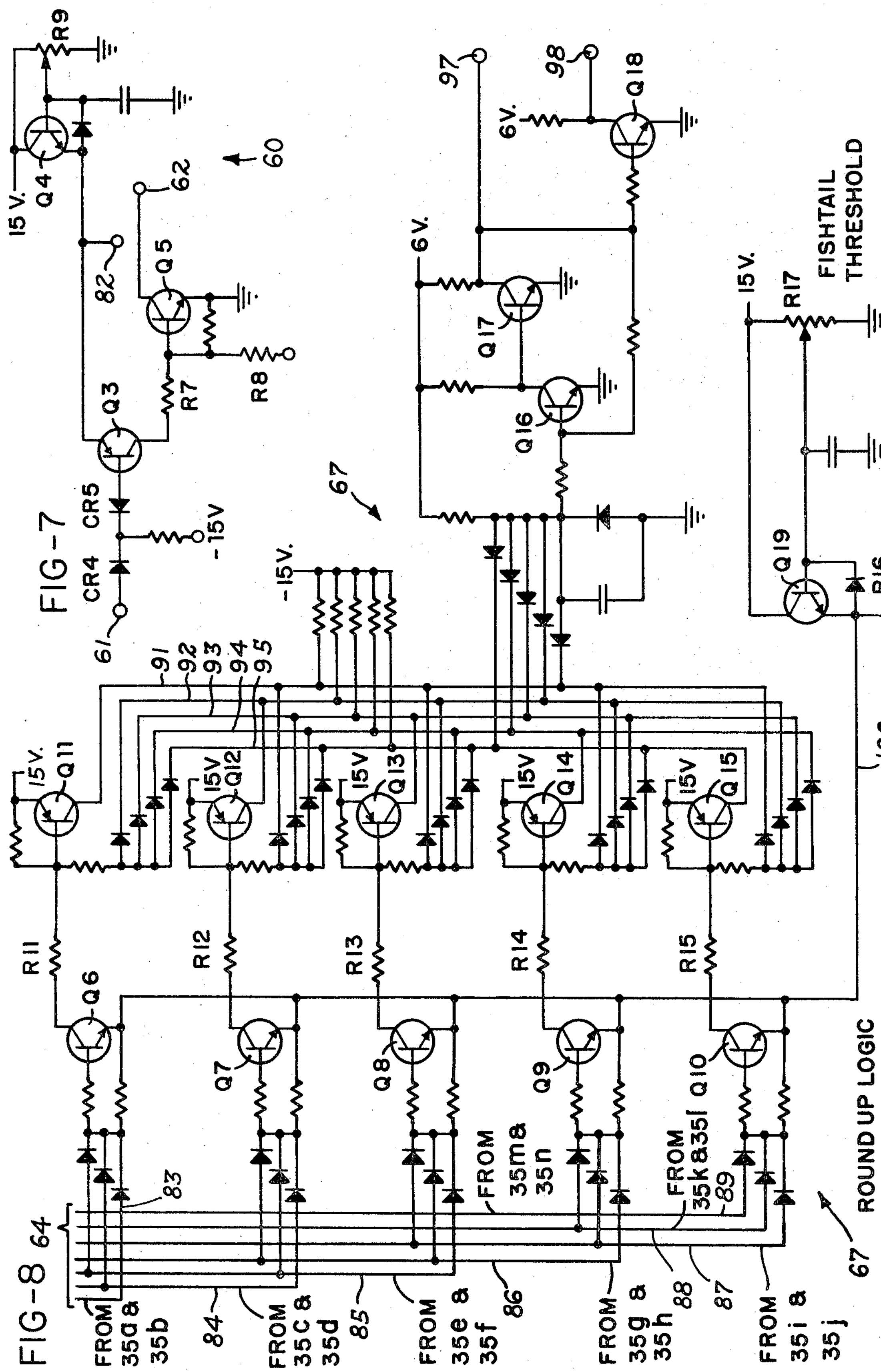
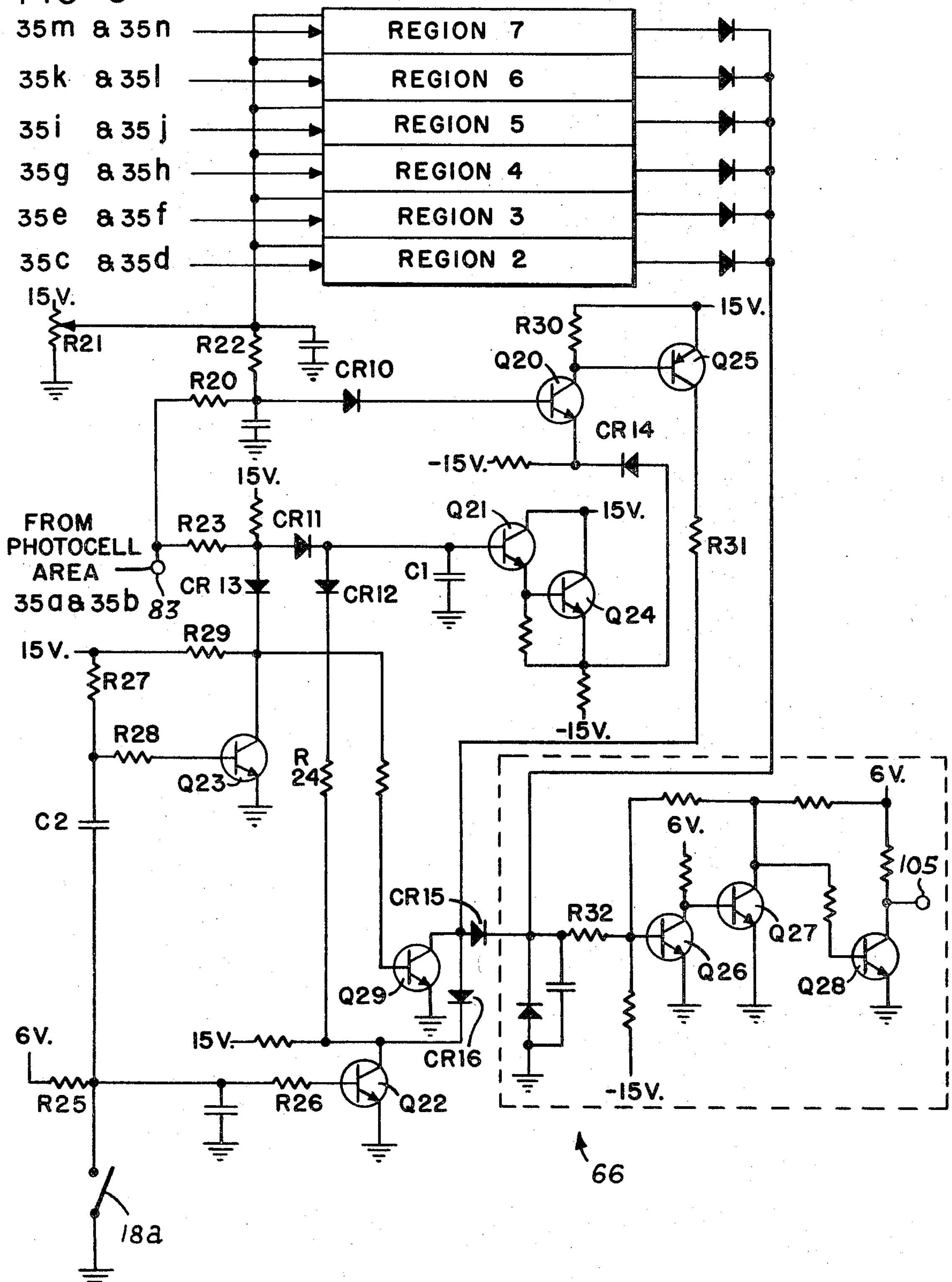


FIG-7
FIG-8
15 V.
Q4
R9
60
62
82
Q5
Q3
R7
R8
CR5
CR4
-15V
61
97
98
Q18
6V.
Q17
Q16
67
FISHTAIL THRESHOLD
15V.
R17
Q19
R16
-15
-15V.
91
92
93
94
95
Q11
Q12
Q13
Q14
Q15
15V
100
R11
R12
R13
R14
R15
Q6
Q7
Q8
Q9
Q10
ROUND UP LOGIC
64
83
FROM 35ma 35n
FROM 35k&35l
89
FROM 35a& 35b
84
FROM 35C& 35d
85
FROM 35e& 35f
86
FROM 35g& 35h
88
87
FROM 35i& 35j

FIG-9


35m & 35n
35k & 35l
35i & 35j
35g & 35h
35e & 35f
35c & 35d
REGION 7
REGION 6
REGION 5
REGION 4
REGION 3
REGION 2
15 V.
R21
R22
CR10
R20
R30
Q20
Q25
CR14
-15V.
15V.
FROM PHOTOCELL AREA 35a & 35b
83
R23
CR11
CR13
CR12
Q21
C1
Q24
R31
R29
R27
R28
Q23
R 24
C2
CR15
R32
6V.
105
Q26
Q27
Q28
Q29
CR16
R25
R26
Q22
66
18a

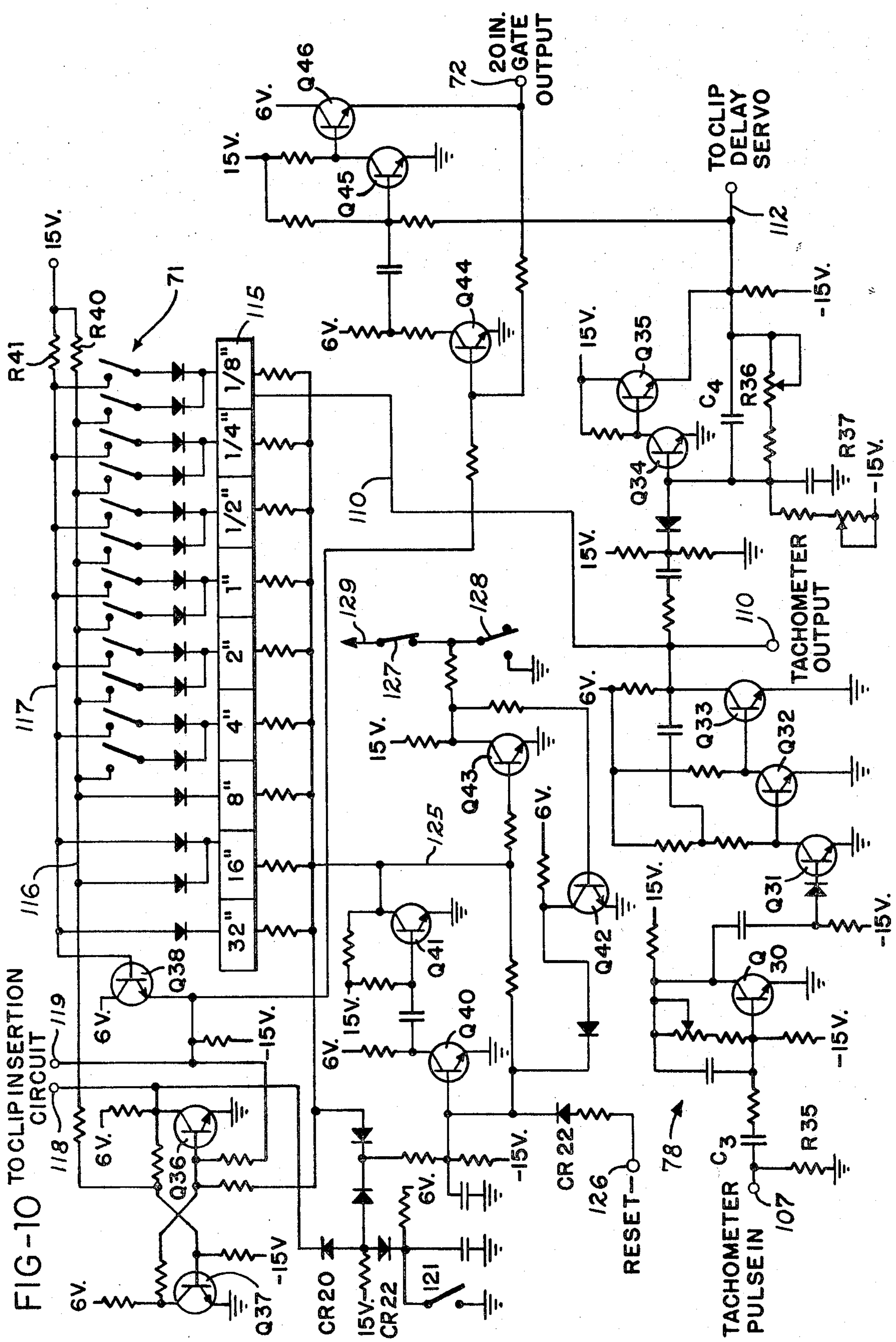

20 IN. GATE OUTPUT
TO CLIP DELAY SERVO
TACHOMETER OUTPUT
TACHOMETER PULSE IN
RESET
TO CLIP INSERTION CIRCUIT

FIG-10

FIG-11A

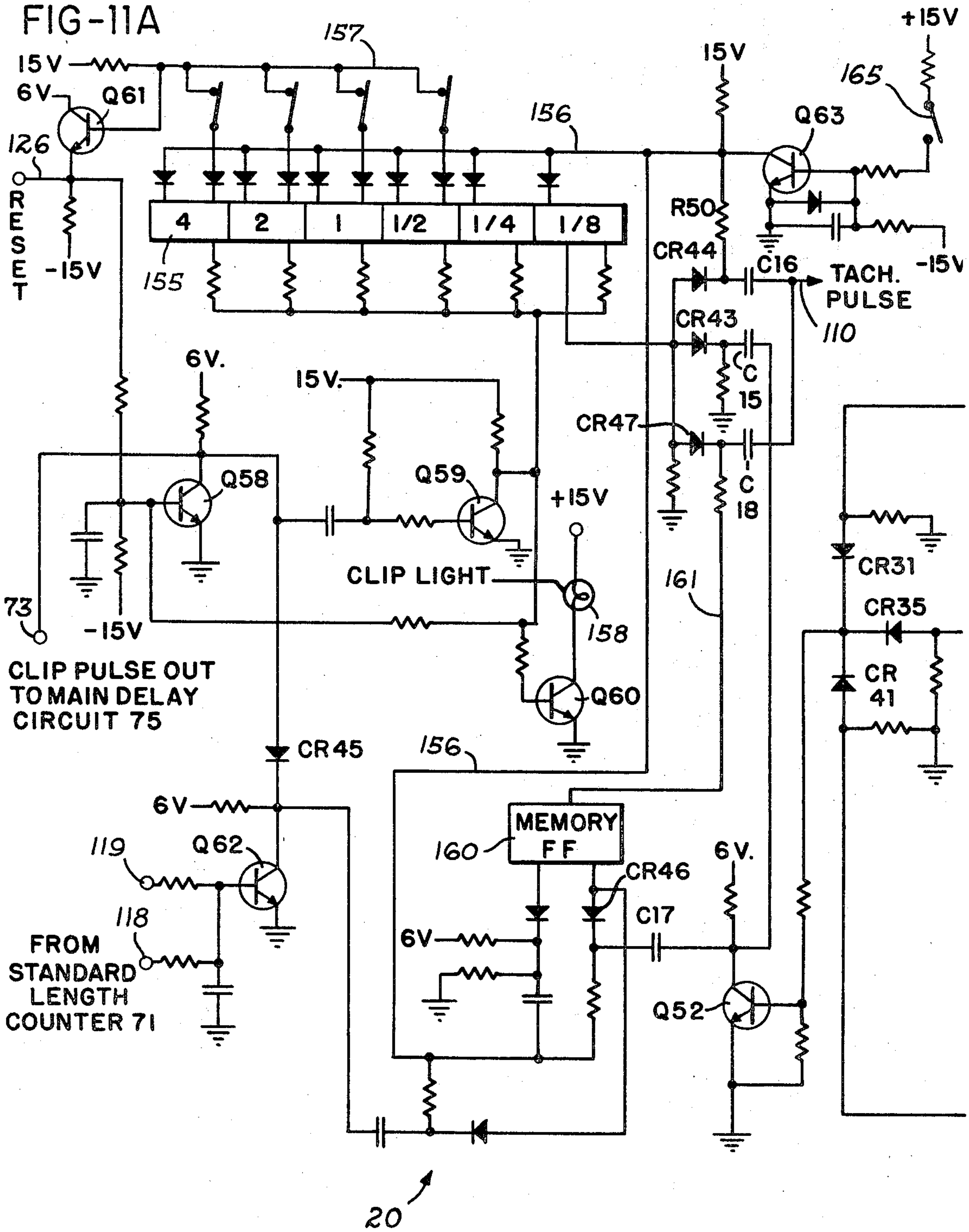

157
15V
6V
Q61
126
RESET
-15V
155
4
2
1
1/2
1/4
1/8
156
15V
+15V
165
Q63
R50
CR44
C16
TACH. PULSE
110
-15V
CR43
C 15
CR47
C 18
6V.
15V.
Q58
Q59
+15V
CLIP LIGHT
158
73
-15V
CLIP PULSE OUT TO MAIN DELAY CIRCUIT 75
Q60
161
CR31
CR35
CR 41
CR45
156
6V
119
Q62
118
FROM STANDARD LENGTH COUNTER 71
MEMORY FF
160
CR46
6V.
C17
6V
Q52
20

FIG-11B

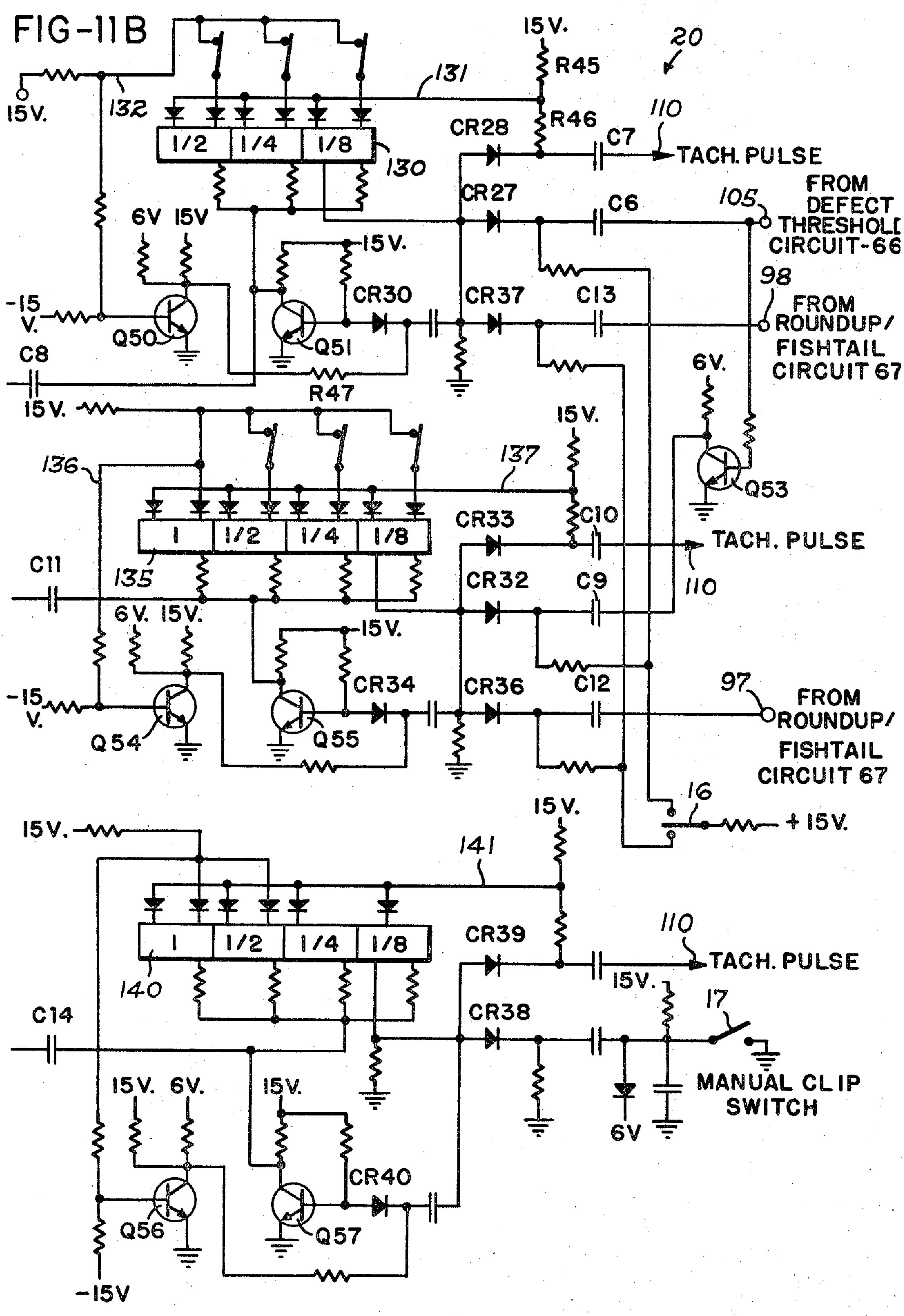

20
15V.
132
131
R45
R46
1/2
1/4
1/8
130
110
CR28
C7
TACH. PULSE
CR27
C6
105
FROM DEFECT THRESHOLD CIRCUIT-66
6V 15V
-15V.
CR30
CR37
C13
98
FROM ROUNDUP/ FISHTAIL CIRCUIT 67
Q50
Q51
C8
R47
6V.
Q53
136
137
CR33
C10
TACH. PULSE
1
135
C11
CR32
C9
110
6V. 15V.
CR34
CR36
C12
97
FROM ROUNDUP/ FISHTAIL CIRCUIT 67
Q54
Q55
16
+15V.
141
CR39
140
CR38
C14
17
MANUAL CLIP SWITCH
6V
15V. 6V.
CR40
Q56
Q57
-15V

FIG-12

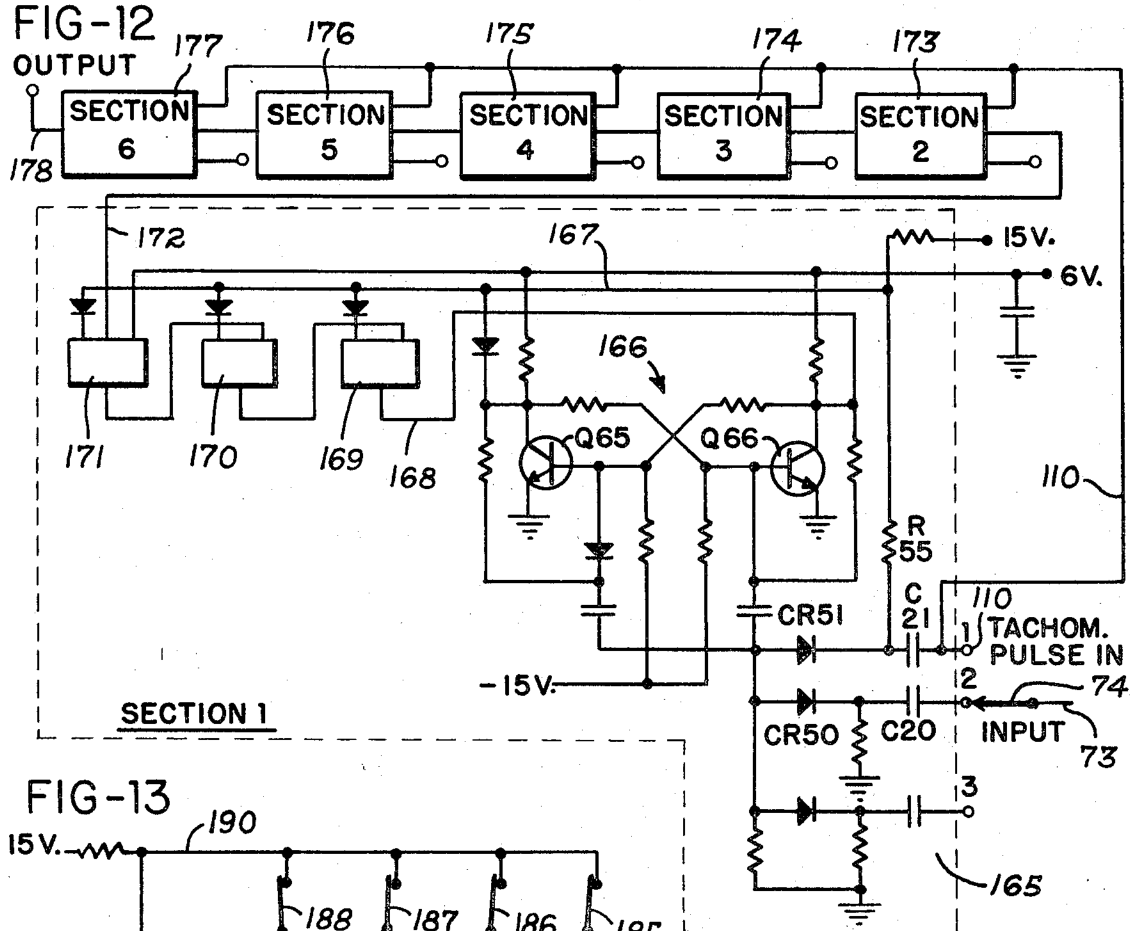

OUTPUT
177
176
175
174
173
SECTION 6
SECTION 5
SECTION 4
SECTION 3
SECTION 2
178
172
167
15V.
6V.
166
171
170
169
168
Q65
Q66
110
R 55
C 21
CR51
110
1 TACHOM. PULSE IN
2
74
INPUT
73
-15V.
SECTION 1
CR50
C20
3
165

FIG-13

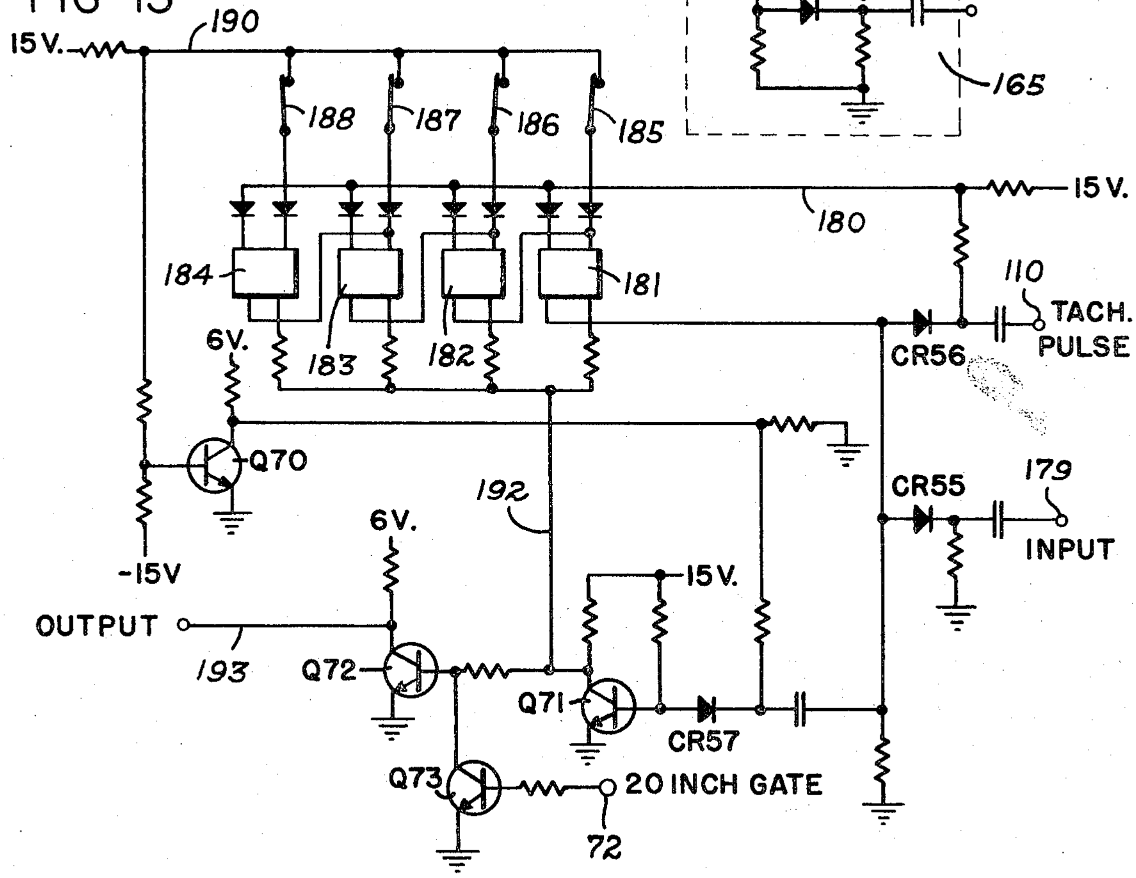

15V.
190
188
187
186
185
180
15V.
184
181
110
TACH. PULSE
183
182
CR56
6V.
Q70
179
CR55
INPUT
192
-15V
6V.
15V.
OUTPUT
193
Q72
Q71
CR57
Q73
20 INCH GATE
72

FIG-14A

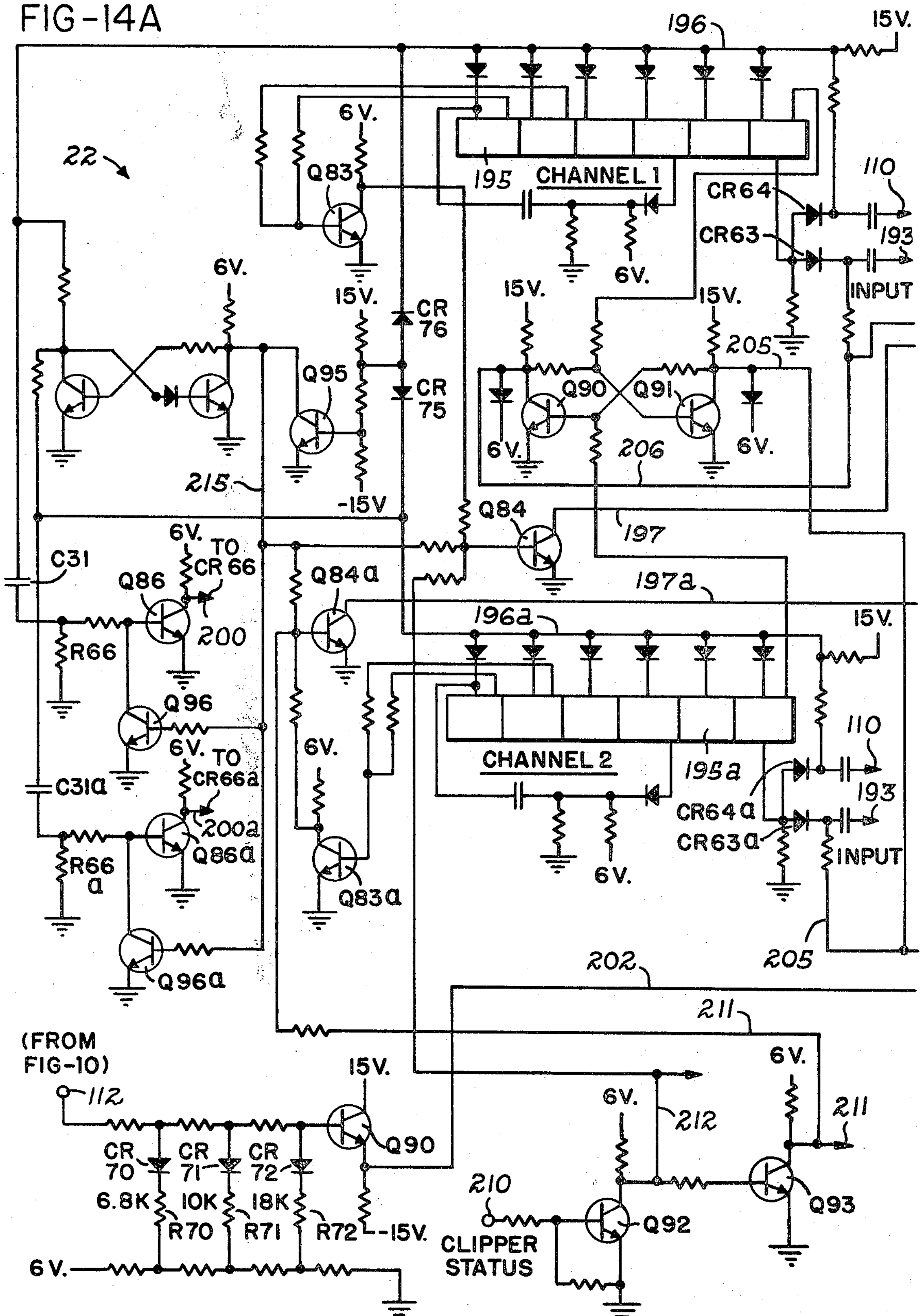
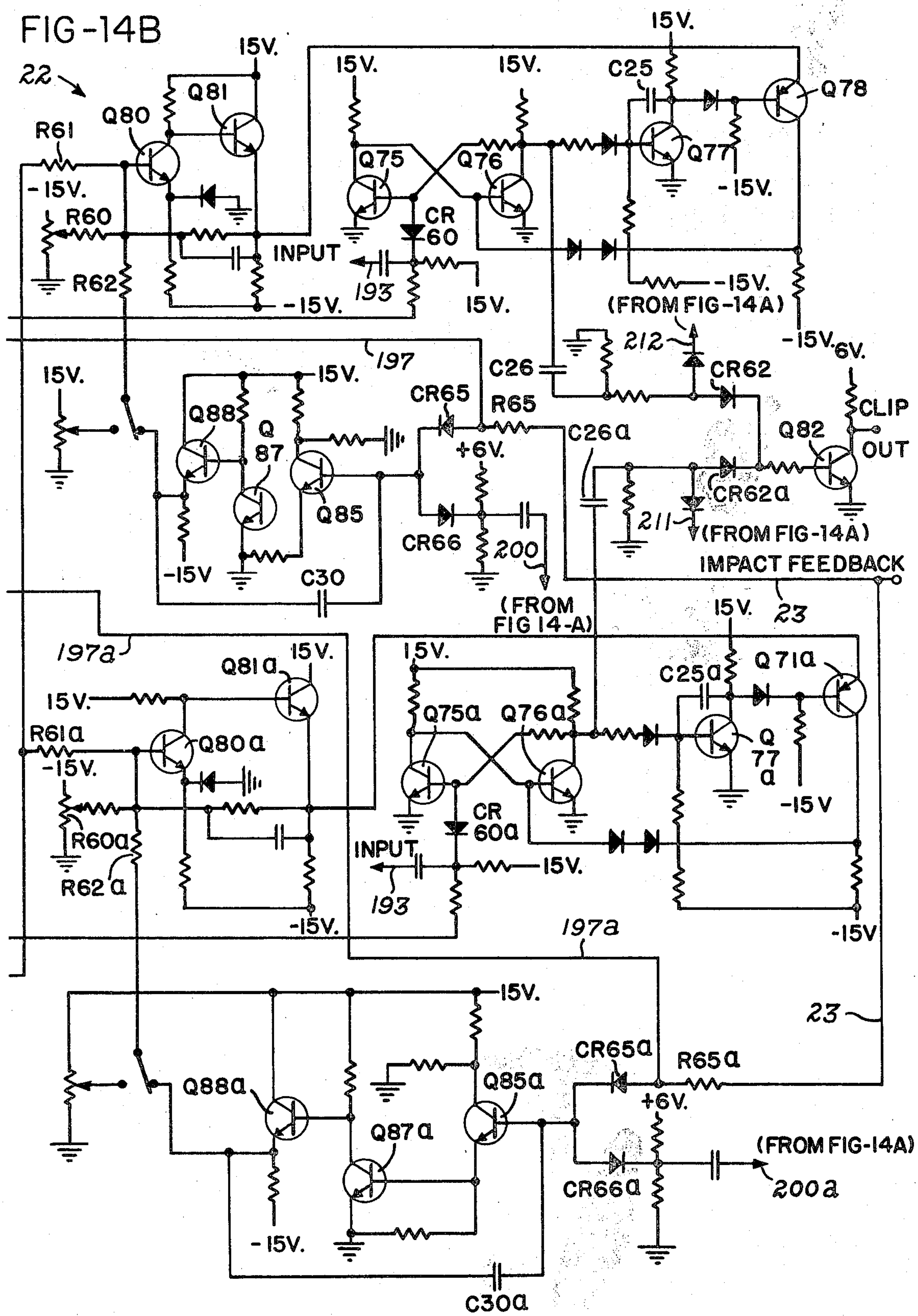

196
15V.
22
6V.
Q83
195
CHANNEL 1
110
CR64
CR63
193
6V.
INPUT
15V.
CR 76
CR 75
Q95
15V.
Q90
Q91
15V.
205
6V.
206
6V.
215
-15V
Q84
197
C31
6V. TO CR 66
Q86
200
Q84a
197a
R66
196a
15V.
Q96
6V.
110
6V. TO CR66a
CHANNEL 2
195a
C31a
200a
CR64a
193
R66 a
Q86a
CR63a
INPUT
Q83a
6V.
Q96a
202
205
211
(FROM FIG-10)
15V.
6V.
112
6V.
212
211
Q90
CR 70
CR 71
CR 72
210
Q93
6.8K
10K
18K
R70
R71
R72
-15V.
Q92
CLIPPER STATUS
6 V.

FIG-14B


22
15V.
Q81
Q80
R61
-15V.
R60
R62
INPUT
-15V.
193
15V.
Q75
Q76
CR 60
C25
Q77
Q78
-15V.
(FROM FIG-14A)
212
-15V.
6V.
197
C26
CR62
CR65
R65
+6V.
C26a
Q88
Q 87
Q85
CR66
200
(FROM FIG 14-A)
-15V
C30
Q82
CLIP
OUT
CR62a
211
(FROM FIG-14A)
IMPACT FEEDBACK
23
197a
Q81a
Q80a
R61a
R60a
R62a
Q75a
Q76a
CR 60a
C25a
Q71a
Q 77 a
-15V
-15V.
197a
23
Q88a
Q87a
Q85a
CR65a
R65a
CR66a
(FROM FIG-14A)
200a
C30a

VENEER DEFECT DETECTOR AND CLIPPER CONTROL

This application is a continuation of Ser. No. 552,940, filed May 25, 1966, and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to a clipper control for use in cutting moving sheet material such as a wood veneer ribbon and to a detector apparatus and to a novel method to aid in the removal of defective areas from rapidly moving sheet material.

It is presently the practice of the veneer industry for an operator to scan visually moving ribbons of veneer to determine the occurrence and location of a defect. The operator estimates the rate of veneer travel, estimates the time required for the defect to travel into a veneer clipper and then actuates the clipper control switch at the proper moment to cut the veneer as close to the defect as possible thereby to eliminate completely the defect without cutting away acceptable veneer.

The operator must be experienced and possess considerable skill and judgment in order to anticipate when the clipper knife will actually contact and cut the veneer ribbon since the response time of the clipper, *i.e.*, the time between the closing of the clipper control switch and the actual engagement of the knife with the veneer, may vary to a considerable degree with changes in the operating temperature or changes in the means supplying the power to the clipper.

In addition, clippers having a toggle actuated knife have a different response time when the toggle is moving to the right and when the toggle is moving to the left. The operator must compensate for this asymmetrical nature of the clipper and accurately anticipate the delay in the response time if the veneer is to be cut as close to the defect as possible and not leave an excessive amount of good veneer in the removed portion, or leave a portion of the defect in that part of the veneer which is considered acceptable.

In one of the toggle actuated veneer clippers in common use, a source of air pressure is supplied through an electrically actuated pneumatic control valve to air cylinders to cause the clipper toggle bar to move in one of two directions. A variation in the response time of this pneumatic control valve to the actuating signal will introduce a variation in the operation of the knife and thereby cause inaccurate cutting of the veneer. It is not uncommon for electrically actuated pneumatic solenoids, if operated on alternating currents, to vary in their response time by as much as one one- hundred twentieth of a second. This variation in the time of the response may cause an error of as great as one-fourth inch in the actual cutting of a veneer ribbon traveling at a rate of 150 feet per minute. Attempts have been made to use direct current controls to eliminate this source of error, but even these controls are subject to long term drift and will ultimately allow a variation in the response rate of the clipper.

It is also the practice of the industry to utilize the same type of clippers described above to cut the veneer into standard lengths if no defects are present. Two methods are in common use to provide measurement for the cutting of standard lengths of veneer. One method uses a photocell limit switch arrangement which senses the leading edge of the veneer after it has been cut. The photocell method is restricted in its use by the fact that the measurement is accurate only on perfectly flat pieces and if the flow rate of the veneer is accurately known. Another method uses a cam follower wheel which travels with the veneer to indicate when a length of veneer has passed beneath a clipper without a defect. The cam follower must follow the veneer precisely in order to measure the length of the veneer accurately, but vibration and sudden changes in ribbon speed, such as caused by clipping, can cause tracking errors. When used in combination with a device to remove defective regions, the mechanical standard length measuring cam must also be reset each tie time a defect is removed so that the standard length thereafter may be measured. It is apparent that the response characteristics of the clipper must also be taken into consideration when performing the standard length clipping function.

Since the standard lengths of veneer must be greater than a certain minimum dimension, but may not be smaller than the minimum dimension, it has been a common practice to determine the total variations introduced by the various components and adjust the equipment such that, using the minimum tolerance in each case, the sheet will not be less than the minimum standard length. The cut veneer sheets from the clipper may vary in size from the required standard length to pieces which may be as much as 1¼" oversize. These oversize sheets which may be 10 feet in width, of course, represent a waste which may be considerably reduced if the range of tolerances in the equipment could be reduced.

SUMMARY OF THE INVENTION

The present invention eliminates the above-mentioned sources of error by providing an electronic system which aids the operator in determining where a cut is to be made in the veneer and which provides compensating means to adjust automatically the time delay between defect detection and the application of the electrical cutting signal to the clipper such that the clipper knife actually engages the ribbon of veneer at precisely the proper position on the veneer, notwithstanding variations in flow rate of the veneer or drift in the response time of the clipper.

In the present invention, a defect in the veneer may be observed before the veneer enters the clipper, either by the operator as a defect passes a reference location, or by directing a source of radiation through the veneer sheet and detecting the change in the radiation intensity as an indication of the presence of a defect. Once a defect is detected, an electrical signal is created which is placed into a memory or delay circuit for use in causing the clipper to cut the sheet after the veneer has moved the distance from the reference location on the detector to the clipper. A variable time delay is provided to compensate for variations in the response time of the clipper such that the knife actually cuts the veneer at the exact location preselected by the operator or by the radiation detector.

The effects of the variations in the response time of the clipper due to temperature, air pressure, wear, etc., and to the asymmetrical response time characteristics of the toggle-type clipper mechanisms commonly in use, may be eliminated by comparing the actual occurrence of the cutting of the veneer to the location where the cutting should occur, and modifying the time of application of the clipper actuating signal to cause the veneer to be cut at the required location. Since the toggle-type clipper has two primary response times, two delay circuits are used in conjunction with an electronic memory and these delay circuits are selected in synchronism with the toggle-type action of the clipper.

The time delay between sensing the defect at the reference location and the actual occurrence of the clipping operation will vary depending upon the velocity of the veneer. Since various velocities or veneer flow rates can be accommodated, the electronic memory providing the necessary delay is made flexible to insure that the knife cuts the veneer at the exact location previously selected. A tachometer is placed in mechanical contact with the flowing sheet of veneer and produces a series of pulses, each pulse corresponding to a ⅛" increment of veneer travel. The electronic memory providing the delay is divided into two parts, the first providing a delay which is dependent solely upon the distance the veneer travels irrespective of the veneer velocity, and the second being related to the velocity of the veneer. The electronic memory is divided between the two types of delay means to provide for flexibility and accuracy in the operation of the system.

Two methods are employed in a preferred embodiment of this invention in locating defects in moving veneer sheets, one of which includes using a visual reference means to permit the operator to actuate a switch manually when a defect passes the reference location, and the other means includes using a photoelectric system measuring the intensity of the radiation transmitted through the veneer to indicate the presence of defective wood.

The manual method uses a shadow line produced on the veneer by a source of radiation situated above the traveling sheet and a wire stretched perpendicularly to the veneer travel and between the source and the veneer. When using the shadow line reference in conjunction with the time delay means which compensates for the drift and asymmetrical characteristics of the toggle-type clipper, more accurate cutting of the wood is possible with a resultant savings in money since less waste is created. By providing a shadow line reference, the operator no longer must watch a defect approach the clipper and anticipate when the blade will cut the veneer. Therefore, the operator's reflexes and judgment are no longer major factors in determining the location of the cut.

The photoelectric type of defect detector includes a plurality of photoelectric cells positioned beneath the traveling veneer which are primarily sensitive to the infrared radiation which passes through the veneer. When a defect occurs, such as a knot, or a void in the veneer, the photocells will receive an additional amount of radiation and will actuate appropriate circuitry to cause the defect to be removed.

It has been found that sound veneer absorbs more radiation than large knots or voids in the woods. This is due to the microscopic anatomy of the wood where it appears that the wood itself is formed from an aggregate of tubular shaped units or cells with their longer axis aligned with the longitudinal axis of the tree member. Thus, the cells are aligned with the longitudinal axis of the tree member. Thus, the cells are aligned vertically in the tree trunk, and horizontally in the limbs of the tree. Since the veneer is removed from the tree in such a way that the thickness dimension of the veneer is almost perfectly radial with respect to the longitudinal axis of the tree, all of the cells which comprise the wood will be in the same plane and will be parallel to the supporting table. As the veneer continues to be stripped from the tree, the limbs will be sliced at right angles producing knots. The cell orientation of the knots will be perpendicular to that of good wood and will be aligned parallel to the thickness direction. The infrared radiation will therefore pass through the material more readily when a knot is present due to this cell orientation. The photoelectric transducer therefore measures the intensity of the radiation and indicates the presence of a defect when the radiation received increases.

Since the area immediately adjacent to a defect which is observed by the photocells is also discolored and may be considered defective or unacceptable, it is often desirable to remove a portion of the wood which immediately precedes and that which follows the defective area as observed by the photoelectric detector. A circuit is provided in the present invention within the time delay memory to cause the knife to cut the veneer a first predetermined distance before the area of the defect (lead) and to cut the veneer at a second predetermined distance after the defect passes beneath the knife (lag). Both the lead and lag distances may be equal.

The photoelectric cells are divided into regions which extend transversely across the ribbon of veneer. When the operator observes the defect approaching the detectors, he activates the photocell region through which the defect will pass to establish a reference level for the radiation which is transmitted through acceptable wood. When the defect thereafter passes through the detecting region, an increase in intensity will be observed. Since wood varies in its infrared transmission characteristics due to changes in thickness, wood type, wood coloring, and other factors, it is desirable to have a detecting device which is flexible and which may accept any type of wood without requiring constant manual readjustment of the detecting device. For this reason, and because the photocell sensitivity and radiation source intensity may also vary, the operator, immediately prior to the observation of a defect, activates the particular cell region through which the defect will move thereby to establish automatically the reference level for the photocells. When the defect leaves the detecting region, a change in intensity is again noted an and this change is utilized to cause the clipper again to operate thereby isolating the defective area and completely removing it from the veneer ribbon.

The photocell detector of this invention may also be used to detect the presence of acceptable wood which exceeds a certain predetermined width in what is called the roundup/fishtail mode. In this mode, much of the wood being stripped from the tree initially is in the form of small broken pieces which cannot be used as veneer, but does contain wood exceeding a predetermined width which may be utilized. Therefore, rather than detecting defects in the veneer, which would be extremely numerous under these conditions, the photocell detectors are connected to a logic circuit which indicates when wood exceeding a predetermined width is present beneath the detector.

The photocell detector is divided into approximately seven regions and in the preferred embodiment of this invention three consecutive photocell regions must indicate the presence of acceptable wood. When wood of the acceptable minimum predetermined width is present, the clipper will separate that portion of the veneer from the remainder of the wood. Should the acceptable region of the wood extend laterally, while maintaining the minimum predetermined width, a different set of three consecutive photocell regions would be activated, and since the initial set of photocell regions no longer indicate the necessary minimum dimensions, another clipping pulse will be initiated. On the other hand, should the initial set of three photocell regions continue to sense acceptable wood, no further clipping pulses would be created even though other photocell regions may begin sensing acceptable wood.

Since the electronic circuitry used in detecting the occurrence of defects or good wood can respond extremely rapidly, and since the mechanical clipper is limited in its response time due to the inertia inherently present in that type of device, a further memory circuit is provided to hold any clip command pulses which occur too frequently to be responded to by the clipper so that a complete removal of a defective area may be accomplished even though the defective area has a dimension less than the response capability of the clipper. The memory merely resupplies the necessary clip pulse after a sufficient time delay has passed, based upon the mechanical limitations of the clipper.

The electronic circuitry included in the present invention also provides that, in the event no defects occur in the veneer, the wood may be cut into one of two standard lengths, with the longer of the lengths preferred. Therefore, the longer length will be cut from the continuous veneer ribbon unless a defect occurs in the region between the shorter predetermined length and the longer predetermined length, in which case the shorter standard length will be cut and the defect removed. Increased accuracy in this function is also made available by use of the standard length memory circuits in conjunction with the compensating means for the clipper response.

The photocell detectors are also provided with a logic circuit which detects lateral movement of the veneer and makes insensitive the edge cells which have been exposed on one side of the detector and which activates corresponding detecting cells on the other side of the detector. This arrangement permits the ribbon of veneer to wander laterally without producing a clip pulse merely because one edge photocell became exposed, provided that its corresponding photocell on the other side of the ribbon became covered, but which permits the continuous observation of the edges of the veneer for defective regions.

Accordingly, it is an object of this invention to provide a clipper control device which automatically compensates for variations in the response time of the clipper due to drift caused by changes in air pressure, temperature, wear, etc., and which compensates for the asymmetrical response characteristic of the clipper and thereby to cause moving sheet material such as veneer to be cut accurately at a location which was preselected prior to the sheet material passing through the clipper.

It is another object of this invention to provide a mechanism whereby moving sheet material may be cut into one of two possible standard lengths with the actual cut being made at the longer of the two standard lengths should no defects occur in the region between the shorter standard length and the longer standard length.

It is another object of this invention to provide a control device for a sheet material clipping mechanism which compensates for variations in the velocity of the sheet material and for variations in the response time characteristics of the clipper mechanism such that the sheet material may be cut within close tolerances at a location preselected either by an operator by a photoelectric detection device, or cut into standard lengths as determined by a length measuring means.

It is another object of this invention to provide a method of detecting defects in moving sheet material wherein a shadow producing device is positioned between a source of visible light and the sheet material to establish a reference shadow line whereby an operator may visually observe a defect passing said shadow line and manually operate an electrical switch to produce a cutting command signal which causes the defect to be removed from the sheet material after the sheet material has moved a predetermined distance.

It is another object of this invention to provide a method for detecting and removing defects from moving sheet material wherein a source of radiation is positioned on one side of the material and a radiation detector is placed on the other side of the material to sense the radiation transmitted therethrough, wherein a reference signal indicating the level of radiation passing through acceptable material is established, wherein a cutting command signal is produced indicating a defect when the intensity of the radiation transmitted through the material increases above a reference level, and wherein the cutting command signal is utilized to cut the material to remove the defect after the material has moved a predetermined distance.

It is another object of this invention to provide a process for detecting and separating acceptable sheet material exceeding a predetermined width from moving sheet material wherein a photoelectric defect detecting element including a plurality of photocells senses the radiation passing through the moving sheet material and establishes when a predetermined number of consecutive photocells indicates the presence of acceptable sheet material to produce a cutting command signal, and thereafter produce additional cutting command signals whenever the width of acceptable sheet material either decreases below said predetermined width or whenever the sheet material of acceptable width does not have at least one edge portion corresponding to the edge of the sheet material initially having the minimum predetermined width.

It is another object of this invention to provide a visual reference means located a predetermined distance from the clipper by which the operator may establish the exact location of a defective area within moving sheet material and manually initiate a cutting signal by reference to the visual reference means, and to provide a control means to automatically compensate for the variations in the response time of the clipper being used whereby the sheet material may be cut at a position remote from the operator at the exact location selected by the operator notwithstanding changes in the response characteristics of the clipper and any changes in the velocity of the sheet material.

It is another object of this invention to provide a photoelectric defect detecting means to sense the occurrence of a defect in moving sheet material such as wood veneer and to eliminate the drift in the response characteristics of the photocell, the intensity of the radiation source, or in the radiation transmission characteristics in what is considered acceptable material, and to establish in the photocell circuit a reference level of transmitted radiation through acceptable material immediately prior to the detection of a defective area within the moving sheet material to which the radiation passing through the defective region may be compared.

It is a further object of this invention to provide a means responsive to a defect signal from a photoelectric defect detecting element, monitoring moving sheet material whereby a clipper located at a remoté location may be caused to cut a defective portion a predetermined distance ahead of the defect and a predetermined distance behind the defect thereby to insure complete removal of the defective region.

It is another object of this invention to provide a detecting apparatus for monitoring moving sheet material and to separate acceptable portions of the material which exceed a predetermined minimum width from the remainder of the material.

It is a further object of this invention to provide a memory device to store cutting command signals which are too closely spaced in time for the proper operation of the mechanical cutting device, such a memory circuit reissuing the cutting signals after a sufficient time delay has elapsed to permit subsequent operation of the cutting device.

It is another object of this invention to provide a device which allows the constant observation of the edges of a sheet material for defects although the material may wander laterally within certain limits as it is being scanned by a photoelectric defect detecting device by simultaneously enabling and disabling pairs of photoelectric cells at opposite edges of the material.

These and other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified view of a defect detector constructed according to this invention showing the physical relationship of the defect detector with respect to the cutting means, and a simplified block diagram showing the electrical control circuitry;

FIG. 2 is a detailed sectional view of the radiation source, the wire forming the shadow line and the photocell defect detector;

FIG. 3 is a sectional view taken along line 3—3 in FIG. 2 and so shows a portion of the radiation source, shadow line, and photocell defect detector extending transversely across the sheet material;

FIG. 4 is a pictorial view of moving sheet material showing the relationship of the defect detector to the cutting means;

FIG. 5 is an electrical block diagram showing the electrical connections among the various electrical components which comprise the defect detector and clipper control circuits;

FIG. 6 is an electrical schematic of one of the photocell boards which comprise the photoelectric defect detector;

FIG. 7 is a schematic electrical diagram of the edge logic circuit which controls the photocells in use and allows the veneer ribbon to wander laterally;

FIG. 8 is an electrical schematic diagram of the logic circuit used when the photoelectric detector is operated in the roundup/fishtail mode;

FIG. 9 is an electrical schematic diagram of the automatic photocell threshold establishing circuit;

FIG. 10 is an electrical schematic diagram of the tachometer pulse amplifier and the standard length counter which supplied clipping pulses to the cutting means after a predetermined length of acceptable sheet material has passed through the cutting means;

FIGS. 11A and 11B are schematic electrical diagrams of the clip insertion and pulse holding circuit included in this invention;

FIG. 12 is an electrical diagram of the main delay circuit with a portion of the circuit schematically shown in detail;

FIG. 13 is a schematic electrical diagram showing another portion of the main delay circuit; and

FIGS. 14A and 14B comprise a schematic electrical diagram of the clip delay servo circuit.

Referring now to the drawings which show a preferred embodiment of this invention, and particularly to FIG. 1 which is a simplified view showing the physical arrangement of the components which make up the defect detector and clipper control of this invention, a sheet of ungraded veneer **10** is moved by means of conveyor belts **11** between 100 and 200 feet per minute through a defect detector **12** and into a cutting means such as a clipper generally indicated at **13** where the defective region in the sheet may be isolated. The clipper **13** may also function to cut the sheet into standard lengths if no defects are observed.

BRIEF DESCRIPTION OF THE DRAWINGS

The exact speed of sheet travel is measured by a tachometer **14** which provides an electrical pulse for each ⅛ -inch increment of sheet travel. This tachometer pulse provides the necessary information required to cause the clipper subsequently to cut the moving sheet when a defective area is observed or when a predetermined length of veneer has passed through the clipper.

The machine operator is provided with a console **15** from which he may select the particular mode of operation for the machine. The operator may select by switch **16** the defect detecting mode wherein voids or knotholes in the veneer are detected and subsequently removed, or he may select the roundup/fishtail mode wherein acceptable wood exceeding a predetermined width may be isolated from unacceptable wood. The operator is also provided with a manual control **17** whereby he may initiate the operation of the clipper at any time. The operator's console is also provided with a plurality of switch means **18** whereby he may activate the particular photocell region through which a defect will pass and simultaneously establish a reference level of the radiation transmitted through acceptable wood immediately prior to the defective are area passing through the defect detector.

The operator's console **15** is connected to a clip insertion circuit **20** which receives commands both from the manually operated switch **17** and from the photoelectric defect detector **12**. The clip insertion circuit modifies the output from the photocells and from the manually operated switch and applies this modified signal through a delay or memory circuit **21**. The delay circuit **21**, as well as the clip insertion circuit **20**, are in part controlled in their operation by the output from the tachometer **14** and the output from the delay circuit **21**. The output from the delay circuit **21** is applied to the clip delay servo circuit **22**.

The function of the clip delay servo circuit **22**, as will be described in detail later in this application, is to apply an electrical actuating signal to the clipper at such a time that the clipper knife will actually cut the veneer at the location selected by either the photoelectric defect detecting elements or by the operator observing the defect passing a reference line. In order to maintain accuracy in the cutting of veneer, a feedback signal **23** is generated when actual cutting of the veneer ribbon occurs and used to adjust the time of application of the electrical signal to the clipper such that the veneer ribbon is cut accurately at the preselected location notwithstanding variations in the response rate of the clipper.

The defect detector **12** is shown in detail in FIGS. 2 and 3 and includes a lamp assembly **25** comprising a bracket **26** supported above the moving sheet of veneer **10** by appropriate means, not shown. Secured to the bracket **26** is a plate **27** having downwardly sloping portions **28** which function as light shields. A plurality of lamps **30** are mounted in brackets **31** which in turn are secured to the plate **27** by insulators **32**. A slot **33** in the brackets **31** receives the end of each lamp. Electrical current for supplying power to energize the lamps may be supplied to the bracket and then to the lamps through the bolt **34** which secures the lamp, bracket, and insulator to the plate **27**. The lamps are designed to emit radiation primarily in the infrared region of the spectrum, although a portion of the radiation is visible. A sufficient number of lamps is provided to illuminate the entire width of the widest anticipated ribbon of veneer.

The defect detector **12** also includes a photocell assembly **35** mounted on the opposite side of the veneer ribbon **10** and positioned to receive the radiation transmitted through the veneer. The photocell assembly **35** includes a plate **36** supported by suitable support posts **37** adjacent the underside of the moving veneer and the plate **36** in turn supports a bracket member **38** mounting the photocell boards **39** onto which the photocells **40** are secured. An aperture **41** is formed in the plate **36** and a glass plate **42** is mounted flush to the upper surface of the plate **36** to prevent dirt and wood particles from passing through the aperture and accumulating on the photocells **40**. It has been found that the glass will not lose its radiation transmission characteristics even after being subjected to continuous rubbing by the veneer ribbon. Each photocell **40** has an adjusting potentiometer **43** associated therewith to provide the initial adjustment of the defect detector and insures an equal voltage output from each of the photocells **40** when the same intensity of radiation is applied thereto.

In the preferred embodiment of the invention described herein, a separate photocell **40** is provided to monitor each 1 -inch width of the veneer. A plurality of shields **44** are secured to the plate **36** and are so positioned between the photocells that each photocell **40** senses only the radiation transmitted through the veneer for that area and does not sense the radiation transmitted through an adjacent area.

In the preferred embodiment, nine photocells monitor a 9 -inch width of the veneer and are connected electrically into what is termed a photocell area. These nine photocells are connected to a common amplifier means and therefore have a single electrical output which is a function of the maximum intensity of the light transmitted through the monitored 9 -inch segment of veneer. Two photocell areas are connected electrically in parallel to form what is termed a photocell region which therefore monitors an 18 -inch width of veneer. A total of seven photocell regions are used to monitor the entire width of the moving veneer ribbon.

The photocells used in the preferred embodiment of this invention are model T3SA20 Infratron photocells which are especially sensitive to infrared light. In view of the sensitivity of these cells to infrared, external sources of heat may adversely affect the sensitivity and operating levels of the photocells. Accordingly, means are provided to maintain the photocells at a near constant temperature by circulating conditioned air over the photocells and associated circuit components. This air if first chilled by a water heat exchanger and then reheated to a regulated temperature by a fast-acting electric heater controlled by a thermistor heat sensor. Therefore, with a constant temperature environment, the operating level of the photocells will not change and the cells will sense only the infrared energy which passes through the veneer ribbon.

The defect detecting assembly **12** further includes a shadow line forming means which includes a shadow line wire **45** placed to one side of the imaginary line which joins the lamp and the photocell. This wire **45** will cause a shadow to be formed on the moving ribbon of veneer at a location approximately one-half inch to one side of the center line of the aperture **41**. By reference to this shadow line, the operator may visually observe a defect and manually control the operation of the clipper to accomplish accurate cutting of the veneer.

As shown in FIG. 4, the clipper **13** is a toggle-type veneer clipper having a supporting member **47** mounted securely above the moving sheet of veneer **10**. A knife blade **48** is secured to the member **47** by several toggles **49**. A toggle bar **50** connects each of the toggles **49** and may be caused to move either to the right or to the left by means of pistons slidably mounted in pneumatic cylinders **51** and **52**, or by electric solenoids. In the embodiment shown, the toggle bar **50** is powered by a source of air pressure **53** supplied to the cylinder **51** at the left and to the cylinder **52** at the right-hand side of the clipper, and an electrically actuated set control valve **54** is provided to apply pneumatic pressure to alternate cylinders on command from the clip delay servo **22**. As previously explained, the clipper **13** will have one of two different response times depending on whether the toggle bar is being moved to the right or to the left, thus giving the clipper an asymmetrical response characteristic. It is therefore important to apply the electrical actuating pulse at one of two different times in synchronism with the clipper operation in advance of the actual clipping location if accurate cutting of the veneer is to be accomplished.

The actual time when the knife **48** cuts the veneer is sensed by an impact detector **55** mounted on the supporting member **47**. The output of this impact detector **55** is applied to amplifier **56**, the output of which is a pulse of a standard width and amplitude. The output **23** of amplifier **56** is the feedback signal **23** used to adjust the time when the electrical actuating signal is applied to the clipper **13**.

A block diagram of the connections among the various electrical components which comprise the veneer defect detector and clipper control circuit of this invention is shown in FIG. **5**. The photoelectric defect detector **35** is divided into 14 areas designated **35*a*** through **35*n***. A pair of photocell areas, such as areas **35*a*** and **35*b***, comprise a region, and seven regions form the entire photocell assembly **35**. It is anticipated that two different standard widths of sheet material may pass through the defect detector in the present invention, therefore, for wider of the two widths, **W1**, nominally 125 inches, all of the photocell regions are utilized, but for the narrower of the two widths, **W2**, nominally 102 inches, the photocell region including areas **35*m*** and **35*n*** will be disconnected. A selector switch **58** is provided to select the width of sheet material to be monitored.

When monitoring a sheet having either a width **W1** or width **W2**, four of the photocells in either photocell area **35*l*** or **35*n*** as well as four photocells in area **35*a*** do not continuously monitor the sheet but are provided with circuit means **60** to disconnect, for example, photocells in area **35*a*** when a corresponding photocell in either area **35*l*** or **35*n*** becomes covered by the edge of the sheet material thereby allowing the sheet to wander laterally without a signal indicating a defect being produced by the photocells at the edge of the sheet. The selector switch **58** determines whether the edge cell inhibit circuit will be connected to area **35*l*** or to area **35*n***. Cable **61** carries the output of the photocells in each of these which have become covered and applies that information through the selector switch to the edge cell inhibit circuit **60**. This circuit in turn supplies an inhibit signal along line **62** to the corresponding photocell at the opposite edge of the sheet.

The outputs from each of the regions comprising the photocell defect detector **35** are applied along cable **64** to both the region defect threshold circuits **66** and the roundup/fishtail logic circuit **67**. As previously explained, the apparatus described herein may be used either to detect and cut away a defect in a moving sheet of veneer or it may be used to isolate good veneer of a width exceeding a predetermined minimum width from the remainder of the veneer ribbon. The particular mode of operation may be selected by switch **16** on the operator's console **15**. The outputs from both the region defect threshold circuit **66** and the roundup/fishtale logic circuit **67** are applied to the clip insertion logic circuit **20**. In addition, the manually operated switch **17** is also connected to the clip insertion logic circuit **20** and may be used by the operator to produce a clipping signal when a defect is observed passing the shadow line reference.

The region defect threshold circuit **66** senses the voltage output from each of the photocell regions **35** and establishes a reference voltage corresponding to the intensity of the radiation transmitted through acceptable wood. When the operator observes a defect approaching the detector **12**, he will close one of the switches **18** on the operator's console **15** to select the photocell region through which the defect will pass, and when the selection is made, the region defect threshold circuit will be automatically calibrated, using the intensity of the radiation through the acceptable veneer immediately preceding the defect as a reference. In this way, frequent manual adjustments of the photocell sensitivity for various types of wood, thickness of veneer, etc., are eliminated.

The roundup/fishtail logic circuit **67** senses when a predetermined number of consecutive photocell regions sense the presence of acceptable veneer. In a preferred embodiment of the invention, the roundup/fishtail logic circuit **67** senses when three consecutive photocell regions observe a continuous width of acceptable veneer and the circuit **67** will produce an output to cause the veneer ribbon to be cut thereby to isolate the acceptable veneer from the remainder of the ribbon when this mode of operation is selected by the operator.

As will be explained in detail hereafter, the output from the clip insertion logic circuit **20** is delayed by an amount determined in part by the mode of operation selected. For example, in the roundup/fishtail mode of operation the photocells sense the presence of an acceptable minimum width of wood and a clipping signal is applied to the clip insertion logic circuit **20**. If the operator were to close switch **17** manually and apply a clipping signal to the circuit **20**, it would be necessary to delay the ultimate clipping of the veneer by an amount equal to the displacement of the shadow line on the veneer. When the apparatus is used in the defect detecting mode, it is desirable to cause the veneer to be cut a small amount both before and after the defect signal is produced by the photocells to insure that the entire defective region is removed from the veneer ribbon. It has been found that a small amount of unacceptable veneer is associated with the defect as observed by the photocells.

A standard length counter **71** supplies an input to the clip insertion logic circuit **20** when either of two standard lengths of veneer pass beneath the defect detectors without a defect being observed. In a preferred embodiment of the invention, a clipping signal is applied to the clip insertion logic circuit **20** after the shorter standard length, nominally 27 inches, has moved under the defect detector since the last clipping signal and another signal is also applied after the veneer has moved under the defect detector for the longer standard length, nominally 54 inches. Since the longer of the two standard lengths is preferred, an inhibit signal will be applied along line **72** to inhibit the clipping signal for the shorter standard length.

The output from clip insertion logic circuit **20** is applied along line **73** to a selector switch **74** connected to the first stage main delay circuit **75**. Further delay circuits **76** and **77** are also provided to delay the application of the clipping signal to the veneer clipper until the veneer has moved the distance from the defect detector to the clipper. The delay circuits **75**, **76** and **77**, as well as the clip insertion logic circuit **20** are controlled by pulses generated by the tachometer **14** and amplified by the tachometer pulse amplifier **78**. These tachometer pulses are generated for every one-eight inch increment of veneer travel. The amount of delay in delay circuit **75** may be determined by the setting of switch **74** and is made adjustable in order to provide for flexiblity in the installation of the defect detector and control circuit of this invention on presently existing veneer cutting equipment. The output from the main delay circuit **77** is then applied to the clip delay servo circuit **22**.

The output from the clip delay servo circuit **22** is applied to the clipper control **54** at a time such that the knife will actually cut the veneer after a standard time delay. The actual time of cutting of the veneer is detected by the impact detector **55**, amplified by the amplifier **56** which produces a feed back pulse having a fixed predetermined amplitude and duration, and applies this pulse to the clip delay servo **22**. The clip delay servo circuit **22** is actually two separate circuits which act alternately in synchronism with the clipper to compensate for the asymmetrical response characteristics of the clipper. The output from the clip delay servo to the clipper will, of course, vary in time by an amount necessary to cause the knife to actually cut the veneer at the proper time.

PHOTOCELL CIRCUIT

Referring now to FIG. 6, which is a schematic electrical diagram of one of the photocell areas which comprise the defect detector, with one of the nine photocell circuits comprising the area shown in detail. The photocells **40** are type T3SA20 Infratron photocells which are sensitive to the infrared radiation which is transmitted through the moving veneer sheet.

Each of the photocells in the area are provided with a positive bias voltage of between 6 and 15 volts from a voltage divider network including potentiometer R1 and resistor R2. A capacitor C1 functions to stabilize the bias voltage. A negative source of voltage is applied to the other side of the photocell through an individual adjustment potentiometer R3, and resistor R4. Diode CR1 prevents excessive voltage from being applied across the cell **40**. Potentiometer R3 is so adjusted that the voltage output from each photocell circuit is the same when the same intensity of radiation is applied to the photocells.

The resistance of the photocell **40** will decrease as the intensity of the radiation falling on the cell increases, therefore, when more radiation falls on the cell, the voltage at the base of transistor Q1 will increase and cause an increasing or positive going voltage at its emitter electrode.

The voltage at the junction of photocell **40** and resistor R4 may also be applied to the base of transistor Q2 provided that diode CR2 is biased into conduction by current flowing through resistors R3 and R4.

Transistor Q2 is also connected to the other eight photocell circuits in the area and acts as a power amplifier supplying the output signal to the remainder of the system. The output from the emitter of transistor Q2 is connected in parallel to the output from an adjacent photocell area which comprises the photocell region and the common output is directed through cable **64** to either the region defect threshold circuit **66** or the roundup/fishtail logic circuit **67**.

For photocell areas **35***a*, **35***l* and **35***n*, four of the edge photocell circuits are provided with the individual output amplifier Q1. The output from the emitter of transistor Q1 is applied along cable **61** to the edge cell inhibit circuit **60** and an inhibit signal may be applied along cable **62** to the junction between resistors R5 and R6. When it is desired to inhibit the output from a particular photocell in a photocell region due to the corresponding photocell at the opposite edge of the veneer ribbon being covered by the sheet, a ground potential will be applied on cable **62** and will place the junction between R5 and R6 at zero potential. This will cause diode CR2 to be biased into a nonconducting state and prohibits the voltage variations at the junction of photocell **40** and resistor R4 from being applied to the base of transistor Q2.

EDGE CELL INHIBIT CIRCUIT

The edge cell inhibit circuit shown in FIG. 7 permits the veneer sheet to wander laterally and prevents a defect signal from the photocell at the edge which is uncovered from developing an output, provided that a corresponding cell on the opposite edge of the veneer is covered by the veneer at the same time. A transistor is gated on when voltage from the individual output of the photocell at the edge of the veneer which is becoming uncovered develops a voltage of such magnitude to overcome a preset bias and causes another transistor to also be gated into the nonconducting state thereby to remove an inhibiting condition on the output of the corresponding photocell on the other edge of the sheet. Therefore, with the arrangement desired herein, the veneer sheet is permitted to move laterally within certain limits and while still monitoring the edge of the veneer sheet for defects.

The output from one of the photocells at one edge of the sheet, for example, one of the photocells in area **35***a*, is applied along cable **61** from transistor Q1 to the base electrode of transistor Q3 through diodes CR4 and CR5. The collector electrode of transistor Q3 is grounded through resistors R7 and R8 when the edge cell circuits are enabled while the emitter electrode has a positive voltage supplied through transistor Q4. The voltage at the emitter of transistor Q3 is determined by the setting of the adjustable tap on potentiometer R9 and establishes the threshold voltage above which the voltage on the base electrode of transistor Q3 must rise before that transistor will go into the nonconducting state. Since the edge cells are subjected to a wide range of change in the intensity of the radiation they receive, the edge cell threshold may be placed at a high level. Terminal **82** provides the same threshold voltage to several other similarly constructed circuits. In the present invention, eight circuits are connected in the manner described to allow the veneer sheet to wander through a total distance of 4 inches.

When the voltage on the base of transistor Q3 rises die to an increase in the intensity of the light falling on one of the photocells **40** in area **35***a*, that transistor will cease conduction and cause the voltage applied on the base electrode of transistor Q5 to decrease. The collector electrode of transistor Q5 is connected by line **62** to the junction between resistors R5 and R6 (FIG. **6**) in either the photocell area **31***l* or **35***n*, depending on the width of the veneer sheet being monitored, and when transistor Q5 ceases to conduct, current is allowed to pass through resistor R6 to bias diode CR2 into the conducting state and allow the variations in voltage from photocell **40** to be applied to the base of transistor Q2. At this time, therefore, when the photocell on one edge of the veneer becomes uncovered, the corresponding photocell on the other side will be placed into operation and defect detection will continue as previously explained.

ROUNDUP/FISHTAIL CIRCUIT

When the operator adjusts switch **16** on the operator's console to select the roundup/fishtail mode of operation, the circuit **67** shown in FIG. **8** is placed into operation. This circuit is connected directly to the output from the photocell areas and senses when veneer of acceptable quality having a width which exceeds three photocell regions is present beneath the detector. When this condition occurs, an output signal from this circuit is developed which is applied to the clip insertion circuit **20** and which ultimately causes the veneer to be cut and separate the acceptable portion from the unacceptable portion. The circuit **67** also senses when the acceptable portion of the veneer having the predetermined minimum width moves laterally and acceptable veneer is no longer present under any one or more of the three photocell regions which initially sensed the acceptable width of veneer even though three other consecutive photocell regions subsequently provide an output indicating acceptable veneer.

In the circuit shown in FIG. **8**, the output from each of the photocell regions is applied along cable **64** to a set of five NOR gates, each formed from a combination of three isolating diodes and a transistor. Thus, the three photocell regions comprising photocell areas **35***a* and **35***b*, **35***c* and **35***d*, and **35***e* and **35***f* are connected to the first NOR gate comprising transistor Q6 by lines **83**, **84** and **85**, respectively. Therefore, each of transistors Q6 through Q10 are connected to three consecutive photocell regions through lines **83** through **89** which form the cable **64**. The transistors of the AND gates are connected to these lines through isolating diodes which serve to present a signal from one area from appearing on a line carrying a signal from another area. Each of these AND gates is enabled when the three consecutive photocell regions connected thereto develop an output representing the occurrence of acceptable veneer.

The collector electrodes of transistors Q6 through Q10 are connected through resistors R11 through R15 to the base electrodes of transistors Q11 through Q15. The emitter electrodes of transistors Q11 through Q15 are connected to a positive source of voltage, while the collector electrodes are connected to lines **91** through **95**, respectively. Each of these lines is connected through a collector load resistor to a suitable source of negative voltage. Each of lines **91** through **95** is also connected to the base electrode of all the other transistors

Q11 through Q15 through an isolating diode. Thus, the collector of transistor Q11 is connected to the base electrode of each of transistors Q12 through Q15 through an isolating diode but not to its own base electrode. Therefore, the operation of one transistor may control the operation of all of the other transistors connected to it.

Each of the lines 91 through 95 is also connected through another set of isolating diodes to the base electrode of transistor Q16 which forms a part of the output circuit. The collector electrode of transistor Q16 is connected directly to the base of transistor Q17, the collector electrode of which is connected to the clip insertion circuit 20 by line 97 and to the base electrode of transistor Q18. The collector electrode transistor Q18 is connected to the clip insertion circuit 20 by line 98. Transistor Q17 provides an output to the clip insertion circuit causing a cutting signal to be developed when the veneer exceeds a predetermined minimum width while transistor Q18 supplies the signal to the clip insertion circuit when the veneer width decreases below the minimum width or when the acceptable width of veneer moves from one set of photocell regions to another set.

The bias voltage for transistors Q6 through Q10 is supplied on line 100 from the junction of the emitter electrode of transistor Q19 and resistor R16. The magnitude of the voltage on line 100 is determined by the setting of the adjustable tap on potentiometer R17 and establishes the value of the voltage which must be applied to the base electrodes of transistors Q6 through Q10 to cause them to go into the nonconducting state.

Before the veneer sheet begins to pass between the radiation source and the photocell detectors, a maximum intensity of radiation is falling on the photocells in each region and causes the maximum possible positive voltage output to be present on lines 83 through 89. Under these conditions, each of transistors Q6 through Q10 will be gated on or into the conducting state. As acceptable wood begins to move between the radiation source and the detectors, the voltage level on certain of lines 83 through 89 will decrease and when the voltage level on three consecutive lines indicates the presence of acceptable wood, for example on lines 83 through 85, the transistors Q6 will be gated into a nonconducting state and cause a rise in the voltage level on the base of transistor Q11 to gate that semiconductor into the nonconducting state also.

When transitor Q11 ceases conducting, the voltage on line 91 will change from a positive value to a negative value of such a magnitude that the voltage applied to the base electrode of transistors Q12 through Q15 will cause these elements to remain in the conducting state notwithstanding any subsequent changes in the state of conduction of transistors Q7 through Q10.

The change in voltage on line 91 will also be reflected onto the base electrode of transistor Q16 through the isolating diode to cause that semiconductor to cut off and thereby gate transistor Q17 to conduction. At this time, a negative going signal from the collector transistor Q17 will be applied to the clip insertion circuit 20 along line 97 to cause the development of a clipping signal. Also, the base of transistor Q18 will become less positive to cause that element to gate off and apply a positive going signal on line 98 to the clip insertion circuit. However, only negative going signals are utilized by the clip insertion circuit 20 to develop the necessary pulse to cause the clipping of the veneer.

When the width of the veneer sheet becomes less than the three regions including photocell areas 35*a* through 35*f*, the voltage level on one or more of lines 83 through 85 will increase and transistor Q6 will again conduct and cause transistor Q11 to be gated on thus raising the voltage on line 91 and removing the biasing voltage on the base electrodes of transistors Q12 through Q15. Transistor Q16 resumes conducting and a negative going voltage will appear at the collector electrode of transistor Q18 which will be applied on line 98 to the clip insertion circuit 20.

Assuming, for example, that in addition to photocell areas 35*a* through 35*f* sensing acceptable veneer, the photocell areas 35*g* and 35*h* also begin to sense acceptable veneer. This condition will cause a lower voltage to be developed on line 86 as well as on lines 83 through 85 and will cause transistor Q7 to go into the nonconducting state. The voltage at the base of transistor Q12, however, will not change due to the voltage applied thereto from line 91 due to the action of transistor Q11. Therefore, the covering of an additional photocell region with acceptable veneer will have no apparent effect on the remainder of the circuit.

If the photocell region including areas 35*a* and *b* subsequently become uncovered, however, the bias on the base of transistor Q12 from line 91 will be removed and the action of transistor Q7 will be effective to cause transistor Q12 to go into the nonconducting state. Once this happens, bias voltage will be applied to the base electrodes of each of transistor Q12 and transistors Q13 through Q15. It will require, however, that the bias voltage on line 91 be removed first and this will cause a cutting command signal to be generated since transistor Q16 will conduct and remain conducting until transistor Q12 is placed in the nonconducting state.

DEFECT DETECTING CIRCUIT

The machine operator may also select the defect detecting mode of operation by adjusting switch 16 on the operator's console shown in FIG. 1. This causes the circuit 66 shown in FIG. 9 to become effective in controlling the operation of the clipper. In this mode of operation the operator will observe a defect approaching the defect detector 12 and activate the photocell region through which the defect will pass. By closing one of the switches 18 on the operator's console, the defect detecting circuit then momentarily senses the intensity of radiation passing through an acceptable portion of the sheet to establish a reference level and thereafter compares that reference level to the intensity of the radiation which subsequently passes through the veneer. As a defect moves between the radiation source and the photocells, an increase in the amount of radiation will be received and the voltage representing this radiation will be compared to the reference voltage. When the change in voltage occurs, a clipping signal will be developed which will be applied to the clip insertion circuit 20 to initiate the subsequent cutting of the sheet.

The output of each of the photocell regions are applied on lines 83—89 in cable 64 to seven similarly constructed threshold circuits 66, only one of which is shown in detail in FIG. 9. The common output from the photocells in the region including photocell areas 35*a* and 35*b* is applied on line 83 to the base of the transistor Q20 through resistor R20 and diode CR10. The setting of the adjustable tap on potentiometer R21 will place a bias voltage at the junction of resistor R20 and diode CR10 through resistor R22 to bias diode CR10 into a nonconducting state until the voltage on line 83 rises above the bias voltage. The potentiometer R21 is located on the operator's console where the sensitivity of the entire system to defects may be established.

The output of the photocells in areas 35*a* and 35*b* on line 83 is also applied to the base of transistor Q21 through resistor R23 and diode CR11. A capacitor C1 will charge to the voltage applied to the base of transistor Q21 and maintain that change during the defect detecting operation. Prior to that operation, however, C1 is shorted to ground through diode CR12, resistor R24 and transistor Q22. The base of transistor Q22 is maintained at a positive voltage to keep the transistor in conduction by supplying voltage through resistors R25 and R26. Also, prior to the defect detecting operation, the junction between resistor R23 and diode CR11 is shorted ground potential through diode CR13 and transistor Q23. This transistor is in the conducting state due to the positive voltage applied to its base electrode through resistors R27 and R28. Collector voltage is applied through the collector load resistor R29.

When the operator observes a defect approaching the defect detector **12**, he will close one of the switches **18** on the operator's console, such as switch **18a**, and maintain the switch closed until the defect completely passes the defect detector assembly. Closing switch **18a** places a ground on the base of transistor Q22 which will stop conducting and remove the short from C1. Closing switch **18a** will also cause a negative going pulse to be reflected through capacitor C2 and momentarily place a negative voltage on the base of transistor Q23. Capacitor C2 will again change through resistor R27 to a positive value, and allow transistor Q23 to conduct again. The time constant of capacitor C2 and resistor R27 is such that transistor Q23 will stop conducting only for a period of approximately 2 milliseconds, or for approximately one-tenth inch of veneer travel. When transistor Q23 momentarily stops conducting, the short circuit is removed from the junction of R23 and CR11 and allows C1 to charge to the voltage appearing on line **83**. When Q23 starts conducting again, the voltage on line **83** will be isolated from capacitor C1 by diode CR11.

The voltage at the base of transistor Q21, which is maintained by capacitor C1, controls the current flow in the emitter circuit of that element and thus the voltage on the base of the emitter follower transistor Q24. The output from transistor Q24 is applied on the emitter of the transistor Q20 through diode CR14. This voltage is therefore determined by the intensity of the light falling on the photocells in the defect detector during the short period of time when transistor Q23 was in the nonconducting state. When the voltage on line **83** subsequently increases as a defect passes between the radiation source and the photocells in the detector, that voltage will appear on the base of transistor Q20, assuming that it is of a magnitude sufficient to overcome the bias established by potentiometer R21. As the voltage on the base electrode increases and becomes positive with respect to the voltage on the emitter electrode, current will flow through resistor R30 in the collector circuit to change the voltage on the base electrode of transistor Q25. The result is that more current will flow through Q25 and resistor R31 and cause a positive voltage to be applied on the base of transistor Q26 through diode CR15 and resistor R32.

The circuit including transistors Q26 through Q28 comprise a Schmitt trigger and inverter wherein a negative going voltage on line **105** indicates when a defect is sensed by the photocells, and a positive going voltage on line **105** represents the end of the defect. This Schmitt trigger and inverter circuit is common to all of the region threshold circuits.

The junction between resistor R31 and diode CR15 is also connected directly to the collector of transistor Q29 and to the collector of transistor Q22 through diode CR16. As long as the operator maintains switch **18a** closed, the changes in voltage from Q25 will be allowed to pass through diode CR15 to transistor Q26 and not be shorted to ground through Q22. Once the switch **18a** is opened, Q22 will conduct and no output will be passed through CR15 to the Schmitt trigger. Also, during the short period when the threshold is being established and transistor Q23 is not conducting, transistor Q29 will be gated on and prevent any output from Q25 from being applied to the Schmitt trigger.

TACHOMETER PULSE AMPLIFIER

The tachometer pulse amplifier **78** shown in the lower portion of FIG. **10** receives the pulses from the tachometer pulse generator **14** where they are amplified and routed to various of the components which comprise the remainder of the clipper control system. In one embodiment of the invention, the tachometer generator **14** is a Dynapar Model 70 magnetic Rotopulser, supplying a 0.25 volt pulse into a 100 ohm load for each one-eight inch of travel of the veneer. The output of the tachometer is applied along line **107** to the load resistor R35 and onto the base of transistor Q30 through capacitor C3 where it is amplified and the output applied to the base of transistor Q31. Transistors Q31 through Q33 further amplify the tachometer pulses. The output from Q23 is applied on output line **110** to the standard length counter circuit **71**, to be described later, and to a converter circuit whereby a direct current voltage is produced having a magnitude which is proportional to the velocity of the sheet material.

The converter circuit includes an operational amplifier comprising transistors Q34 and Q35 and an integrating capacitor C4 and wherein adjustable resistors R36 and R37 are included to establish the operating level of the amplifier. The output from the emitter of transistor Q35, is applied on line **112** to a gate circuit, to be described in detail later, and to the clip delay servo circuit **80**. The voltage appearing on line **112** is therefore a function of the velocity of the sheet material as measured by the tachometer pulses.

STANDARD LENGTH COUNTER

The standard length counter circuit **71**, shown in detail in FIG. **10** produces clipping command pulses which are applied to the clip insertion circuit **20** whenever the length of acceptable veneer passing through the clipper since the last cut of the veneer exceeds either one of two predetermined standard lengths. The circuit may be arranged in such a manner that if the longer of the two lengths becomes available, an inhibit signal is produced to make ineffective the signal which would otherwise cut the veneer at the shorter length.

The standard length counter uses a set of multivibrators, or flip-flops, connected in series to count the number of tachometer pulses produced since the last cutting signal was generated by the clip insertion circuit. Once the number of pulses representing the shorter standard length is reached, an output is applied through the clip insertion circuit to the main delay circuits **75—77** (FIG. **5**). If the standard length counter is allowed to count enough tachometer pulses to indicate the longer standard length, then another output is created, and, at the same time, an inhibit signal is applied to the main delay circuit **77** to prevent the clipping signal for the shorter of the two standard lengths from being applied to the clip delay servo circuit **20**. The inhibit or gate signal is of such a length that it will inhibit any cutting signal occurring with a 20-inch length travel of veneer around the location where the veneer would be cut for the shorter standard length.

Tachometer pulses from the tachometer pulse amplifier **78** are applied on line **10** to the set input on the first stage or ⅛-inch counting stage multivibrator or flip-flop in the counter **115**. Each of the ⅛-inch to 4-inch flip-flops have an output which may be connected through isolating diodes and switches to lines **116** and **117**. The 8-inch flip-flop is connected to line **116** only and the 32-inch flip-flop is connected to line **117** only while the 16-inch flip-flop is connected to both lines **116** and **117**. Lines **116** and **117** are connected to a source of positive voltage through load resistors R40 and R41, respectively, and to the base electrodes of transistors Q37 and Q38. The flip-flops in counter **115** are so constructed that an open circuit is presented to either of lines **116** or **117** when the flip-flops are in the reset condition, and a ground or short circuit is presented when they are in the set state or condition. Therefore, once a flip-flop connected to either of lines **116** or **117** become set, the voltage on these lines will be changed from the source voltage to essentially ground potential and cause the transistor amplifiers connected to these lines to cease conduction. When the flip-flops connected to either lines **116** or **117** have completely counted the necessary pulses from the tachometer, they will return to the reset condition and lines **116** or **117** will again assume the source potential to cause either transistor Q37 or Q38 to conduct.

By connecting selected ones of the flip-flops in counter **115** to the lines **116** and **117**, the standard length between cutting signals may be made to vary between 24 and 28 inches for the shorter length and between 48 and 56 inches for the longer length. Once the counter **115** begins to count, the transistors Q37 and Q38 cease conducting and the voltage on output lines **118** and **119** will assume a negative value. These output lines are connected into the clip insertion circuit 20, and will cause a cutting command signal to be generated only when the voltage on these lines goes positive. This condition will occur when either lines 116 or 117 goes positive when all of the flip-flops connected thereto are in the reset condition or when a standard length of veneer has been measured.

The transistor Q37 along with transistor Q36 forms a flip-flop which allows only one shorter standard length pulse to be generated for each cycle of operation of the counter 115. Thus, when the line 116 becomes positive, transistor Q37 will begin to conduct. This will, in turn, cause the voltage at the base of transistor Q36 to decrease and place that transistor in the nonconducting state. The voltage from the collector electrode of transistor Q36 will then become positive and applied on output line 118 to the clip insertion circuit 20. The voltage at the collector electrode of transistor Q36 is also applied to the base of transistor Q37 to hold that transistor in the conducting state until the flip-flop is reset. Thus, subsequent changes in the voltage on line 116 will produce no further output pulses from line 118 until the standard length counting circuit is reset.

When the standard length counter circuit is to be used to produce both shorter and longer standard length pulses, switch 121 is closed, and the cutting command signals from terminal 118 through diode CR20 are shorted to ground through diode CR21. Therefore, only reset signals from the clip insertion circuit 20 on line 126 will be effective in resetting the circuit. On the other hand, if only the shorter standard length cutting function is required, switch 121 will remain open and the pulses generated on line 118 will be allowed to pass through diode CR21 and be applied to the base of transistor Q40 to gate it into conduction and in turn momentarily gate off transistor Q41 to apply a positive going reset signal on line 125 to reset each of the flip-flops in counter 115. A reset signal may also be applied on line 126 from the clip insertion circuit through diode CR22 onto line 125 to cause the counter 115 to reset. Thus, the counter flip-flops 115 may be reset either when the standard length cutting signal has been generated or when a cutting command signal is generated from the defect detecting portion of the system.

When the reset pulse is applied to the counter 115, this same positive going pulse will also be applied to the base of transistor Q36 to cause it to conduct and thereby place transistor Q37 in the nonconducting state where it will remain until a shorter standard length is again counted by the counter 115. Transistor Q36 may also be reset by a signal from the emitter of transistor Q38 when a longer standard length signal is created.

An inhibit gate including transistors Q44 and Q46 is provided to eliminate the cutting signal for the shorter standard length and is actuated when transistor Q38 begins conducting indicating the occurrence of the longer standard length. The duration of the inhibit signal on line 72 to the main delay circuit 77 is determined by the magnitude of the voltage on line 112 representing the velocity of the sheet and will present an inhibit signal for a 20-inch length of veneer around the location where the shorter standard length would otherwise be cut.

Means are also provided in the present invention to place manually actuating pulses directly to the clipper and to place standard length pulses automatically onto the clipper without utilizing the remainder of the electronic circuitry described herein. The operator may close switch 127 to select this type of operation and thereafter momentarily close switch 128 to place a ground on line 129 to the clipper and thereby to cause operation of that element. The standard length counter will reset at this time since transistor Q42 will be gated off during the time when switch 128 is closed and place a reset signal on line 125 to the standard length counter 115. Thereafter, when the standard length counter resets, transistor Q43 will be momentarily gated into the conducting state and place an actuating signal on line 129 to the clipper.

CLIP INSERTION CIRCUIT

The clip insertion circuit 20 shown in FIGS. 11A and 11B provides an output on line 73 to the main delay circuit 75 when a clipping pulse is developed and applied to the clip insertion circuit from either the standard length counter circuit 71 (FIG. 10) the defect threshold circuit 66 (FIG. 9) the roundup/fishtail circuit 67 (FIG. 5) or from the manual clipping switch 17.

The clip insertion circuit 20 is provided with four delay circuits, one of which receives the output from the other three and which may be considered a part of the main delay circuit 75. One of the other delay circuits responds to a signal from the defect threshold circuit 66 indicating the occurrence of a defect and provides an output at the proper time to cause the veneer to be cut exactly at the location of the defect or at a predetermined distance in advance of the detected defect. This circuit is called the "lead" memory since it causes the cut in the sheet to lead the defect as sensed by the photocell detectors (see FIG. 4). Another one of the delay circuits responds to the signal from the defect threshold circuit 66 representing the end of a defective region. This circuit allows the cutting of the sheet to lag the detected end of the defective area when using photocell detectors. It has been observed that the unacceptable area of the veneer actually extends a short distance to either side of the detected defect. For this reason, the equipment constructed according to this invention is provided with means to cut away more than just the detected defective area.

The remaining delay circuit responds to the closing of the manual clipping switch 17 when the operator observes a defect under the shadow line. Since the shadow line is displaced from the photocell detectors, a different relay is provided such that the veneer is subsequently cut at the location selected by the operator.

Referring to FIG. 11B, a defect signal from the defect threshold circuit is applied on line 105, through capacitor C6 and diode CR27 to the set input of a set of three multivibrators or counter flip-flops 130. The counter 130 is similar to the counter 115 shown in FIG. 10, with reference to the description of the standard length counter, in that line 131 is ungrounded only when all of the flip-flops are in the reset condition and that the other outputs of the flip-flops will cause the line 132 to be at ground potential until all of the flip-flops which are connected to line 132 are placed in the set condition.

Line 131 is connected to the junction between resistors R45 and R46 and, as long as all of the flip-flops 130 remain in the set condition, a positive bias voltage will be applied to diode CR28 to prevent tachometer pulses on line 110 from being applied to the first stage of counter 130.

In the preferred combination of the invention, the maximum amount of lead is provided when none of the flip-flops 130 are connected to the line 132 and the minimum lead occurs when all are connected to the line 132.

When a defect occurs, the leading edge of the defect will be represented by a negative going signal on line 105 which will set the ⅛-inch flip-flop in the counter 130 and cause line 131 to obtain a ground potential. All tachometer pulses thereafter to be applied to capacitor C7 will pass through diode CR28 to the set input on the ⅛-inch flip-flop which will then proceed to count to a maximum of 1 inch of veneer travel.

In addition, assuming that each of the flip-flops in counter 130 are connected to line 132, this line will be at ground potential and prevent the transistor Q50 from conducting and in turn inhibit the operation of the transistor Q51 by applying a positive clamping voltage to diode CR30 through resistor R47 until the preset delay is obtained. This prevents the tachometer pulses from being applied to the base electrode of transistor Q51. However, when all of the flip-flops in counter 130 are placed in the set condition, or at least those connected to line 132, transistor Q50 will begin conducting and remove the bias on diode CR30 and allow the next tachometer pulse to be applied onto the base of transistor Q51. At this time, transistor Q51 will momentarily cease conducting and a positive will be applied through capacitor C8 and diode CR31 to the base of transistor Q52 (FIG. 11A). This pulse also resets each of the flip-flops in counter 130 in the event that only selected flip-flops were connected to line 132.

The trailing edge of the defect causes the voltage level on line 105 to be positive going when the defective area is no longer detected by the photocells and this positive going signal will cause transistor Q53 to conduct and place a negative going pulse through capacitor C9 and diode CR32 to the first stage in the counter flip-flop 135. This circuit provides the maximum amount of lag when all the flip-flops in the counter 135 are connected to line 136.

Line 137 is connected to an output of all of the flip-flops in the counter 135 and allows an inhibiting voltage to prevent tachometer pulses from passing through capacitor C10 and diode CR33 to the first stage or ⅛-inch flip-flop as long as all flip-flops are in the reset condition. Once the ⅛-inch flip-flop is set due to the action of the transistor Q53, tachometer pulses thereafter are allowed to pass through diode CR33 to continue the counting operation. Line 136 controls the operation of transistor Q54 and will in time bias diode CR34 off and prevent tachometer pulses from being applied to the base of transistor Q55 until all the flip flops connected to line 136 are placed in the set condition. When this occurs, the bias is removed from diode CR34 and the tachometer pulse will cause Q55 to place a positive pulse through capacitor C11 and diode CR35 to the base of transistor Q52 (FIG. 11A).

When the apparatus is used in the roundup/fishtail mode of operation, the signal representing the beginning of the minimum width of acceptable wood is applied on line 97 and through capacitor C12 and diode CR36 to the first stage of counter 135 thereby to allow the cut to be made in the veneer either at the exact location of the minimum width, or a short distance afterward, depending on which flip-flops in counter 135 are connected to line 136. In a similar manner, the signal representing the end of the acceptable width is presented on line 98 through capacitor C13 and diode CR37 to the first stage flip-flop in counter 130 and will allow the cut to be made at or ahead of the end of the fishtail region.

In the preferred embodiment of this invention, the operator selects the particular mode of operation by switch 16 located on the operator's console. If the defect detecting mode is selected, a positive voltage is routed through switch 16 to bias diodes CR36 and CR37 out of conduction thereby preventing any signals on lines 97 and 98 from passing through those semiconductors. In the roundup/fishtail mode, however, the diodes CR27 and CR32 are inhibited and any output from the defect threshold circuit 66 is prevented from producing an output from the clip insertion circuit.

In addition to developing a cutting command signal by means of the photocells, it is also possible to create such a signal by manually closing the manual clipping switch 17 located on the operator's console. This causes a negative going pulse to be transmitted through diode CR38 to the counter 140 to initiate the counting sequence. Line 141 will then be grounded to remove the inhibiting bias voltage from CR39 allowing tachometer pulses thereafter to be applied to the counter 140, and causes transistors Q56 to remove the bias on diode CR40 when the 1-inch and ½-inch flip-flop in the counter 140 become set thereby to allow the next tachometer pulse to be applied to transistor Q57 and from that element to the base of transistor Q52 through capacitor C14 and diode CR41. The time delay for the manual clip mode is fixed since the operator, by reference to the shadow line, can positively control the operation of the clipper. The fixed delay automatically compensates for the displacement of the shadow line from the photocell detectors.

Once transistor Q52 (FIG. 11A) receives a positive pulse from either the lead circuit, the lag circuit, or the manual delay circuit, the voltage at the collector electrode will be negative going and will be applied to the first stage or one-eighth inch flip-flop in the counter 155 through capacitor C15 and diode CR43. Counter 155 provides a delay of between one-half inch to 8 inches of the cutting command signal to the main delay circuits. When the counting sequence is initiated, the inhibit to diode CR44 is removed by grounding line 156, and tachometer pulse thereafter are allowed to pass through capacitor C16 and diode CR44 to continue the counting operation.

Once the counters connected to line 157 have all set, a positive voltage will be applied to the base of the transistor Q58. This produces a negative going signal on line 73 to the main delay circuit 75 (FIGS. 5 and 12) and causes the flip-flops in counter 155 to be reset through the action of transistor Q59. Transistor Q60 will also conduct and pass current through an indicating lamp 158 to inform the operator that a cutting command signal has been generated.

A reset signal is also generated by the action of transistor Q61 and applied on line 126 to the standard length counter 71 to reset that circuit and start its length measurement from the last cutting command signal. The output of the standard length counter, in turn, is applied to the base of transistor Q62 on lines 118 and 119, and the output of this element is applied on line 73 to the main delay circuit 75 through diode CR45.

In the event that two cutting command signals separated in time by a value which is less than the response time of the clipper are applied to the base of transistor Q3, it becomes necessary to preserve the second cutting command signal and reapply it to the clipper at a later time, otherwise it would be lost. For example, assume that the clipper can only cut the veneer in 4-inch intervals and that a defect is detected which is only 3 inches in length. This would cause a cutting command signal to be applied at the beginning and ending of the defect and spaced within the response time of the clipper. The first cutting command signal will be applied in the normal manner and will cause the normal operation of the clipper. Should no provision be made to preserve the second cutting command signal, it would also be applied to the clipper during the time the clipper is already completing its operation and would therefore be lost. Consequently, the veneer would be cut only at the beginning and not at the end of the defect.

When a first cutting command signal is applied to transistor Q52, a negative going signal was applied through capacitor C17 to diode CR46 at the same time that the signal was placed into counter 155. Diode CR46 was biased into a nonconducting state by the voltage on line 156, however, and the first cutting command signal will have no effect on the memory flip-flop 160. Once the counting sequence was started, the biasing voltage is removed from line 156 and a subsequent cutting command signal will be permitted to place the memory flip-flop 160 in the set state. This has the effect of removing an inhibiting signal from line 161 and allowing tachometer pulses to pass through capacitor C18 and diode CR47 even though the counter 155 resets and the voltage on line 156 biases diode CR44 off. Therefore, the next tachometer pulse will be placed onto the first stage of the counter 155 and the counting sequence resumed with the second cutting command signal being spaced from the first by a distance determined by the counter 155. Once the counter 155 begins counting again, line 156 will be negative going and a reset pulse to be applied through diode CR47 to the memory flip-flop 160.

The clipper can also be caused to operate repeatedly at a rapid rate by closing switch 165 to bias transistor Q63 into conduction. This removes the bias from diode CR44 and allows tachometer pulses to be applied continuously to the first stage flip-flop in counter 155 notwithstanding the periodic resetting of the counter and the application of cutting command signals to the main delay circuit.

MAIN DELAY CIRCUITS

A delay circuit 21 located between the clip insertion circuit 20 and the clip control circuit 22 provides a major portion of the delay of the cutting command signal between the production of the cutting command signal and the application of the actuating signal to the clipper. The delay is correlated with the speed of the veneer and causes the veneer to be actually cut at the proper location after the veneer has traveled from the defect detecting assembly into the clipper.

In the preferred embodiment of the invention described herein, three separate substantially identical delay circuits **75** through **77** are provided, one of which is shown in detail in FIG. **12**. Each of the delay circuits **75** and **76** provides a delay of up to 12 inches of veneer travel while the delay circuit **77** provides for a delay up to 10 inches of veneer travel. The delay circuits are each controlled by tachometer pulses from the tachometer **14** which measures the rate of travel of the moving sheet of veneer and delays the output of the cutting command pulse which is applied to the delay circuit by an amount sufficient to allow the veneer to move substantially into the veneer clipper.

Each of the delay circuits **75** and **76** are divided into a set of six sections, each having a delay of 2 inches, with each section consisting of four multivibrators of flip-flops connected in series. One of the sections in FIG. **12** is shown in block diagram with one of the multivibrator circuits in that section shown in detail. In the main delay circuit **75** (FIG. 5), the section onto which the clip signal is placed from the clip insertion circuit **20** is determined by the setting of the selector switch **74**. Thus, the delay may be varied in increments of 2 inches to provide flexibility in the installation of this equipment on presently existing veneer cutting machines.

With the selector switch **74** set to provide an input to the first section **165** of the main delay circuit **75**, a cutting command signal from the clip insertion circuit will be applied through capacitor C20 and diode CR50 to place the multivibrator **166** consisting of transistors Q65 and Q66 into the set state. This means that transistor Q65 will conduct to cause the voltage on line **167** to approach ground potential and remove the bias previously applied through resistor R55 to diode CR51. Thereafter, the tachometer pulses applied on line **110** will pass through capacitor C21 and diode CR51 to the multivibrator circuit **166**. The next pulse applied will cause transistor Q66 to conduct and provide an output on line **168** to the following multivibrator **169** to place it in the set state. At this time, the multivibrator **166** will return to the reset state, however, line **166** will remain at substantially ground potential through the action of multivibrator **169**. Therefore, for each tachometer pulse, the multivibrator **165** will change from the reset state to the set state and from the set state to the reset state and provide an output on line **167** after each alternate tachometer pulses. The multivibrator **166** therefore counts ⅛-inch increments of veneer travel while the multivibrator **169** will count one-fourth inch increments of veneer travel. In like manner, the multivibrators **170** and **171** will count ½-inch and 1-inch increments of veneer travel, respectively.

After a total of 2 inches of veneer travel has been monitored by the tachometer, the multivibrator **171** will provide an output on line **172** to the next section **173** which will then provide an additional delay equivalent to 2 inches of veneer travel. Each of sections **173** through **177** therefore provide a delay equivalent to 2 inches of veneer travel. The output from section **177** on line **178** is applied to the next delay circuit **76** which functions in a similar manner.

The main delay circuit **77** (FIG. 5) includes four sections of multivibrator similar to those described above giving a total delay of 8 inches and in addition includes a further delay circuit shown in FIG. **13** which provides for varying the delay in ⅛-inch increments of veneer travel up to a total delay of 2 inches. The delay circuit shown in FIG. **13** is similar to the delay circuits described in connection with the clip insertion circuit **20** wherein cutting command signal to the delay circuit on line **179** through diode CR55 will set the multivibrator **181** and cause line **180** to approach ground potential and unbias diode CR56 to allow subsequent tachometer pulses to be applied to the multivibrator **181**. Each of the multivibrators **181** through **184** may be connected through switches **185** through **188** to line **190**.

In the event that all of the switches **185** through **188** are closed, a 2-inch delay will be provided and if all of the switches are open, no delay from the circuit is available. Assuming all of the switches **185** through **188** are closed, the voltage on line **190** will be at approximately ground potential until each of the flip-flops of multivibrators **181** through **184** are placed in the set condition. At this time, transistor Q70 is allowed to conduct, the bias voltage placed on diode CR57 will be removed and the next tachometer pulse on line **110** will be placed on the base electrode of transistor Q71 to cause it to momentarily cease conducting. At this time a reset voltage on line **192** will be applied to each of the flip-flops **181** through **184** to place them in the reset condition. A negative going pulse is also applied to the base of transistor Q72 to provide cutting command signal to the clip delay servo **21** on line **193**.

The output from transistor Q71 may be inhibited by transistor Q73 when it is desired to remove the cutting command signal generated by the standard length counter **71** for the shorter standard length when the longer standard length becomes available. Thus, an output on line **72** from the 20-inch inhibit gate (FIG. **10**) will cause transistor Q73 to conduct and effectively short out any input to transistor Q72.

CLIP DELAY SERVO CIRCUIT

The clip delay servo circuit **22** shown in FIGS. **14A** and **14B** receives a cutting command signal from the output of the main delay circuit **75** and thereafter applies an actuating signal to the veneer clipper at such a time that the knife will actually engage and cut the moving veneer at the preselected location. Since the veneer clipper has asymmetrical response characteristics, the clip delay servo circuit is provided with two circuits, each having a different time delay to compensate for the asymmetrical response of the clipper with each channel being selected in accordance with the movement of the clipper toggle bar. The clip delay servo circuit of this invention also compensates for changes in the response rate of the clipper due to changes in the ambient temperature, air pressure, wear, or other causes.

Each of the delay circuits in the clip delay servo circuit includes an operational amplifier and a ramp generator with the outputs of each of these elements being connected to a voltage comparator. Upon the application of a cutting command pulse to the clip delay servo circuit, the operation of the ramp generator is initiated and when the voltage output from the ramp generator is equal to the voltage output from the operational amplifier, an actuating signal is produced which is applied to the clipper drive mechanism. A reference means including a counting circuit is also actuated by the cutting command signal and controlled by the movement of the veneer to produce a reference electrical output after the veneer has moved a predetermined distance after the application of the cutting command pulse. A feedback signal is also produced when the knife actually engages the veneer sheet and this feedback signal is compared with the reference electrical signal to produce a voltage which is applied to the input of the operational amplifier to vary the time of application of the actuating signal to the clipper drive in such a way that the knife will contact the veneer at the location preselected by the cutting command pulse.

Since the clipper used with the present invention has asymmetrical response characteristics, the circuit shown in FIGS. **14A** and **14B** includes means to determine in which direction the toggle bar on the clipper will move to select the proper delay circuit and correct only that circuit for errors in timing. Means are also provided to determine whether two cutting command signals are applied to the clip delay servo circuit in closely spaced intervals to prevent the feedback signal from being applied to the wrong delay circuit to cause an undesirable change in the time delay characteristics of that circuit.

Referring specifically to FIG. 14B, the clipping command pulse from the main delay circuit 75 is applied on line 193 and through diode CR60 to the base of transistor Q75 which will bias that element into a nonconducting state. At this time transistor Q76 will begin conducting and remove the positive voltage previously applied to the base of ramp generator transistor Q77. Capacitor C25 will then begin to charge and the voltage appearing at the base of transistor Q76 will begin to rise.

The transistor Q78 is a voltage comparison device wherein the voltage applied to the base of the transistor from the ramp generator Q77 is compared with the voltage applied to the emitter electrode Q78 from the operational amplifier including transistors Q80 and Q81. The voltage output from the operational amplifier is controlled by a preset voltage obtained from the adjustable tap on potentiometer R60, from a voltage through resistor R61 representing the velocity of the moving sheet, and an error correction voltage obtained through resistor R62.

When the voltage at the base of the voltage comparator Q78 approximately equals the voltage at the emitter electrode of Q78, the transistor will cease conducting and cause a negative going signal to be applied to the base of transistor Q76 to gate off that element and cause a positive voltage to be applied to the base of transistor Q75 to place it in conduction thereby resetting the multivibrator formed by transistors Q75 and Q76. Also, a positive voltage will be applied through capacitor C26 and diode CR62 to the base of transistor Q82. The output from transistor Q82 is the actual signal applied to the clipper to cause the operation of that mechanism.

At the same time the cutting command pulse on line 193 was applied to initiate the operation of the ramp generator Q77, a cutting command was also applied through diode CR63 (FIG. 14A) to set the first stage multivibrator in the reference counter counter 195. The counter 195 functions to produce a reference electrical output after the veneer has traveled a predetermined distance, a total of 7½ inches in the preferred embodiment described herein, and applies this output to an error correcting circuit. Once the counter 195 begins counting, the voltage on line 196 will approach ground potential to remove the bias on diode CR64 and tachometer pulses thereafter will be allowed to continue the operation of the counter. After the counter 195 has counted at least 2 inches of veneer travel, transistor Q83 will be placed in the conducting state to gate off transistor Q84. At this time a short circuit is removed form line 197 and diode CR65 may thereafter conduct. When the counter has counted tachometer pulses representing veneer travel of 7½ inches, transistor Q83 will be gated off and transistor Q84 will short out the input to diode CR65.

When the clipper knife actually engages the veneer, the impact pickup 55 (FIGS. 4 and 5) will produce a pulse having a predetermined constant positive voltage and duration. Thus, if the clipper knife engages the sheet before the reference counter 195 resets, the positive pulse on line 23 will be applied through resistor R65 and diode CR65 to the base of transistor Q85 and one side of capacitor C30. If the impact feedback on line 23 appears after the counter 195 has reset, however, no positive voltage will be applied through diode CR65 to transistor Q85.

Referring again to FIG. 14A, when the counter 195 resets, a positive pulse on line 196 will be reflected through capacitor C31 onto the base of transistor Q86. This transistor will therefore conduct for a period determined by the value of capacitor C31 and resistor R66 and produce a negative pulse on line 200 through diode CR66 (FIG. 14B) to the base of transistor Q85 and one side of capacitor C30. Capacitor C30 therefore acts as an integrator comparing the value of the positive source of energy derived from the impact feedback signal on line 23 and the negative pulse applied on line 200. The output from the emitter of transistor Q88 is then applied to the operational amplifier Q80 and Q81 to adjust the voltage output from that circuit.

Thus, if the knife actually engages the sheet in advance of the desired location, more positive voltage will be applied to the base of transistor Q85 in the correction circuit which will ultimately cause the voltage output from the operational amplifier at the emitter of transistor Q78 to increase thereby requiring that the voltage output from the ramp generator Q77 be higher to produce an actuating signal. Since it takes a longer period of time for the ramp generator to produce a higher voltage, a longer time delay is thereby provided. On the other hand, if the impact feedback signal on line 23 occurs after the desired delay, diode CR65 will be shorted and the negative pulse on line 200 will cause output of the operational amplifier to be ultimately reduced.

Since the actuating signal to the clipper must be applied sooner when the veneer is traveling at higher speeds, it is necessary to adjust the output from the operational amplifier in accordance with the speed of the moving sheet of veneer. For this purpose, the voltage at the base of transistor Q80 in the operational amplifier is also controlled by the voltage on line 202 from transistor Q90. Transistor Q90 in turn is controlled by the analogue voltage produced by the circuit shown in FIG. 10, the output of which is developed in line 112. This is a direct current voltage which is proportional to the magnitude of the speed of travel. The diodes CR70 through 72 and resistors R70 through 72 modify the voltage-to-speed ratio.

The operation of the other channel of the clip delay servo circuit is substantially similar and corresponding elements in that circuit are designated by the same reference numerals with the suffix *a*.

The particular channel next to be used is determined by the status of the flip-flop shown in FIG. 14A, including transistors Q90 and Q91. When the second channel is the last to have been used, the next cutting command signal is directed to the first channel. Under such circumstances, transistor Q90 is conducting while transistor 91 is in the nonconducting state. With transistor Q91 cut off, a positive voltage is applied on line 205 to bias diode CR65*a* and diode CR60*a* (FIG. 14B) into a nonconducting condition to prevent the cutting command signal from the main delay circuit from passing through these semiconductors. In like manner, the voltage on line 206 is placed at a positive value when the second channel is to be utilized.

The feedback signal from the clipper knife is directed to the proper channel so that the correcting voltage may be applied to the correct operational amplifier by an input provided on line 210 (FIG. 14A) from the clipper drive 54. When the voltage on this line is positive, transistor Q92 will conduct and transistor Q93 will be in the nonconducting state. Therefore, a positive voltage will appear on line 211 to bias transistor Q84*a* into conduction and short line 197*a* to ground thereby preventing the impact feedback signal from passing through diode CR65*a*. Lines 211 and 212 are also connected to diodes CR62*a* and CR62, respectively, to prevent an output from the second circuit while the first circuit is in operation.

Means are also provided in the clip delay servo circuit of this invention to prevent the application of the impact feedback signal to either channel in the event that the operation of both channels overlap each other. This overlapping condition is sensed by transistor Q95 which is connected to lines 196 and 197 by diodes CR75 and CR76. When both of these lines are at ground potential, transistor Q95 will cut off and a positive voltage will thereafter exist on line 215 to cause transistors Q84 and Q84*a* to conduct, and thus short out the impact feedback signal, and also cause transistors Q96 and Q97 to conduct and thereby prevent the operation of transistors Q86 and Q86*a* and the application of a negative pulse to the error correcting circuits.

The veneer defect detector and clipper control of this invention therefore may produce a cutting command signal at a preselected location upstream from the clipper either by manually operating a switch, by using photocell detectors, or by a standard length counter and thereafter applying an actuating signal to a veneer clipper at such a time that the clipper knife will actually cut the veneer at the preselected location, notwithstanding changes and variations in the response rate of the clipper or to the asymmetrical response characteristics of the most commonly used toggle-type veneer clippers.

While the methods and forms of apparatus herein described constitutes preferred embodiments of the invention, it is to be understood that this invention is not limited to these precise methods and forms of apparatus and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

We claim:

1. An apparatus for transversely cutting a strip of moving sheet material for use with a cutting device having asymmetrical actuation response characteristics:
 means for producing cutting command signals prior to the sheet material moving into said cutting device for cutting the sheet material at preselected locations;
 reference means for producing reference signals after the sheet material has moved a preselected distance after the production of said cutting command signals;
 first and second circuit means connected to receive said cutting command signals and adapted to apply actuating signals to said cutting device after a time delay, each of said circuits having a different time delay characteristic to compensate for the asymmetrical actuation response characteristics of the cutting device in corresponding positions;
 feedback means associated with said cutting device for producing electrical signals upon the actual cutting of said sheet material; and
 means responsive to said feedback signals and said reference signals for modifying the delay in each of said circuit means in such a way that the time interval between the feedback signal and the reference signal is maintained at a value such that the sheet material is cut at the preselected location.

2. The apparatus as defined in claim 1 wherein said means for producing cutting command signals includes:
 means located a predetermined distance from said cutting device in a direction opposite to the direction of the sheet material flowing into said cutting device to provide a shadow line reference location including a source of light illuminating said moving sheet material and means between said light and said sheet material for producing a shadow line extending transversely across said sheet material; and
 manually operated switch means which may be actuated to produce cutting command signals to be applied to either said first and second circuit means as a defective portion of said sheet material passes under said shadow line.

3. The apparatus as defined in claim 1 wherein said means to produce cutting command signals includes:
 means located a predetermined distance from said cutting device to provide for defect detection prior to the defect moving into said cutting device including;
 radiation producing means located on one side of said sheet material, said radiation being directed toward said sheet material with a greater portion of the radiation passing through the sheet material in the areas where defects occur;
 radiation sensing means located on the opposite side of said sheet material from said radiation producing means to receive the transmitted radiation; and
 output means connected to said radiation sensing means to produce cutting command signals upon a change in the intensity of the radiation transmitted through said sheet material as a result of a defective area passing between said radiation source and said radiation detecting means.

4. The apparatus as defined in claim 1 wherein said cutting device includes a knife mounted to be actuated through the cutting and return stroke by the movement of a toggle bar from one limit position to another limit position and includes means to reciprocate the toggle bar upon the application of successive actuating signals thereto; and wherein switching means are included for selecting either the first or the second circuit means in response to the position of said toggle bar whereby the time delay characteristics of each of said first and second circuit means are maintained in synchronism with the operation of said cutting device.

5. The apparatus as defined in claim 1 wherein each of said first and second circuit means includes:
 an operational amplifier;
 a ramp generator;
 a voltage comparator operably connected to said operational amplifier and said ramp generator for developing an actuating signal to be applied to said cutting device when the output from said ramp generator equals the output from said operational amplifier; and
 wherein the means responsive to said feedback signal and said reference signal is operably connected to said operational amplifier to modify the output from said operational amplifier in such a way that the actuating signal developed by said voltage comparator occurs at such a time in advance of the actual cutting of the sheet material that the sheet will actually be cut at the preselected location.

6. The apparatus as defined in claim 1 further including means associated with said sheet material for producing an output signal for specified lengths of travel of sheet material; and wherein said apparatus further includes means connected to said output means for delaying the application of the cutting command signals to either the first or second circuit means until the sheet material has moved from the means producing the cutting command signals substantially to the cutting device.

7. The apparatus as defined in claim 1 further including memory means for sensing the occurrence of cutting command pulses which are spaced together too closely for the proper operation of the cutting device, said memory means resupplying the later, closely spaced cutting command signals to said first and second circuit means after a delay sufficient to permit the subsequent operation of said cutting device.

8. The apparatus as defined in claim 1 wherein said means for producing cutting command signals comprises:
 radiation producing means positioned on one side of said sheet material, said radiation being directed toward said sheet material with a greater portion of the radiation passing through the sheet material in areas where defects in the sheet material occur;
 radiation sensing means positioned on the opposite side of said sheet material to receive the radiation transmitted therethrough;
 reference means connected to the output of said radiation sensing means to measure momentarily the intensity of the radiation transmitted through said sheet material prior to the sensing of a defect to provide a reference level indicating the intensity of the radiation transmitted through an acceptable portion of the sheet material; and
 means comparing said reference level to the output from said radiation sensing means to provide a first cutting command signal when the intensity of the ra diation transmitted through said sheet material increases above said reference level and to provide a second cutting command signal when the intensity of the radiation passing through said sheet material thereafter decreases.

9. The apparatus as defined in claim 1 wherein said means for producing cutting command signals comprises:
 radiation producing means positioned on one side of said sheet material with the radiation therefrom directed toward said sheet material;
 radiation sensing means positioned on the opposite side of said sheet material to receive the radiation transmitted therethrough;
 means connected to said radiation sensing means to provide a first signal when the intensity of the radiation trans-

mitted through said sheet material increases thereby indicating the beginning of a defect and to provide a second signal when the radiation passing through said sheet material decreases thereby indicating the end of the defect;

means for producing an output signal for specified lengths of travel of the sheet material;

means connected to said output signal producing means and responsive to said first signal to produce a first cutting command signal after the sheet has traveled a first predetermined distance after the occurrence of the first signal;

further means connected to said output signal producing means and responsive to said second signal for producing a second cutting command signal after the sheet has traveled a second predetermined distance after the occurrence of said second signal; and

whereby the defect may be cut from the sheet material a predetermined distance prior to the defect and a predetermined distance after the defect thereby to insure complete removal of the defect from the sheet material.

10. The apparatus as defined in claim 1 wherein said means **for producing cutting** command signals includes:

radiation producing means located on one side of said sheet material;

radiation sensing means located on the opposite of said sheet material to sense the intensity of the radiation transmitted therethrough;

means connected to the output of said radiation sensing means to measure momentarily the intensity of the radiation passing through said acceptable sheet material prior to the sensing of a defect and thereby to provide a reference level;

comparator means to compare thereafter the reference level with the output from said radiation sensing means to provide a first signal in response to an increase in the intensity of the radiation above-said reference level and to produce a second signal in response to a decrease in the intensity of the radiation to or below said reference level;

first delay means responsive to said first signal to produce a cutting command signal to be applied to either said first or said second circuit means at such a time that the sheet material will be cut a predetermined distance prior to the defect as observed by said radiation sensing means; and

a second delay means responsive to said second signal to produce a cutting command signal to be applied to the other of said first or second circuit means at such a time that the sheet material is cut a predetermined distance after the defect as observed by said radiation sensing means.

11. The apparatus as defined in claim 1 wherein said means for producing cutting command signals includes:

radiation producing means located on one side of said sheet material;

radiation sensing means positioned on the opposite side of said sheet material to receive the radiation transmitted therethrough, said radiation sensing means including a plurality of photocells arranged to extend transversely across said sheet material;

means connected to said plurality of photocells to produce a cutting command pulse when the output from said photocells increases above a predetermined value; and

means sending the individual output of the photocells at each edge of the sheet material to disable selectively the output from each of said photocells to said cutting command signal producing means when said photocells become uncovered and to enable selectively a corresponding photocell at the opposite edge of said sheet material thereby permitting the lateral movement of the entire sheet without producing a cutting command signal indicating a defect provided the corresponding photocell at the opposite edge of the sheet becomes covered by said sheet material.

12. The apparatus as defined in claim 1 wherein sheet material having a predetermined minimum continuous width may be separated from the remainder of the sheet material, said apparatus including:

radiation producing means positioned on one side of said sheet material;

a plurality of radiation responsive photocells positioned on the opposite side of said sheet material and aligned to receive the radiation transmitted through said sheet material; and

circuit means connected to the output of said photocells for providing a cutting command signal when a predetermined number of consecutive photocells indicate the presence of acceptable sheet material corresponding to the predetermined minimum width, said circuit means further providing a cutting command signal when the number of consecutive photocells indicating the acceptable minimum predetermined width does not include the original photocells indicating the minimum predetermined width of acceptable sheet material.

13. The apparatus as defined in claim 1 wherein said means to produce cutting command signals includes:

means operably associated with said moving sheet material to produce output signals after specified lengths of sheet material have moved through said cutting device; and

means connected to said output means to provide cutting command signals after the sheet material has moved a predetermined distance through said cutting device since the last cutting command signal thereby to cut the sheet material into standard predetermined lengths.

14. The apparatus as defined in claim 1 wherein said means to produce cutting command signals includes:

means operably connected with said moving sheet material to produce output signals after specified lengths of sheet material have moved through said cutting device;

means connected to said output means to provide cutting command signals after the sheet material has moved a first predetermined distance since the last cutting command signals provided another cutting command signal has not been applied to said first or second circuit means within said first predetermined distance;

means to produce another cutting command signal after the sheet material has moved a second further predetermined distance since the last cutting command signal provided that no cutting command signal occurs within said second predetermined distance; and

means to inhibit said cutting command signal at said first predetermined distance in the event that a cutting signal is produced at said second predetermined distance thereby to cut the sheet material only at the second or longer predetermined distance.

15. Apparatus for cutting a strip of moving material including:

a cutting device;

means for producing cutting command signals upon the passage of defects in the material a predetermined distance in advance of said cutting device;

output means operably associated with the moving material in advance of said cutting device to produce output signals for specific increments of movement of the material;

second means responsive to the output signals from said output means and further responsive to the cutting command signals from said first means for providing additional cutting command signals after predetermined lengths of material have moved through said cutting device since the last cutting command signal; and

delay circuit means connected to receive said cutting command signals from said first and second means and responsive to the output of said output means for providing actuating signals to said cutting device after the material has moved said predetermined distance.

16. Apparatus of claim 15 wherein said second means includes means for producing a cutting command signal after a first predetermined length of material has moved through said cutting device since the last cutting command signal and means for producing another cutting command signal after the material has moved a second, further predetermined length through said cutting device, and means to inhibit said cutting command signal at said first predetermined length in the event that a cutting command signal is produced at said second predetermined length thereby to cause the material to be cut at said second predetermined length.

17. The apparatus of claim 15 wherein said first means for producing cutting command signals is a manually actuated switch.

18. The apparatus of claim 15 wherein said first means for producing cutting command signals is a sensing device responsive to radiation transmitted through the material upon the passage of a defect in the material across said sensing device.

19. Apparatus for use with a cutting device for cutting a strip of moving material, the combination including:

first means located a predetermined distance in advance of said cutting device for producing first and second cutting command signals indicating the passage of the beginning and end of a defect in the material, respectively;

output means associated with said material in advance of said cutting device for producing output signals for specified lengths of travel of the material;

means connected to said output means and responsive to the first cutting command signal from said first means indicating the beginning of a defect to produce a first actuating signal to said cutting device after the material has traveled a first predetermined distance from the occurence of said first cutting command signal;

further means connected to said output means and responsive to the second cutting command signal from said first means indicating the end of the defect to produce a second actuating signal after the material has traveled a second predetermined distance from the occurrence of said second cutting command signal; and

whereby the material is cut a first predetermined distance prior to the defect and a second predetermined distance after the defect thereby to insure complete removal of the defect from the material.

20. The apparatus of claim 19 wherein said first means for producing cutting command signals comprises:

a source of radiation positioned on one side of the material to sense the intensity

a radiation detector positioned on the opposite side of the material of the radiation transmitted therethrough;

means providing a reference; and

means comparing said reference level to the actual intensity of the radiation transmitted through the material thereby to produce cutting command signals when a defect passes between said radiation source and said radiation detector.

21. The apparatus of claim 19 wherein said first means for producing cutting command signals includes a manually actuated switch.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,552,252 Dated January 5, 1971

Inventor(s) Carl W. Maxey, Grant R. Montague, Warren L. Leyde and Eugene L. Bryan

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

Column 1, line 74, "tie time" should be -- each time a --.

Column 3, line 31, "Thus, the cells are aligned with the longidinal axis of the tree member" should be deleted.

Column 4, line 3, after "noted", "an" should be deleted.

Column 7, line 3, -- DESCRIPTION OF THE PREFERRED EMBODIMENTS should be inserted.

Column 7, line 15 "BRIEF DESCRIPTION OF THE DRAWINGS" should be deleted.

Column 10, line 55, "one-eight inch" should be -- 1/8 inch --.

Column 12, line 14, "die" should be -- due --.

Column 12, line 61, "present" should be -- prevent --.

Column 16, line 41, "with" should be -- within --.

Column 19, line 4, -- pulse -- is omitted after "positive".

Column 23, line 47, "from" is misspelled.

Column 27, line 65, "sending" should be -- sensing --.

Column 30, line 18, -- to sense the intensity -- should be inserted after "material" in line 20 and deleted in line 18.

Signed and sealed this 2nd day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents