United States Patent

[11] **3,554,249**

[72] Inventors **Anders Ingvar Arnelo**
Vasteras;
Nils August Arnelo, Malmo, Sweden

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[73] Assignee **Essem Metotest AB**
Skultuna, Sweden
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[33] **Sweden**
[31] **No. 5462/67**

[54] **METHOD FOR GRADING AND CLASSIFYING DEBRANCHED TREE-TRUNKS AND SIMILAR ROUNDWOOD ACCORDING TO THE USEFULNESS OF THE WOOD CONTAINED THEREIN, AND AN APPARATUS FOR PUTTING THE METHOD INTO EFFECT**
22 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **144/312,** 144/209; 143/168
[51] **Int. Cl.** **A01g 23/02**
[50] **Field of Search** 144/309, 312, 209; 143/168, 168.5

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Primary Examiner—Gerald A. Dost
Attorney—Waters, Roditi, Schwartz & Nissen

ABSTRACT: An apparatus and method are provided for grading and classifying debranched tree trunks or similar roundwood. The apparatus includes a system for sensing change in diameter of the wood along its length; and for registering differences in diameter along the length of the wood. A device then determines the degree of crookedness of the wood along its length and registers the crookedness of the wood whereafter signals are sent in response to variations in diameter of the wood and in response to varying degree of crookedness of the wood. Upon receipt of these signals the wood is cut or marked or sorted according to a predetermined program based upon standard norms for saw wood and pulpwood.

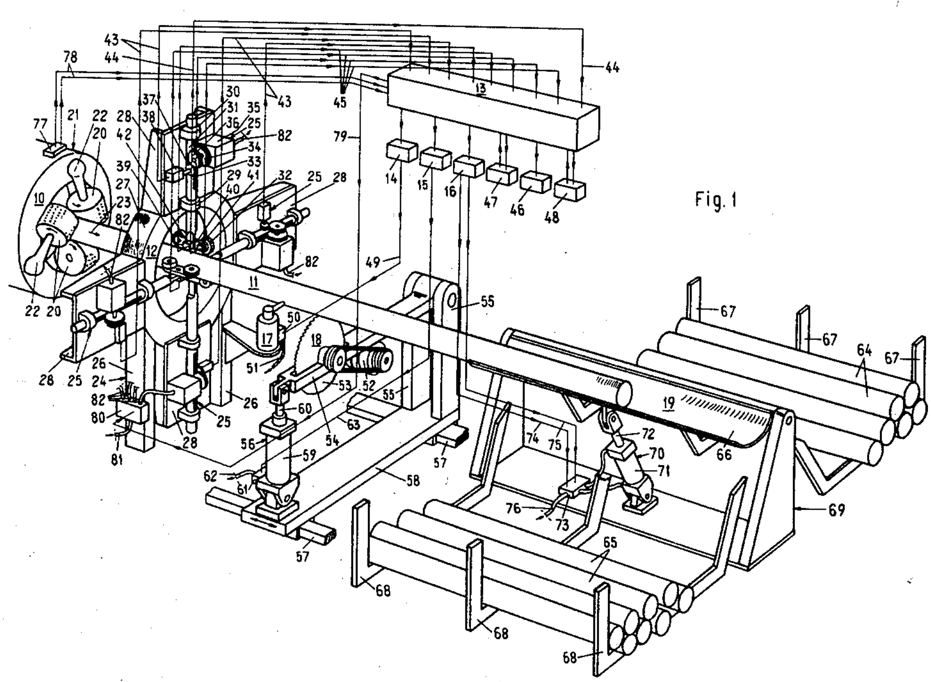

Fig. 1

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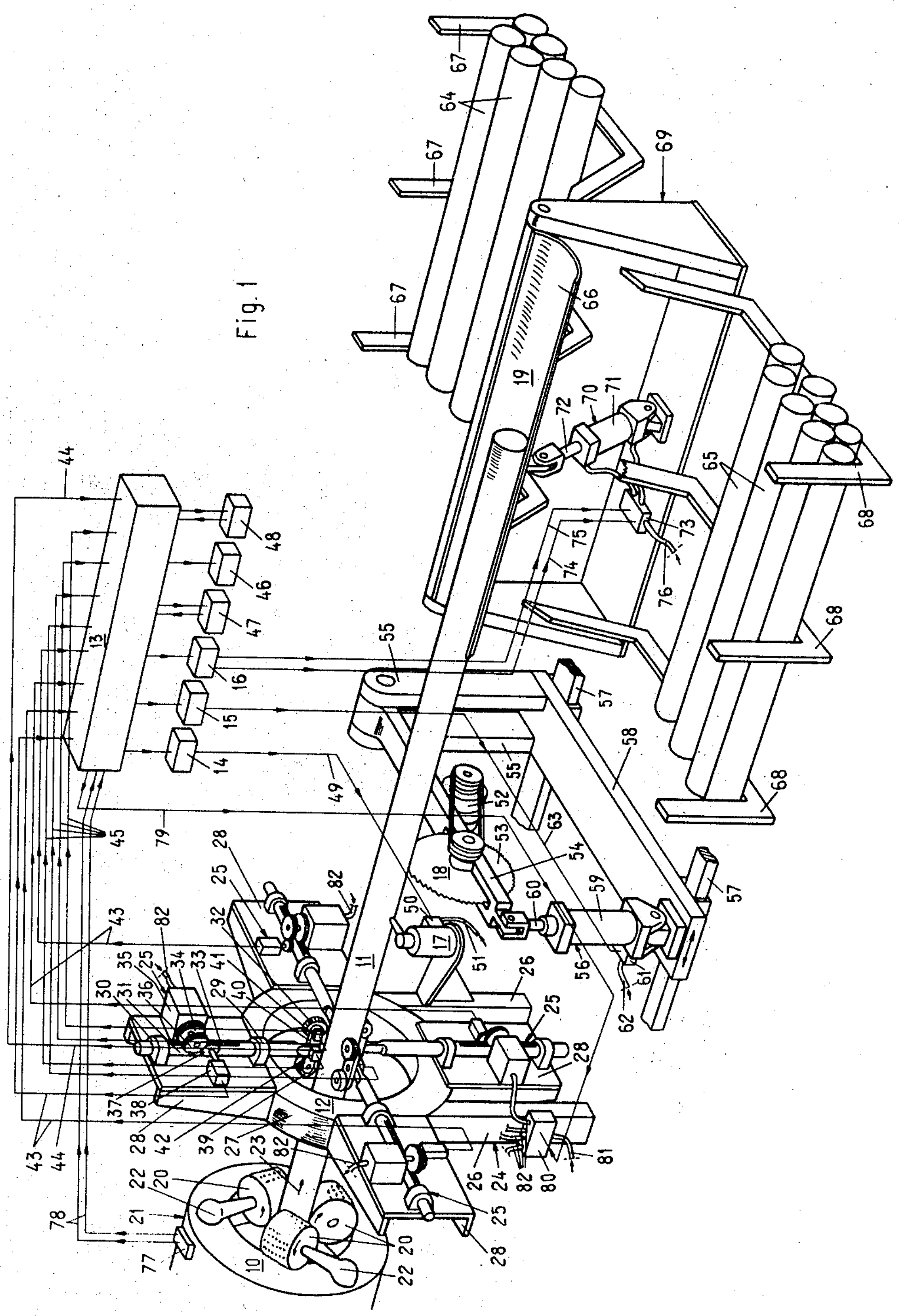

Fig. 1

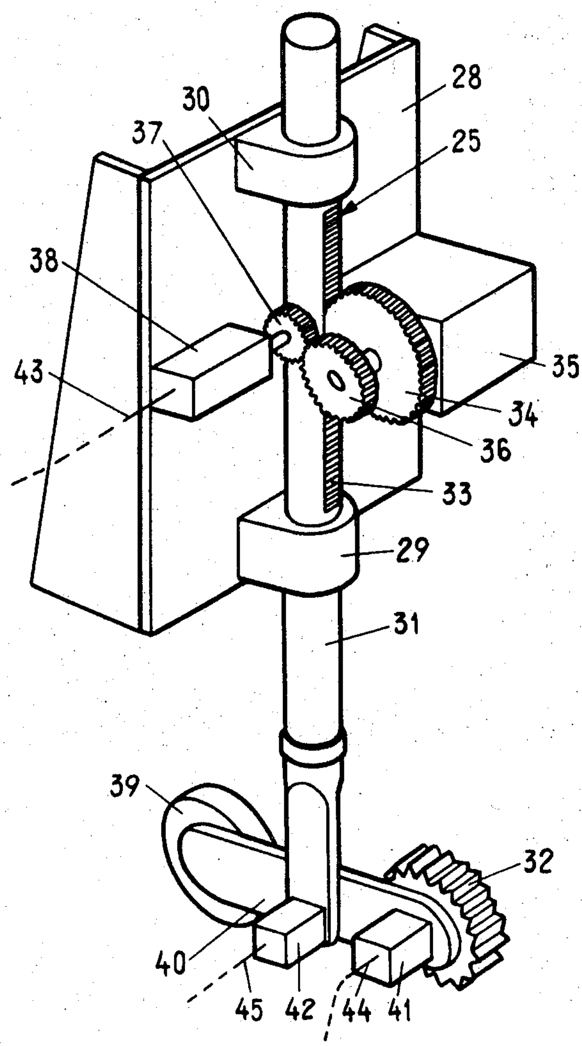

Fig. 2

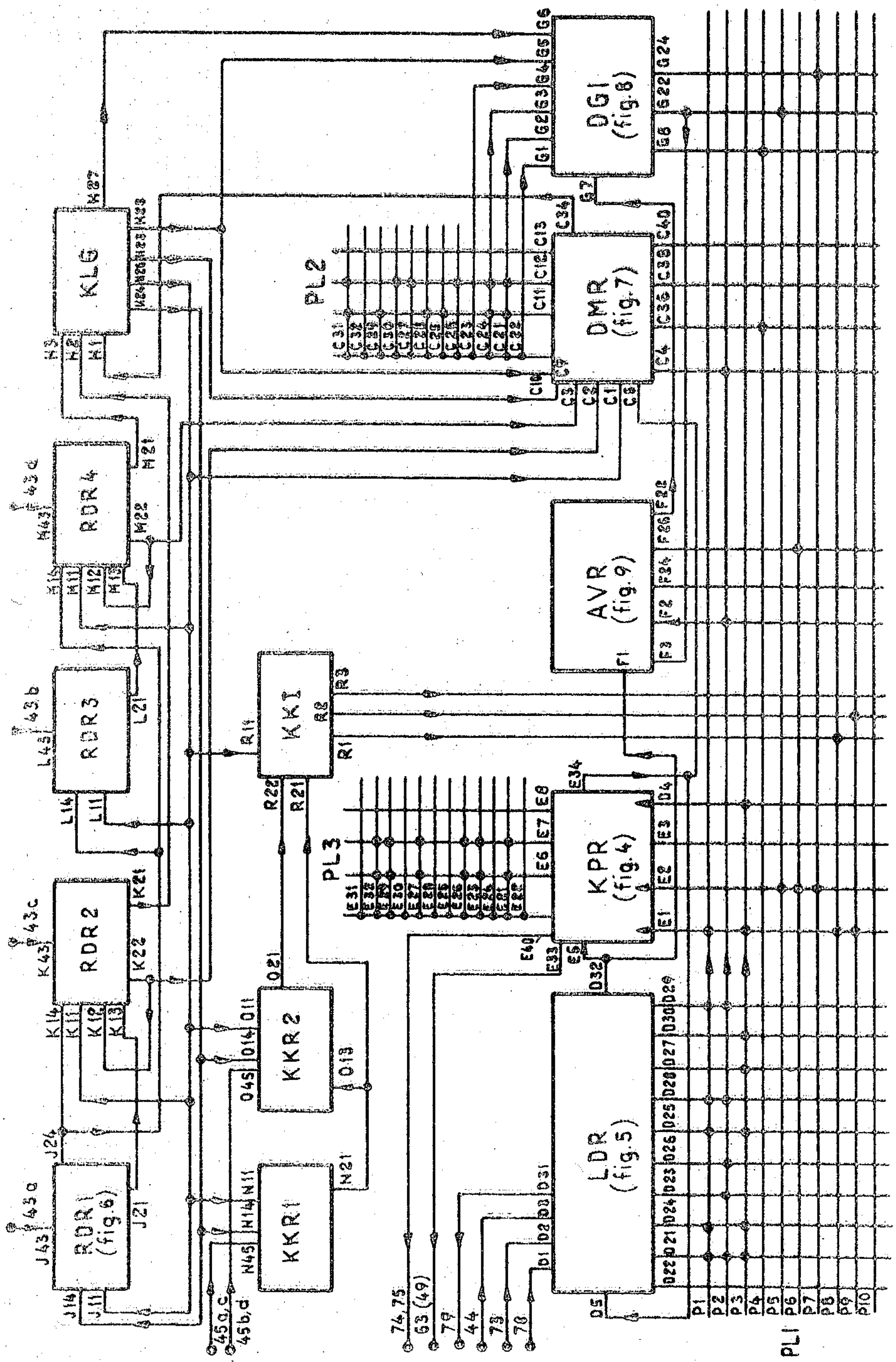
KLG
RDR 4
RDR 3
RDR 2
RDR 1 (fig.6)
KKR 1
KKR 2
KKI
DGI (fig.8)
DMR (fig.7)
AVR (fig.9)
KPR (fig.4)
LDR (fig.5)
PL1
PL2
PL3
43a
43b
43c
43d
45a,c
45b,d
74,75
63 (49)
79
44
73
70

Fig. 3

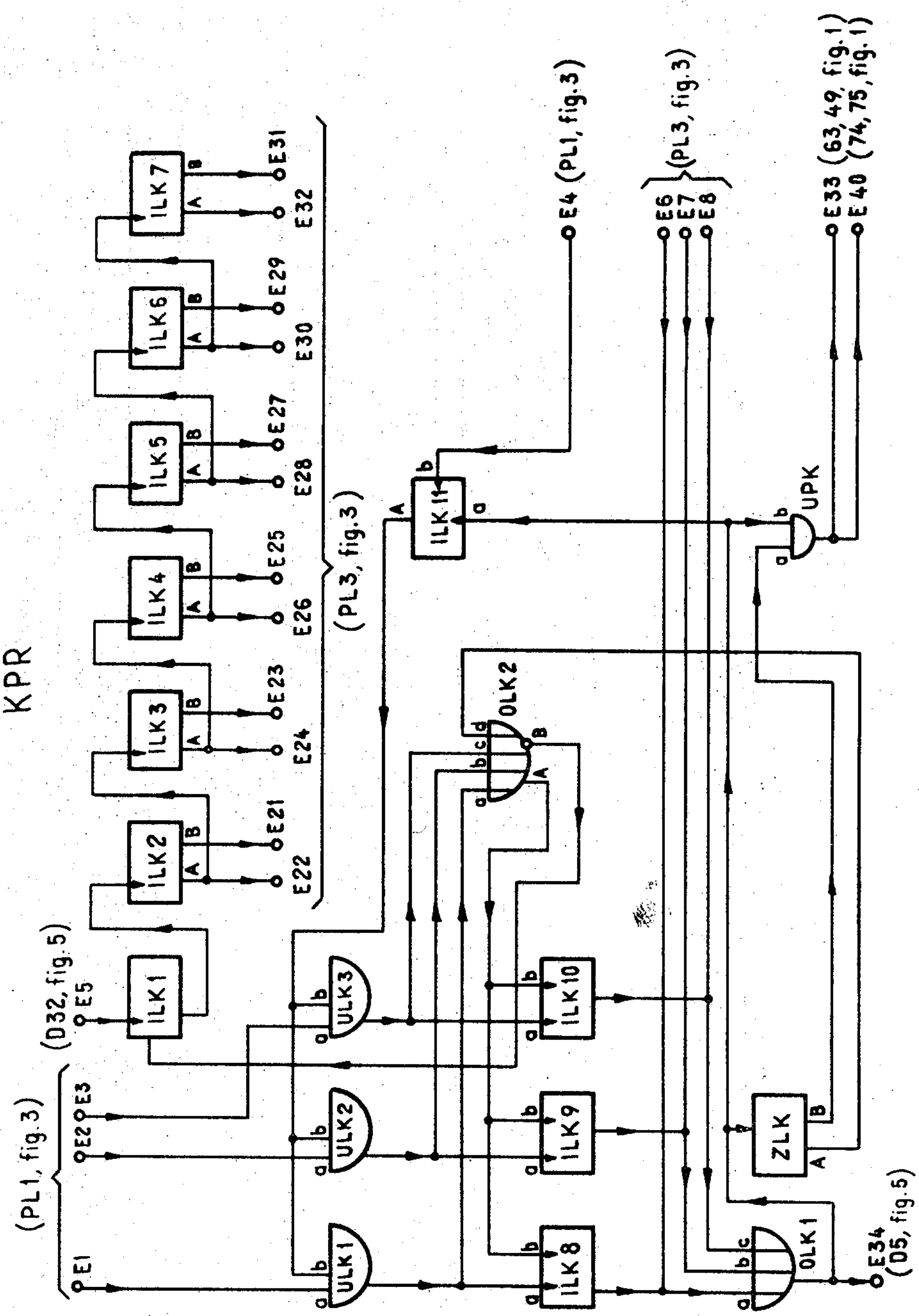
KPR
ILK1
ILK2
ILK3
ILK4
ILK5
ILK6
ILK7
ILK8
ILK9
ILK10
ILK11
ULK1
ULK2
ULK3
OLK1
OLK2
ZLK
UPK
E1
E2
E3
(PL1, fig.3)
E5
(D32, fig.5)
E21
E22
E23
E24
E25
E26
E27
E28
E29
E30
E31
E32
(PL3, fig.3)
E4 (PL1, fig.3)
E6
E7
E8
(PL3, fig.3)
E33 (63, 49, fig.1)
E40 (74, 75, fig.1)
E34
(D5, fig.5)

Fig. 4

LDR

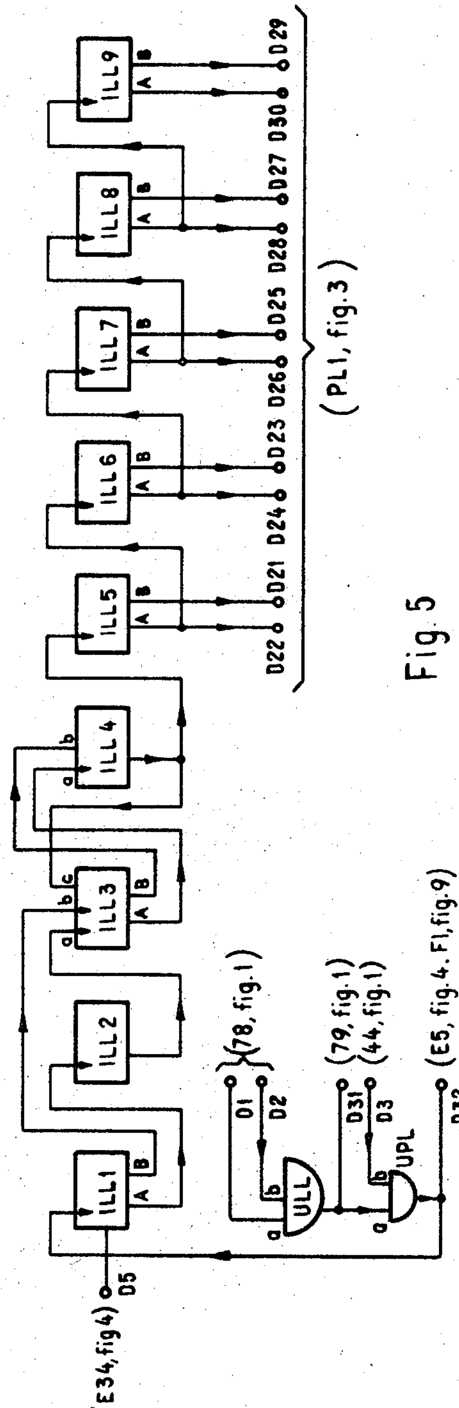
ILL1
ILL2
ILL3
ILL4
ILL5
ILL6
ILL7
ILL8
ILL9
ULL
UPL
(E34, fig 4) D5
D1
D2
(78, fig.1)
D31
D3
(79, fig.1)
(44, fig.1)
D32
(E5, fig.4. F1, fig.9)
D22
D21
D24
D23
D26
D25
D28
D27
D30
D29
(PL1, fig.3)

Fig. 5

RDR

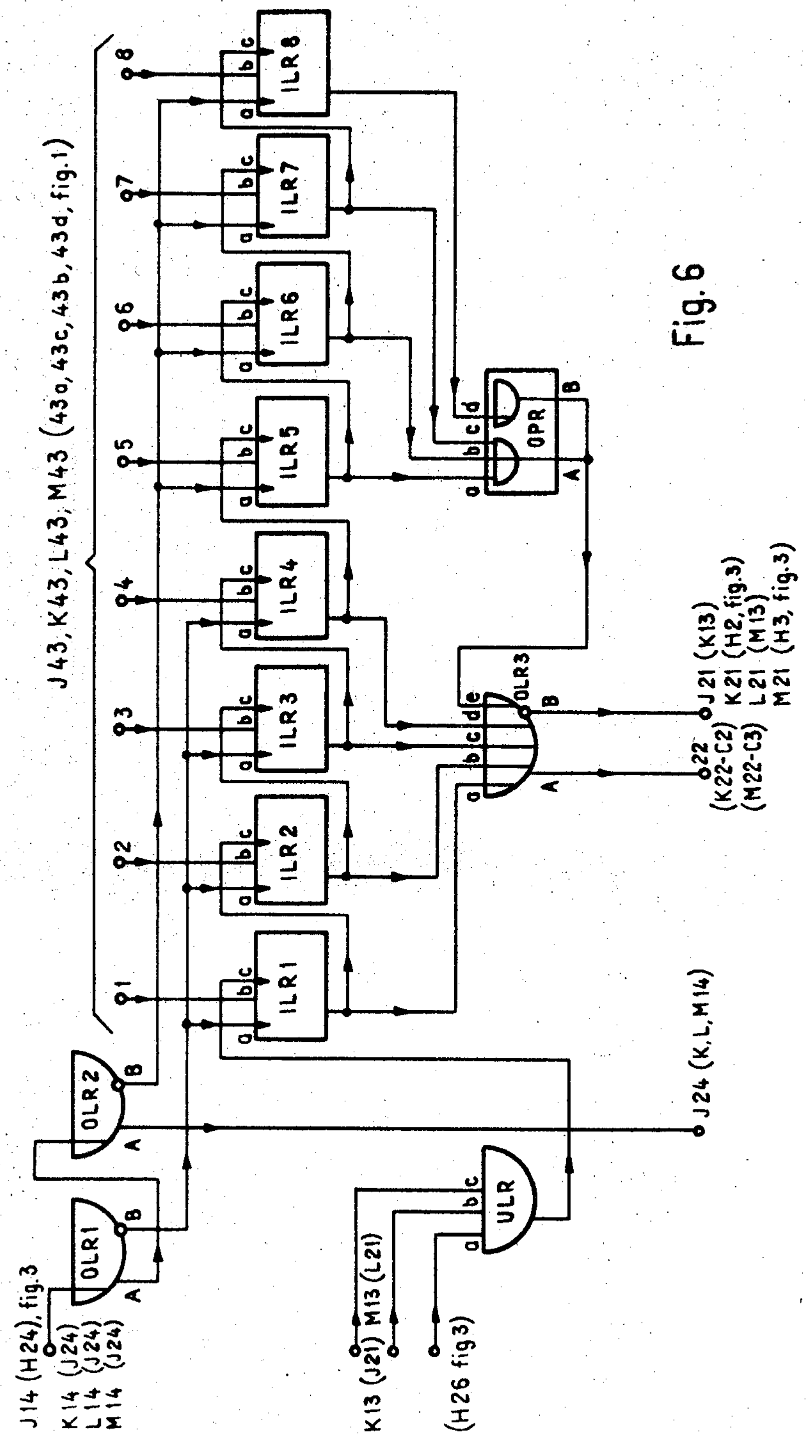
J43, K43, L43, M43 (43a, 43c, 43b, 43d, fig.1)
ILR1
ILR2
ILR3
ILR4
ILR5
ILR6
ILR7
ILR8
OPR
OLR1
OLR2
OLR3
ULR
J21 (K13)
K21 (H2, fig.3)
L21 (M13)
M21 (H3, fig.3)
22
(K22-C2)
(M22-C3)
J24 (K, L, M14)
J14 (H24), fig.3
K14 (J24)
L14 (J24)
M14 (J24)
K13 (J21) M13 (L21)
(H26 fig3)

Fig. 6

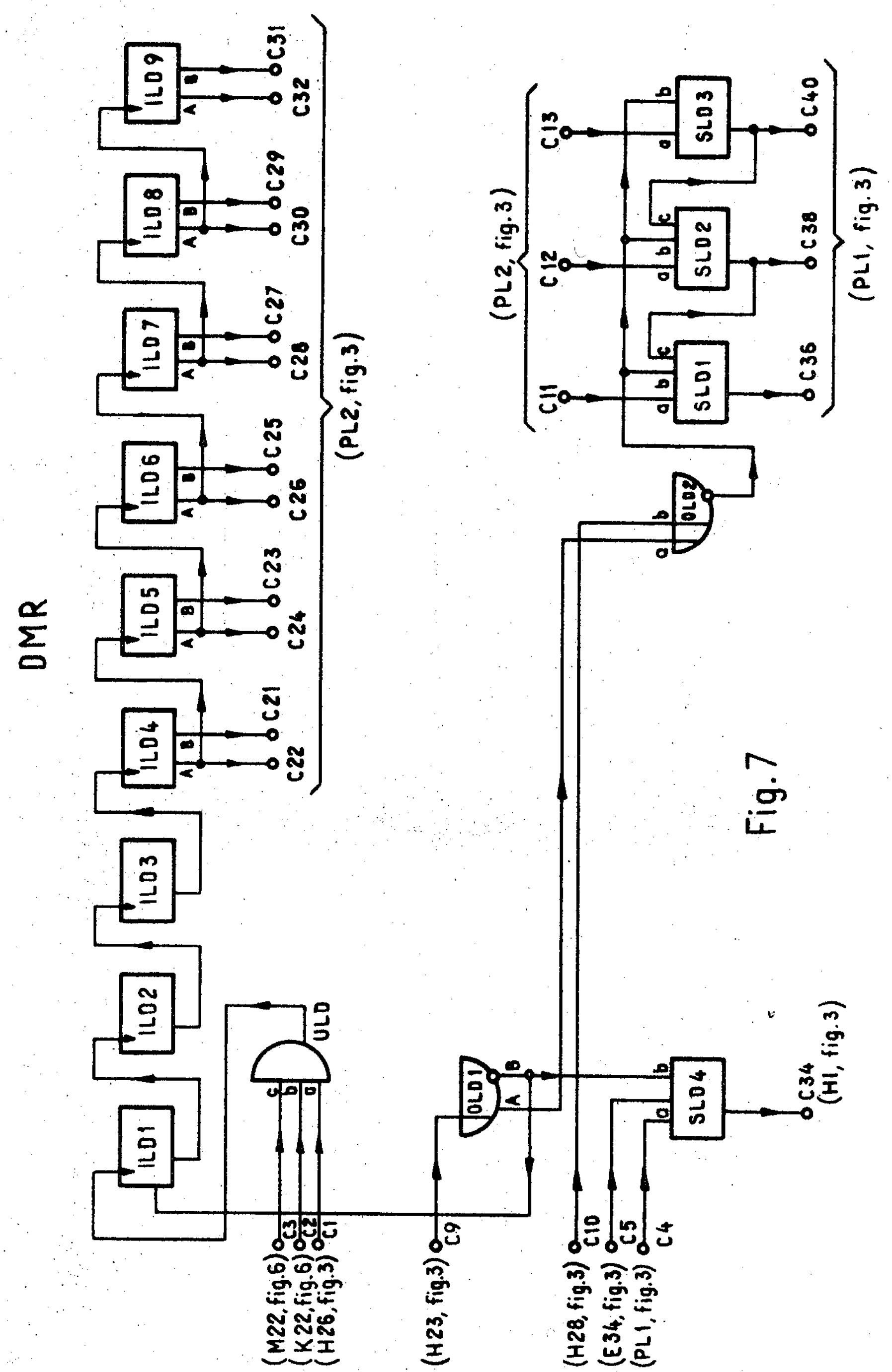
DMR
ILD1
ILD2
ILD3
ILD4
ILD5
ILD6
ILD7
ILD8
ILD9
ULD
OLD1
OLD2
SLD1
SLD2
SLD3
SLD4
C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32
(PL2, fig.3)
C11 C12 C13
(PL2, fig.3)
C36 C38 C40
(PL1, fig.3)
C34 (H1, fig.3)
(M22, fig.6) C3
(K22, fig.6) C2
(H26, fig.3) C1
(H23, fig.3) C9
(H28, fig.3) C10
(E34, fig.3) C5
(PL1, fig.3) C4

Fig. 7

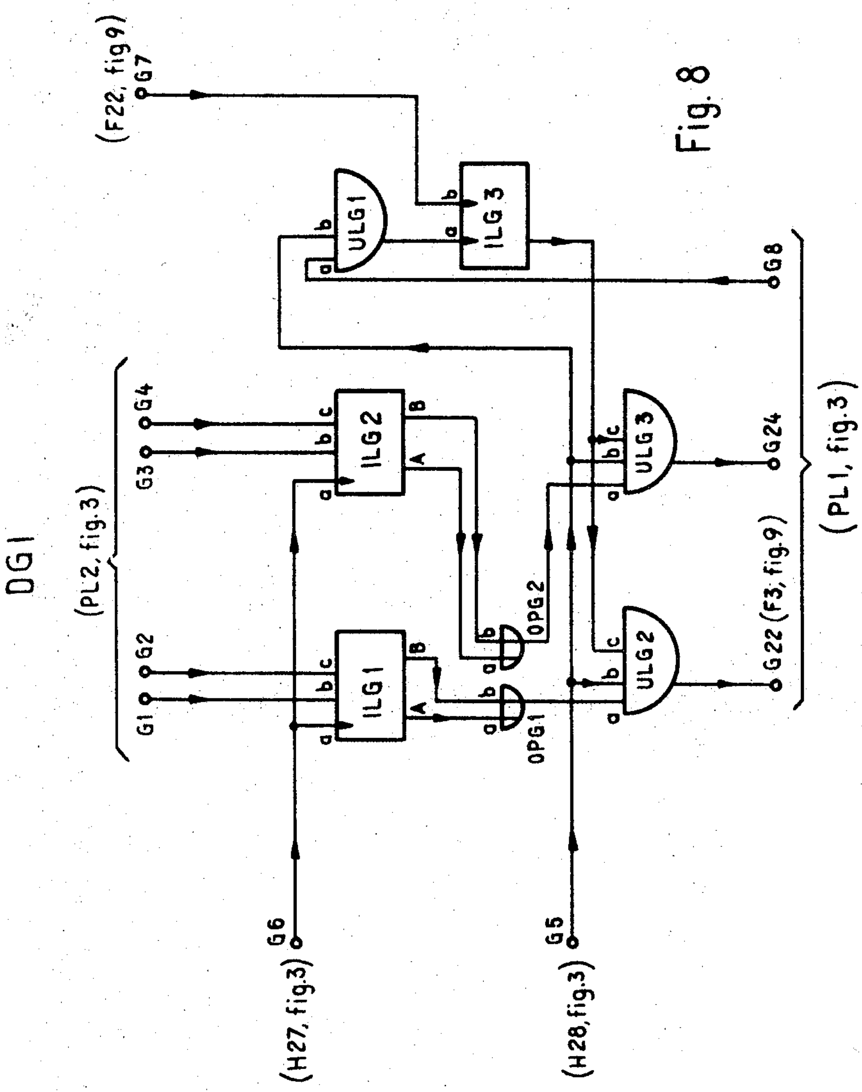
DG1
(PL2, fig.3)
G1
G2
G3
G4
ILG1
ILG2
ILG3
ULG1
ULG2
ULG3
OPG1
OPG2
G5
G6
G7
G8
G22
G24
(H27, fig.3)
(H28, fig.3)
(F22, fig9)
(F3, fig.9)
(PL1, fig.3)

Fig. 8

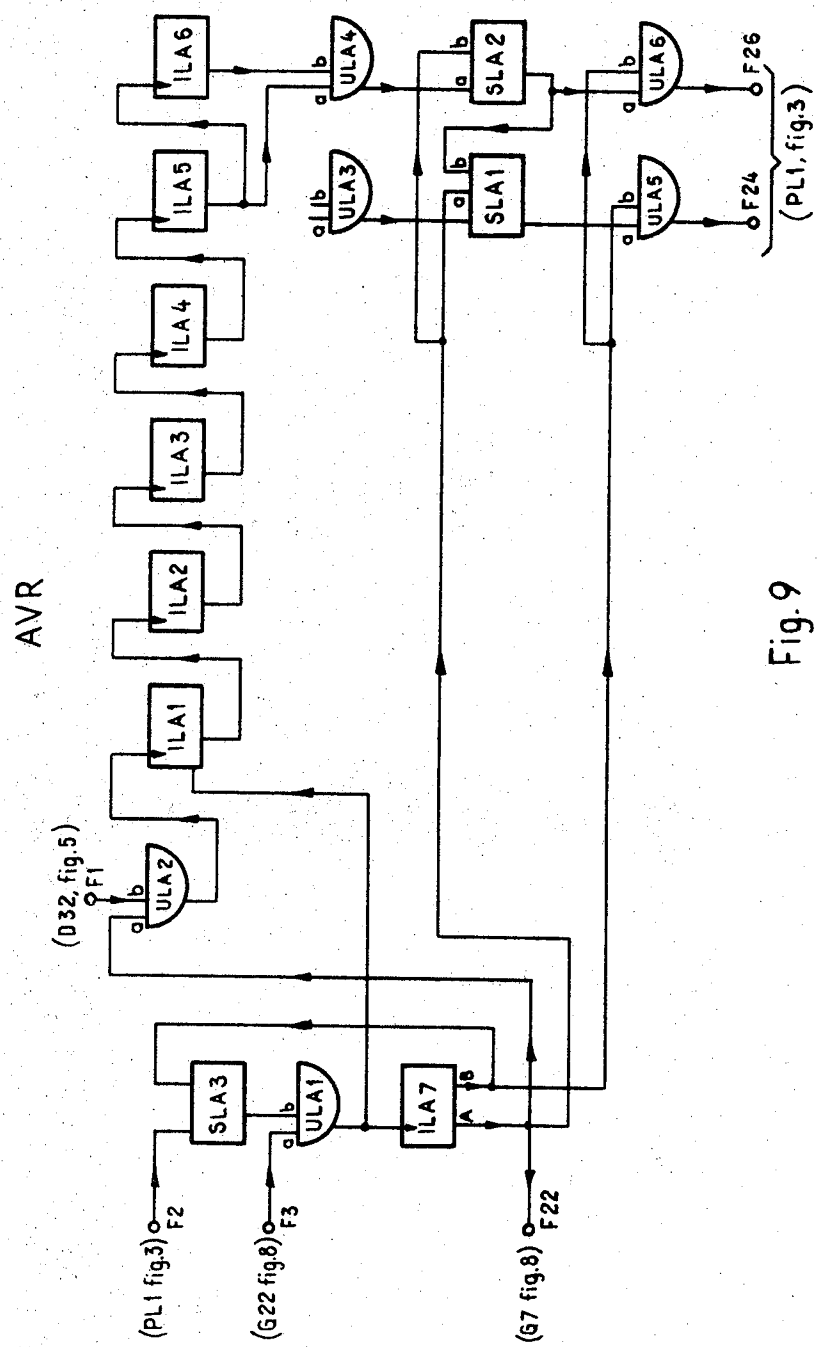
AVR
ILA1
ILA2
ILA3
ILA4
ILA5
ILA6
ILA7
ULA1
ULA2
ULA3
ULA4
ULA5
ULA6
SLA1
SLA2
SLA3
(D32, fig.5) F1
(PL1 fig.3) F2
(G22 fig.8) F3
(G7 fig.8) F22
F24
F26
(PL1, fig.3)

Fig. 9

METHOD FOR GRADING AND CLASSIFYING DEBRANCHED TREE-TRUNKS AND SIMILAR ROUNDWOOD ACCORDING TO THE USEFULNESS OF THE WOOD CONTAINED THEREIN, AND AN APPARATUS FOR PUTTING THE METHOD INTO EFFECT

In the automatic harvesting of wood the task of grading and classifying each individual tree trunk so as to obtain the highest yield therefrom has greatly retarded possible production rates since it has hitherto involved extensive and time consuming manual operations.

The objects of the invention is to provide a method and an apparatus whereby the trunks or similar pieces of roundwood are graded and classified automatically.

For this purpose the invention provides a method for grading and classifying the wood contained within debranched tree trunks and similar roundwood according to the use for which it is best suited, the method in its widest scope being characterized by obtaining information concerning the corresponding cross and long dimensions of each piece of roundwood by automatically sensing magnitudes characteristic for these dimensions and, using said magnitudes as a guide, determining where the trunk is to be divided crosswise in accordance with a predetermined yield program based upon the cross dimension of said wood.

The primary factors used to grade and classify the wood contained in the debranched trunks are the length and cross dimensions of said trunks. However, it is not always possible when grading and classifying the wood contained in the trunk to ignore the extent to which the trunks taper or such quality factors as the straightness of said trunks and the presence of knots therein. It has been discovered that the extent to which the diameter of the trunk varies along its length is often substantially proportional to the occurrence of knots therein. Accordingly, in one advantageous development of the invention magnitudes indicative of the extent to which the diameter of the trunk varies along its length—called in the following "-taper"—are also determined; whereupon when grading the wood contained within the trunk a yield program is used which is based upon the extent to which the trunk tapers and/or the extent of the bends located therein.

The method according to the invention can be restricted to purely gathering information as to in which positions the trunk should suitably be cut. However, in accordance with one advantageous development of the invention this information is converted, and used to automatically control devices for marking out the cutting positions along the length of the trunk or for automatically controlling one or more subsequent processing operations, such as cutting and also possibly sorting the bolts of wood resulting from the cutting operation.

Further, at the same time as the trunk is proportioned into different grades information can be collected concerning the volume of said wood, and used for costing consignments of wood so that it is not necessary to reassess the volume of the wood at a later stage.

The invention is also concerned with an apparatus for putting the novel method into effect. The apparatus is mainly characterized in that it includes a means for automatically sensing characteristic magnitudes of the corresponding cross and long dimensions of a tree trunk, and a means controlled by said characteristic magnitudes for proportioning said trunk in accordance with at least one predetermined yield program, based on cross dimensions of the wood.

The invention will now be described in detail with reference to an embodiment of the same shown in the accompanying drawings; additional characteristic features of the invention being disclosed in conjunction therewith.

FIG. 1 is a diagrammatic view in perspective of an apparatus according to the invention, for putting the novel method into effect.

FIG. 2 is a diagrammatic view in perspective and in enlarged scale of one of the four sensing means which form part of the sensing arrangement according to FIG. 1.

FIG. 3 is a wiring diagram of the proportioning arrangement and associated actuating means.

FIG. 4 is a wiring diagram of a cutting register.

FIG. 5 is a wiring diagram of a length register means.

FIG. 6 is a wiring diagram of a radii register means.

FIG. 7 is a wiring diagram of a diameter register means.

FIG. 8 is a wiring diagram for a diameter limit indicator.

FIG. 9 is a wiring diagram for a taper register means.

Assuming that certain requirements with regard to straightness etc. are fulfilled, the use to which debranched tree trunks or similar roundwood can be put is usually determined by the cross dimension of the wood. For instance, the larger roundwood or the larger portions of the roundwood can be used as saw timber. Which demands a higher price than the smaller roundwood or the smaller portions of the roundwood which, down to a certain minimum dimension, are usually used as pulp wood. The apparatus according to the invention described below and illustrated in the drawings can be adapted or used to determine more or less completely where debranched tree trunks or similar roundwood are to be cut crosswise. For instance, it can be used in certain instances to obtain information which determines whether a piece of roundwood can be used as saw timber and/or pulp wood, and when applicable, for deciding where the trunk should be marked for dividing the same into saw wood and pulp wood with regard to current regulations concerning the length of saw timber bolts and pulp wood bolts. Furthermore, the apparatus can be used, in accordance with a further development of the invention, for obtaining information as to where each cutting position should be placed for dividing the said portions into one-piece lengths; i.e. lengths which are not to be divided at a later stage. If, as is usually the case, the length of one-piece logs for use as saw timber is permitted to vary according to certain regulations within certain limits, and heavy saw timber demands a higher price than light saw timber, the apparatus can also be used for obtaining information as to where the said saw timber should be marked out in one-piece lengths so that the largest possible amount of wood falls within the saw timber class which demands the highest price. The apparatus according to the invention can also be adapted to take into consideration such quality factors as straightness of the trunk and the occurrence to knots therein, during the grading and classifying process.

Corresponding details in the different FIGS. are identified by the same reference numerals.

The apparatus according to the invention, shown in FIG. 1, includes a centering arrangement **10** for centering tree trunks or similar roundwood **11** passing through the same; a sensing means **12** which is adapted to sense dimensions of the trunk **11** and possibly also other characteristics or properties of the trunk **11** passing therethrough and to send signals in response to the sensed values; and an actuator control means **13** which is adapted to receive the said signals sent from the sensing means **12**, and in response to said signals determined where the sensed trunk is to be cut crosswise into single-piece lengths or multipiece lengths, in accordance with a predetermined program based on trunk dimensions and also possibly other characteristics. As shown in the drawing, the means **13** can be adapted to operate actuators **14**, **15** and **16** direct, for the purpose of automatically controlling one or more subsequent working operations. Accordingly, the arrangement may be provided with a marking arrangement **17** controlled by the actuator **14** and adapted to mark the appropriate cutting positions on the trunk **11**. Alternatively, the arrangement **17** can be replaced by a crosscutting arrangement **18**, controlled by the actuator **15**. The apparatus may also include a sorting means **19** controlled by the actuator **16** and adapted to sort roundwood subsequent to its being sensed and possibly processed in subsequent stages.

CENTERING ARRANGEMENT

As shown in FIG. 1 the centering arrangement **10** comprises the feed rollers of a conventional debranching or barking machine **21**, which in other respects is only fragmentarily shown in the drawing. The three feed rollers **20** are driven synchronously by a motor (not shown). The rollers **20**, which rotate in the direction of the arrows, are each supported at one end by their respective arms **22**, the said arms **22** being yieldingly actuated to swing inwardly towards the central, longitudinal axis of the apparatus **21**, and are so interlinked with one another that they operate simultaneously to center the trunk **11** as it leaves the apparatus **21**.

The centering means **10** centers the trunk **11** relative to the sensing means **12**, which will be described below. Centering means are preferably arranged both in front of and behind the sensing means. If the trunk is to be sensed immediately after being debranched or debarked the sensing means may, to advantage, be incorporated in the debarking or debranching machine, situated between the debranching or barking tools and the feed roller. If the trunk is not to be sensed in conjunction with the debranching or barking operation special centering means are arranged on one or both sides of the sensing means.

SENSING MEANS

The trunk **11**, which leaves the centering means **10** in the direction of arrow **23** in FIG. **1**, passes through the sensing means **12**. The shown sensing means includes a frame **24** and four essentially identical sensing devices **25**. The frame **24** comprises a substantially circular body member **27** supported by legs **26** and provided with arms **28**, evenly spaced angularly around and projecting radially outwardly from said body member **27**; each of said arms **28** supporting a sensing device **25**. The frame is assumed to be fixed relative to the centering means in such a position that the centering axis passes through the center of the body member **27**.

As is shown in FIG. **1**, and more clearly in FIG. **2**, each sensing device **25** includes a rod **31** mounted in bearings **29** and **30** for radial movement relative to the body member **27**. Each rod **31** supports at its radially inner end and rotatably mounted roller **32** which, in the shown embodiment, is knurled at its periphery and which is adapted to be moved into contact with the trunk **11** and roll against the same for a purpose which will be described in more detail below. Each rod **31** also cooperates with means for sensing the position to which the rod has been displaced, and with means for yieldingly actuating the same in a direction radially outwardly and radially inwardly.

Accordingly, each rod is provided with a toothed, racklike portion **33** which cooperates with a pinion **34** mounted on the driving shaft of a diagrammatically illustrated pneumatic rotator **35**. The drive shaft of the rotator **35** is also securely mounted to a gear **36** which engages a gear **37** securely mounted to the shaft of a diagrammatically shown digital code disc **38**, whereupon transmission between the pinion **34** and the rack portion **33** and between the gear **36** and the gear **37** is such that the extent of rotation of the code disc **38** between its extreme positions upon movement of the rod **31** does not exceed 360°; whereby it should be realized that the digital code disc **38** always adopts a position of rotation responsive to the position to which the rod **31** is moved.

Although the roller **32** may be rotatably mounted direct onto the radial inner end of the rod **31** it is preferred, for reasons disclosed below, that the roller **32**, as shown, is arranged in a carriage situated at the radial inner end of the rod **31**, and including a further roller **39** and bar **40** which is pivotally mounted at its center to the inner end of the rod **31** and which rotatably supports at its opposite ends the rollers **32** and **39**, arranged in the feed direction of the trunk. If all rollers **32** and **39** of the sensing means are held pressed against the centered trunk **11** passing therethrough the code discs **38** thus adopt, at every instance, a position determined by the distance of the portion of the trunk engaged by the rollers **32** and **39** from the center of the body member **27**, and thus the cross dimension of the portion of the trunk engaged by the rollers can be ascertained.

To enable the length of the trunk to be measured at the same time a pulse generator **41** is adapted to cooperate with at least one of the rollers **32** and reacts to the rotation of the roller **32** associated therewith, and is adapted, in response thereto, to send pulses to the means **13**.

The arrangement of the carriagelike construction at the inner end of each rod **31** affords the advantage whereby radial movements of the rod caused by small irregularities in the surface of the trunk are considerably reduced. A further advantage is gained if the angular position of the bar **40** is sensed. It should be apparent that when the rollers **32** and **39** abut the trunk **11** the angular position of the bar **40** is relation to the associated rod **31** is dependent upon the straightness of the trunk and the extent to which it tapers. According to one embodiment of the apparatus each bar **40** is therefore connected to the shaft of a digital code disc **42**, shown diagrammatically in the drawing, and the position of rotation of which is sensed and which actuates the proportioning of the trunk in a manner described below. The shaft of the digital code disc **42** may be connected direct to a shaft fixed to the bar **40** and supporting the same and mounted on the rod **31**, or may be connected to said shaft via a transmission arrangement.

Normally the trunk **11** is not straight, and usually presents at one and the same position along its length different diameters in different cross directions. Because of this the trunk is, among other things, not always centered exactly. To obtain accurate sensing of the trunk it is therefore necessary to arrange at least three cooperating sensing devices **25**. However, it is simpler from many aspects to use an even number of sensing devices **25** whereby the devices can, to advantage, operate in pairs, as described in the following. The smallest cross dimension sensed is thus a determining factor for the proportioning process.

The invention is not restricted to a sensing means of the described construction. Accordingly, the cross dimension sensing means need not be directly coordinated mechanically with the means for sensing the length dimension of the trunk, as shown; and, for instance, the characteristic magnitudes of the trunk may be sensed optically, or in many other ways.

ACTUATOR CONTROL MEANS

The actuator control means **13** shown diagrammatically in FIG. **1** receives via lines **43** signals arriving from the digital code discs **38**, in response to the positions to which the rods **31** have been moved, and thus in response to the cross dimensions of the trunk **11** passing through the member **27** of the sensing means **12**, and signals arriving from the pulse generator **41** via a line **44**, in response to the passage of the rollers **32** along the surface of the trunk **11** passing through the circular member **27** of the sensing means **12**, and thus in response to the length of the trunk **11**. The means **13** may also be adapted to receive signals from the digital code discs **42** via lines **45** in response to the angular positions of the bars **40** relative to the rods **31**, and thus in response to the extent to which the trunk passing through the circular member **27** of the sensing means **12** tapers and bends. The sensed trunk **11** is proportioned into lengths for cutting transversely to the longitudinal direction thereof in response to the signals, in accordance with a predetermined program.

The actuator control means may be provided with means for calculating the volume of the sensed wood, as indicated at **46**. If the trunk is to be sensed to determine the extent to which it tapers and bends, means **47** and **48** are arranged to influence the proportioning operation when the tapering or bending of the trunk exceeds a certain value; for instance by instructing that the trunk is to be divided into pulpwood lengths, or, if the trunk is abnormally crocked, to recommend that the whole of said trunk or portions thereof be rejected.

The means **13**, which is described below with reference to FIGS. **3—9** in the form of an example is preferably adapted to operate the actuator means **14**, **15**, **16** automatically in response to the sensed magnitudes, for controlling subsequent working operations in an optimal manner within the framework of the selected yield program, which is also described in the form of an example in more detail below.

MARKING

In FIG. 1 the actuator means 14 is, as shown, connected via the line 49 to a control device 50 which causes the marking means 17, stationarily mounted in relation to the sensing means, to mark the trunk at each cutting position determined by the proportioning arrangement 13 by emitting an abrupt stream of paint against the surface of the trunk at said positions. According to one embodiment compressed air is used for dispensing the marking paint, wherein the control device 50 may comprise a valve arranged to open and close upon receiving an impulse from the actuating means 14, and arranged in a line 51 for supplying compressed air to the arrangement 17.

CUTTING

The marking arrangement 17 can be replaced by the cutting means 18, actuated by the actuator 15. The cutting means shown in FIG. 1 comprises a saw 53 operated by a motor 52 and rotatably mounted on an arm 54 which is pivotally mounted on one side in an upright 55 and capable of being swung perpendicularly to the trunk 11, by means of a pneumatic piston-cylinder arrangement 56. The upright 55 and the piston-cylinder arrangement 56 are supported by a frame 58 capable of moving on rails 57 in the feed direction of the trunk 11; the cylinder 59 being pivotally connected to the frame 58 and the piston rod 60 being pivotally connected to the arm 54.

Actuation of the piston-cylinder arrangement 56 to move the saw 53, by rotation of the arm 54, into and out of contact with the trunk 11 is accomplished by means of a control device 61, operated by the actuator 15, the said device 61 in the shown embodiment comprising a valve arranged in the air supply line 62 of the piston-cylinder arrangement and adapted to open and close when receiving an impulse from the actuator 15, via the line 63.

The movement of the frame 58 is suitably positively coordinated with the movement of the trunk 11, in a manner known per se. According to one embodiment (not shown) a worm screw driven by one of the drive motors of the feed rollers 20 may be arranged to engage a toothed racklike portion of the frame for driving the latter in the direction of movement of the trunk and at the same speed. The toothed portion may be adapted to be brought into engagement upon swinging of the arm 54 from the shown position into engagement with the worm, to move the frame 58 against the action of a return means, which when the toothed portion is disengaged, when the arm 54 is returned to the shown position, returns the frame to a position located at a predetermined distance from the sensing means 12.

SORTING

The measured pieces of roundwood, which may also have been subjected to subsequent working operations, can, according to the invention, be sorted by means of a sorting arrangement 19. FIG. 1 shows diagrammatically an arrangement for sorting single-piece lengths cut by the cutting means 18; wherein the logs 64 are assumed to be saw timber and the logs 65 pulp wood. The two assortments are discharged to sorting bins formed by section bars 67 and 68 arranged on either side of a chute 66 which is capable of being tilted crosswise. The chute 66 is mounted in a frame 69, which is stationary in relation to the sensing means and capable of being tilted by means of a pneumatic piston-cylinder arrangement 70, to discharge the saw timber to the bin formed by the section bars 67, and the pulp wood to the bin formed by the section bars 68. The piston-cylinder arrangement 70, whose cylinder 71 is pivotally mounted in the frame 69 and whose piston rod 72 is pivotally connected with the chute 66, is shown in a positive, neutral position in which the chute 66 receives the logs. The piston-cylinder arrangement 70 can be actuated to swing the chute 66 clockwise or counterclockwise, to discharge logs in one bin or the other. The piston-cylinder arrangement 70 is controlled by a device 73 which receives control impulses from the actuator means 16 via lines 74 and 75, and which may comprise a valve means disposed in the air supply line 76 of the piston-cylinder arrangement.

When grading and classifying debranched tree trunks by means of the arrangement according to FIG. 1 the trunks 11 are usually fed bowl-end first through the centering means 10. The pneumatic rotators 35 normally adopt positions in which the rods 31 are located in their radially outer positions. The centering means 10 is provided with switches 77 actuated when the feed rollers are moved apart and which, via lines 78, send start signals to the means 13. The means 13, subsequent to a determined time delay after actuation of the switches 77, send a signal via the line 79 to a valve 80 which regulates the supply of air to the pneumatic rotators 35, thereby passing compressed air from the line 81 to the line 82 so that the rotators move the rods 31 radially inwardly to obtain contact between the rollers 32 and 39 and the surface of trunk 11. The roller 32 associated with the pulse generator 41 then rolls against the trunk 11, whereupon a signal corresponding to the distance travelled by the roller 32 against the trunk 11 is sent via the line 44 to the proportioning means 13. The means 13 is also supplied via the lines 43 with information concerning corresponding cross dimensions of the trunk along its length and, via the lines 45, information concerning the angular positions of the bars 40 relative to the rods 31 associated therewith. The information received by the proportioning means 13 is used to decide at which positions by the proportioning means 13 is used to decide at which positions the trunk should be divided crosswise, in accordance with a predetermined program based upon such information, whereupon, depending upon how the trunk is to be proportioned, signals are sent from the proportioning or actuator control means 13 to one or more of the actuator means 14, 15, 16 for operating control means 50, 60 and 73, respectively. The lines 51, 62, 76 and 81 may, to advantage, be connected to a common source of compressed air.

The sensing devices 25 operate in pairs, as will be described below. Hence, by sensing whether the cooperating pairs of bars 40 slope at the same or different angles, in relation to the associating rods 31 and in the same or opposite directions thereto it can be ascertained whether the trunk tapers or is bent, or both tapers and bends. Signals characteristic of the sensed tapering or crookedness of the trunk can be sent to means 47 and 48, respectively; which if the degree of taper and/or crookedness is too great, are adapted, in turn, to effect the proportioning of the trunk as mentioned above.

Naturally, the information concerning the tapering and crookedness of the sensed trunk can also be acquired in other ways. Accordingly, as described with reference to FIG. 3—9, the extent to which the trunk tapers can be determined by measuring the length along which the cross dimension of the trunk decreases by a certain value. Further, the crookedness of the wood can be determined by measuring the difference in distance of the radially internal ends of the associating pair of rods 31 from the center of the circular member 27.

The radially displacable rods 31 may of course, be replaced by arms capable of swinging towards and away from the trunk 11 being sensed, wherein the angular positions of the arms are dependent upon the cross dimensions of the trunk and which are thus sensed.

Although in the described arrangement the trunk 11 is caused to move past a sensing means it is obvious that the sensing means can be caused to move relative to a piece of roundwood, e.g. a debranched trunk standing on its roots. Further, instead of proceeding according to that which has been shown and described it is possible, instead, to center the sensing means relative to the stationary or moving trunk or similar roundwood in manners adopted within the forestry industry.

PROPORTIONING OR ACTUATOR CONTROL SYSTEM (FIG. 3)

The proportioning arrangement, shown in FIG. 3 in the form of a block diagram, includes four radii registers RDR1—4, which are supplied with input signals from the digital code means 38, via lines 43a—d, namely one line to each code means. A clock pulse generator KLG generates those pulses necessary to the function of the system. Two bend registers KKR1—2 obtain signals via lines 45a—dfrom the digital code means 42 in FIGS. 1, 2. A bend indicator KK1 is controlled from the band registers. A length register LDR receives from the switches 77, via lines 78, signals which initiate the functioning of the proportioning arrangement. Length measurement pulses are received, via the line 44, from the pulse generator 41, in FIGS. 1, 2. Start signals are sent from the length register LDR, over the line 79, to the control valve 80 for starting the pneumatic rotators 35, to actuate the rods 31 radially inwardly against the trunk 11. A cutting register KPR is adapted to send signals, over the lines 63 and 49, to the control devices 61 and 50 for the cutting arrangement 18 and the marking arrangement 17, respectively, for cutting or marking the tree trunk 11. Control signals are sent from the cutting register KPR, over lines 74, 75 to the sorting arrangement 19. The proportioning arrangement also includes a taper register AVR, a diameter register DMR and a diameter limit indicator DGI, which all cooperate with the previously described main components within the apparatus. Also cooperating with the said components are three programming panels (programming coupling fields) indicated by the designations PL1—3, each comprising a series of coordinate lines, which can be selectively connected at their intersections by introducing therein a plug containing a diode for the purpose of setting up the program according to which the work of determining the usefulness of the wood contained within debranched tree trunks or similar roundwood is to be carried out in accordance with the invention.

In FIG. 3 the different connecting points or input and output terminals of the different main components within the apparatus, are indicated by a letter followed by one or two digits. Hence, points or terminals identified with the letter C belong to the diameter register DMR, points or terminals D belong to the length register LDR, points or terminals E belong to the cutting register KPR, points or terminals F belong to the taper register AVR, points or terminals G belong to the diameter limit indicator DGI, points or terminals H belong to the clock pulse generator or the clock KLG, points or terminals J belong to the first radii register RDR1, points or terminals K belong to the second radii register RDR2, points or terminals L belong to the third radii register RDR3, points or terminals M belong to the fourth radii register RDR4, points or terminals N belong to the first bend register KKR1, points or terminals O belong to the second bend register KKR2, points or terminals P belong to the programming panel OL1, and finally points or terminals R belong to the bend indicator KK1.

The programming panel PL1 is arranged to cooperate with the main components LDR, KPR, AVR, KKI, DMR and DGI. The programming panel PL2 is arranged to cooperate with the main components DMR and DGI, and the programming panel PL3 is arranged to cooperate with the register KPR.

The mutual connections between said points and terminals can be seen from FIG. 3, and also from the remaining FIGS. 4—9, in which last mentioned FIG. each such point or terminal is indicated within parenthises to which points, terminals or means the same are connected; besides which reference is also made to the individual FIGS. concerned.

The main components KLG, KKR1—2 and KKI, and similarly the programming panels PL1—3, are only shown in FIG. 3 in the form of a block diagram and will be described in detail with reference to this FIG. The remaining main components are described in more detail in FIGS. 4—9, the cutting register KPR being shown in FIG. 4, the length register LDR in FIG. 5, one radii register RDR in FIG. 6, the diameter register DMR in FIG. 7, the diameter limit indicator DGI in FIG. 8 and the taper register AVR in FIG. 9.

With regard to the system of designations used in FIGS. 4—9 it should be noted that:

The components in these FIGS. are identified with three letters and when several of the same type are to be found in the same main component these letters are followed by one or two digits. The first two letters indicate the type of component in question and the third letter is an abbreviated designation of the main part, in which the component is included. The designations UP and UL indicate AND gates, the designation IL indicates bistable flip-flops or impulse memories, the designations OL and OP indicate OR gates, the designation SL indicates memory means and the designation ZL indicates a time delay means.

The first letter in respective abbreviated designations is used as the third letter for the main components in question, namely D for DMA, K for KPA, L for LDA, A for ADA, A for AVA but G for DGI.

When the different memory means, gates and flip-flops have more than one input or output the inputs are indicated with small letters (e.g. a and b) and the outputs with large letters (e.g. A and B). Input terminals with pulse signals are marked by an arrow point within the pertinent component. The directions in which the signals are sent are marked by arrow points on the respective lines.

The main components of the system will be described in detail below.

CLOCK PULSE GENERATOR KLG (FIG. 3)

The clock pulse generator or clock KLG is adapted to generate the count pulses, set pulses or end pulses require for the function of the other main components within the system. The clock is started for a reading cycle from the diameter register DMR (the terminals C34—H1). The said set pulse is sent from H24 to RDR and to KKR, and the inverse set pulse is sent from H23 to DMR. Count pulses are sent from H26 to RDR1—4 (the terminals 11) and to KKR and KKI and to DMR, terminal C1. The end pulse is sent from H28 to DMR and DGI. Inverse end pulses are sent from H27 to DGI. Stop signal 1 is sent from the first diametrical pair of RDR (RDR1 and 2) from K21 to stop input H2, and stop signal 2 is sent from the other diametrical pair of RDR (RDR3—4) from M21 to stop input H3 in KLG.

The set pulse causes the radii registers RDR1—4 to be set to the values (H24—J14) on respective code discs 38 and the inverse set pulse zeros the diameter register DMR (H23—C9). The count pulses step the register RDR to zero (H26—11), the diameter register DMR counting at the same time (H26—C1). When both radii registers are set to zero in either direction (e.g. RDR1 and 2), DMR is blocked from K22 in RDR2 to C2 in DMR and from M22 in RDR4 to C3 in DMR, respectively. The count pulses continue from KLG until the two remaining radii registers (e.g. RDR3 and 4) are set to zero. The clock then receives the signal from M21 (or K21) are respective stop inputs H3 (or H2), whereupon the count pulses cease and the end pulse is fed from output H28 to C10 in DMR. The end pulses are used in DMR for reading-out from said register. The smallest value of the measured diameter is thus a determining factor for the continued function of the system. The clock pulse generator is thereby reset to zero and a new working cycle can be started.

BEND REGISTER KKR AND BEND INDICATOR KKI (FIG. 3)

The bend register KKR1 and KKR2 are adapted to determine the crookedness of the tree trunk and to supply signals corresponding to the crookedness of the trunk to the bend indicator KKI which in turn controls the cutting register KPR which is adapted to effect the cutting of the trunk if the trunk is too crooked.

The bend registers KKR1, 2 receive input signals via lines **45** on terminals N45, O45, said signals being representative of the bend in two diameter directions which form right angles to each other. The angular position of the bars **40** is suitably used as a primary indication of the crookedness of the trunk. The angular position of said bars is represented by electric signals on the line **45***a*, *c* and **45***b*, *d*, respectively. Data concerning the bends in the trunk is fed in subsequent to the arrival of the set pulse from KLG (H24—N14 and (H24—O14) respectively). The count pulses are fed to N11 and O11, from H26 in KLG. The output N21 is connected to the input O13.

The bend indicator KKI is a binary counter, which can count forwards and backwards. The counter is so designed that the number of count pulses used to fill the registers KKR1 and KKR2 are subtracted. The difference between these values controls the limits for timber and pulp wood over the outputs R1 and R2, respectively, to the cutting register KPR over the program panel PL1. The output R3 is shown in the FIG. to represent the fact that one or more control signals may be arranged as a reserve for products other than the two mentioned and for other purposes. Feed-in from KKR1, 2 takes place over N21—R21 and O21—R22, respectively. The count pulses are fed on R11. The said outputs R1 and R2 are connected over P8, P9 to E1 (cutting delay 1) in KPR.

CUTTING REGISTER KPR (FIG. 4)

The function of the cutting register KPR is to send actuator signals to the cutting arrangement **18** (or the marking arrangement **17**) in response to the calculations made in the taper register AVR, length calculations made in the length register LDR, diameter limit indications obtained in the diameter limit indicator and bend indications obtained in the bend indicator KKL, said signals having a certain cutting delay corresponding to the distance between the measuring position on the tree trunk and the cutting or marking position (in this instance 6 feet). KPR are also adapted to control the sorting arrangement **19** in dependence on said calculations. The cutting delay (6 feet) is set to the desired value on the programming panels PL3 (FIG. 3) associated with KPR.

As is shown in FIG. 4 the cutting register contains a number of bistable flip-flops ILK1—7, which together form a registering portion for length measurement pulses fed from the input E5. The output from registering portion are connected with the terminals E21—E32 of the programming panel PL3 for setting the distance between measuring position (**12** in FIG. 1) and cutting position (**18**) and with the terminals E6, E7 and E8 which feed the set cutting delays of the three cutting delays **1,2,3** respectively from PL3. The cutting delays **1** and **2**, which in the present instance are both equal to 6 feet and a reserve for another cutting delay, are found on respective terminals E6—E8. Cutting signals are fed over terminal E33. Marking signals are also fed over terminal E33, and signals to the sorting arrangement are fed over terminal E40. KPR zeros LDR from terminal E34. Input signals corresponding to the three cutting delays are fed on respective terminals E1—3. AND gates ULK1—3 are controlled from these terminals, said gates in turn controlling the impulse memories ILK8—10. A priority signal for a measured timberlength of 18 feet is fed from terminal I4. KPR also contains two OR gates OLK1 and 2, a time delay means ZLK, a further impulse memory KLK11 and an AND gate UPK.

The first flip-flop ILK1 within the registering portion in KPR, formed of cascade connected flip-flops, obtains at its input, via E5 from terminal DD32 in LDR (FIG. 5) length measurement pulses which step the flip-flops ILK1—7 forwards. The flip-flop ILK1 sends signals to ILK2 after a number of such pulses which correspond to an advance of the timberlength through a distance of 1 inch. In a corresponding manner ILK2 sends signals from output A to ILK3 after 2 inches, ILK3 sends signals to ILK4 after 4 inches, ILK4 sends signals to ILK5 after 8 inches, ILK5 sends signals to ILK6 after 16 inches, ILK6 sends signals to ILK7 after 32 inches and ILK7 sends output signals on output A to terminals E32 after an advancement of 64 inches. Further, ILK2—7 send signals from the output A to respective terminals E with even numbers for 2, 4, 8, 16 and 32 inch. Inverse signals are sent from the outputs B of ILK2—7 to respective terminals E numbered with odd numbers, where the flip-flop is set to zero, i.e. when the timberlength being advanced is not represented by the number of inches associated with an even-numbered terminal E. It is clear that signals and not-signals on the terminals E21—E32 in binary form represent the pertinent measured length of the advanced timber, and more specifically according to the following presentation:

	Signal on E	Not-signal on E
Length in inches:		
2	22	23, 25; 27, 29, 31
4	24	21, 25, 27, 29, 31
6	22, 24	25, 27, 29, 31
8	26	21, 23, 27, 29, 31
10	22, 26	23, 27, 29, 31
12	24, 26	21, 27, 29, 31
14	22, 24, 26	27, 29, 31
16, etc	28, etc.	21, 23, 25, 29, 31, etc.
64	32	21, 23, 25, 27, 29
66	22, 32	23, 25, 27, 29
68	24, 32	21, 25, 27, 29
70	22, 24, 32	25, 27, 29
72	26, 32	21, 23, 27, 29
74, etc	22, 26, 32	23, 27, 29
126	22, 24, 26, 28, 30, 32	...

The setting for 6 feet (i.e. 72 inches) is shown on PL3 on the vertical lines from E6 and E7, while the line E8 is not connected but stands in reserve as indicated above. In the present instance two similar cutting delays of 6 feet are provided. The terminals E26, 32 carry signals while the terminals E21, 23, 27, 29 carry not-signals.

A signal is obtained over P1 in PL1 on the terminal E1, which gives a signal on ULK1*a*. Each signal on any of the terminals E1—3 sets KPR to zero and starts a new delay process. Blocking of these inputs is caused by signals on the priority input E4. The signal on ULK1*a* gives an output pulse from ULK1, which sets the output of ILK8 to one. The gate OLKI obtains negative voltage from E6 over coupling means (not shown) on input *a*, when the condition set on PL3 is fulfilled. This condition means that all diode plugs in PL3 connected to E6 have negative voltage on their anode, which is the case when the register portion ILK1—7 is stepped forward to the desired value, corresponding to the intended cutting delay. The output signal from ULK1 is also fed to ILK8*a* and to OLK2*a*. The gate OLK2 sends an output signal over a circuit (not shown) for zeroing the register flip-flop ILK1—7.

The length measuring pulses on E5 step the register flip-flops, as mentioned, until the desired value is reached. All diodes connected to E6 then have negative voltage on the anodes, and E6 also becomes negative. The signal on E6 is fed to OLK1*a*, whereupon the gate OLK1 sends signals to the time delay member ZLK and to UPK*b*. The gate already has a signal on UPK*a*. The gate UPK sends output signals to terminal E33 on the lines **63** and/or **49**, in FIG. **1**, and possibly further (via circuits not shown) to the lines **74**, **75** to actuate the control devices **61**, **50**, **73** for cutting, marking and sorting, respectively. Subsequent to the time set on ZLK, which should be equal to the time during which respective operating devices **61**, **50**, **73** are to function, the signal on ZLKB disappears, and UPK returns to rest position. At the same time ZLKA obtains a signal which sends a pulse of OLK2*d*. The signal on OLK2A disappears, and ILK8 is zeroed. Thus, E6 is redrawn to zero-potential, whereby OLK1 is zeroed so that the signal to ZLK disappears. The time delay member ZLK is then immediately zeroed.

The AND gates ULK2, ULK3 and the memory means ILK9 and ILK10 function analogously with the means ULK1 and

ILK8 for the other cutting delays, corresponding to input signals on the terminals E2 and E3.

If a new signal arrives on any of the terminals E1—3 before a cutting signal has been issued on E33, the memory means ILK1—7, which are one-positioned, are zeroed and the new signal starts a sequence according to the above. If the priority input E4 obtains a signal simultaneously as any of the inputs E1—3, or before the cutting signal has been issued, ILK11 is one-positioned. The input signal on ULK1*b*, 2*b*, 3*b* disappears, whereby the input signals on E1—3 are blocked.

When the signal on the output from OLK1 disappears the signal ILK11*a* also disappears so that ILK11 is zeroed, whereby new signals can be received on E1—3.

LENGTH REGISTER LDR (FIG. 5)

The purpose of the length register LDR is to receive length measuring pulses from the means which measure the length of the wood (FIG. 1) and send said pulses to KPR and AVR. Further, the smallest limit value and the largest limit value are set on the timberlength where cutting is to be effected by means of the program panel OL1. Further, the length value where diameter measuring is to begin is also set. The register LDR is started in response to the limit position indicators **77** and, in its turn, starts the rotators (over **80** in FIG. **1**).

The length register LDR contains a series of bistable flip-flops ILL1—9, which form the registering portion of LDR. These flip-flops obtain signals from the length indicator **42** (digital codes discs) for each inch advanced by the length of timber. The first four flip-flops ILL1—ILL4 count together up to 12 inches, whereafter ILL5 obtains a pulse for each foot. Each of the flip-flops ILL1, 3, 5—9 is provided with two outputs designated A and B. ILL1A controls the input to ILL2, which in turn controls ILL3*a*. The output ILL3A controls ILL4*a*, and ILL4 controls the input to ILL5. Further, ILL1B controls input ILL3*b* and ILL3B controls ILL4*b*. The output from ILL4 is also connected to ILL3*c*. The outputs A from ILL5—ILL9 are connected to even-numbered terminals D and the outputs B from the same flip-flops are connected to odd-numbered terminals among the terminals D21—D30, said terminals being connected to programming panel PL1, FIG. 3. LDR also contains two AND gates ULL and UPL, and an OR gate OLL. Zero setting signals are fed from KPR to terminal D5. The signals from the limit position indicators (limit **1** and limit **2**) are fed on D1 and D2, respectively. The length measuring pulses are applied to terminal D3. These pulses are passed further to KPR from terminal D32. Terminal D31 is connected to the rotator valve **80** in FIG. **1** for starting the rotators.

As shown above LDR contains means for starting the length measuring operation. The feed rollers **20** of the feed mechanism, i.e. the centering means **10**, actuate limit switches (switch means **77** in FIG. **1**), which are connected via the lines **78** to the input terminals D1 and D2 of the length register. Although not shown in FIG. **1** two sets of feed rollers **20** are arranged in spaced relationship in the feed direction of the trunk. When the trunk has been advanced to an extent whereby the rollers **20** on the discharge side of the centering means **10** (the rollers **20** shown in FIG. **1**) have left their rest position the valve means **80** is actuated over **D31** and **79**, whereby sensing devices **25** are moved into contact with the surface of the trunk. The length measuring operation starts after an adjustable delay has terminated.

Input signals on both D1 and D2 give signals on both ULL*a* and ULL*b*. The AND gate ULL then gives output signals to UPL*a* and signals to terminal D31, the last mentioned causing the sensing devices **25** to advance as described above. The length measuring pulses from D3 are fed to UPL*b* and UPL, and send corresponding signals (length pulses) over D32 to the cutting register KPR and to ILL1, whereby ILL1 is indexed forwards one step for each count pulse, i.e. for each inch advanced by the trunk. Upon termination of a delay time, determined by means not shown, the flip-flops ILL1—9 are zeroed. Continued advance of the flip-flops takes place from this position until signals from the cutting register KPR arrive on terminal D5, said signal actuating the register flip-flops to a position corresponding to 6 feet, which corresponds to the distance between the measuring position and the cutting position. Thus, subsequent to a first cutting operation, the length measuring operation starts on 6 feet. The flip-flops **ILL5—9** of the register portion obtain input signals from respective preceding flip-flops for 1, 2, 4, 8 and 16, feed respectively. The output signals thereof are passed to the previously mentioned output terminals **D21—D30** from the signal outputs **A** and not-signal outputs **B** according to the following:

	Signal D	Not-signal D
Length in feet:		
1	22	23, 25, 27, 29
2	24	21, 25, 27, 29
3	22, 24	25, 27, 29
4	26	21, 23, 27, 29
5	22, 26	23, 27, 29
6	24, 26	21, 27, 29
7	22, 24, 26	27, 29
8	28	21, 23, 25, 29
9	22, 28	23, 25, 29
10	24, 28	21, 25, 29
11	22, 24, 28	25, 29
12	26, 28	21, 23, 29
13	22, 26, 28	23, 29
14	24, 26, 28	21, 29
15	22, 24, 26, 28	29
16	30	21, 23, 25, 27
17	32, 30	23, 25, 27
18	24, 30	21, 25, 27
19	22, 24, 30	25, 27
20, etc	26, 30, etc.	21, 23, 27, etc.

In the example described below the plugs are set up in the programming panel **PL1** for 10 feet, 12 feet and 18 feet. This corresponds to the diode plugs on line **P1** to the intersections of **D21, D24, D25, D28, D29** respectively on the line **P2** in the intersection **D21, 23, 26, 28, 29** respectively, on lines **P3** in the intersections of **D21, D24, D25, D27, D30.**

RADII REGISTER RDR (FIG. 6)

The purpose of the radii register RDR is to transfer the radii values from the measuring devices **38** (the digital code discs) and in cooperation with DMR, combine said values pairwise for diameter KLG and stops the clock when the said smallest value has been determined. The clock KLG, in turn, controls the diameter register DMR in response to said value.

As can be seen from FIG. **6** each of the radii registers RDR include a registering portion comprising the flip-flops ILR1—8. These flip-flops have one input designated from **1—8**, connected to the code discs in the diameter measuring means in FIG. **1**, and these are supplied with signals from the lines **43** to the coupling points J43, K43, L43, M43 shown in FIG. **3**, corresponding to respective lines **43*a*, 43*b*, 43*c*, 43*d***, in FIG. **1**. As was apparent from the description of the clock pulse generator KLG, said generator sends the set pulse to terminals J, K, L, M**14**. This set pulse is fed as an input signal to the OR gate OLR1, which in turn supplies the OR gate OLR2. The set pulse is fed over the output **24** in FIG. **6** to the next RDR, i.e. in this instance RDR2 (terminal **14**). In a corresponding manner the set pulse is passed over terminals L14 and M14 in ADR3 and ADR4, respectively. The count pulses are passed from KLG on input **11** (from terminal H26 in FIG. **3**). The terminal J12 is connected with terminal J22, and terminal L12 is connected with terminal L22. The terminals **11, 12, 13** feed respective inputs *a, b, c*, of the AND gate ULR. This gate, in turn, feeds the flip-flop ILR1 on its input *c*. The inputs *a* to the flip-flops ILR1—4 are fed from the inverting output terminal B of OLR1. The inputs *a* to the flip-flops ILR5—8 are fed from the inverting output terminal B of OLR2. In addition to the series feeding from respective flip-flops ILR to the nearest subsequent flip-flop the outputs of said flip-flops feed signals in sequence to the input terminals *a, b, c, d* of OR gate OLR3. The outputs from ILR5—8 feed respective inputs *a, b, c* and *d* of the OR member OPR. The outputs A and B of this member are connected together and feed the input *e* of the OR gate

OLR3. The output A from the last-mentioned gate feeds the terminals K22 and M22, which are respectively connected to the terminals K12, C2 and M12, C3. The inverse signal is passed from the inverting output B to the terminals J21, K21, L21, M21, which are connected to K13, H2, FIG. 3, M13 and H3, respectively, in FIG. 3. The terminal K22 and M22, respectively, obtains signals when all flip-flops ILR1—8 are not zeroed. Hence, terminal 11 can receive count pulses. When all flip-flops ILR1—8 are zeroed no signal is present on 12, i.e. the output from ULR is blocked.

As is evident from the aforegoing the radii registers RDR1—4 (FIG. 3) are connected in pairs to diametrically opposed digital code discs 38, over the lines 43. When determining the diameter of the roundwood the content of the code discs is transferred to RDR when the set pulse arrives from the clock pulse generator KLG. The count pulses then step the registering portion towards zero, simultaneously as the pulses also step up the diameter register DMR. When any of the two first radii registers RDR1, RDR3 are zeroed the pulses are guided into associating radii registers RDR2 and RDR4, respectively. When either of these registers is zeroed the pulse transfer to DMR is interrupted, which has thereby registered the lowest diameter value. The pulses continue to the last radii register, until this register has also been stepped to zero, whereafter the end pulse arrives and a new reading cycle can be started.

The set pulse is fed, as mentioned, on terminal 14, see FIG. 6, to OLR1, whereupon OLR1B obtains a zero signal and OLR1A obtains a one signal, and hence OLR2B obtains a zero signal. All impulse flip-flops ILR1—8, which receive the signal zero from respective terminals 1—8 on input *b* are then stepped upwards.

The count pulses arrive to a first radii register of one pari, e.g. RDR1 on terminal J11 from H26 in KLG to ULR*a*. The terminals J12 and J22 are connected together so that ULR*b* retains signal as long as OLR3 is one-positioned, which it is as long as one of the impulse flip-flops is one-positioned and gives signals to any of the inputs of OLR 3 and OPR. The terminal J13 is connected to negative potential. The count pulses are present on the output from ULR and step the inpulse flip-flops backwardly, until all are zeroed.

The count pulses arrive at the second register, e.g. RDR2, on terminal K11 and are issued to ULR*a*. The terminal K13 is connected to J21 in the register RDR1 so that the count pulses do not arrive at the impulse flip-flops ILR1—8 until RDR1 is zeroed, and thereby also OLR3 has been zeroed. When the second register RDR2 is also at zero the signal from OLR3A disappears. This stops the forward stepping of the diameter register DMR.

The count pulses continue until all registers RDR have been set to zero, whereupon H2 and H3 in the clock pulse generator KLG obtain signals; the count pulses ceasing and the end pulse is started.

DIAMETER REGISTER DMR (FIG. 7)

The diameter register DMR registers the measured values of timber diameter and passes the same to the diameter limit indicator DGI. The register starts from LDR and, in turn, starts the clock KLG. The register is stepped upwards by count pulses from the clock being controlled by the radii registers RDR1—4 and is stopped by the clock KLG when this is stopped by RDR. The diameter limit values are set on the programming panel PL2 belonging to DMR, and DMR sends output signals to PL1 when these limits are reached.

The diameter register includes bistable flip-flops LD1—9, which are controlled by each other in cascade. Each of the flip-flops ILD4—9 is provided with two outputs A and B. The flip-flop ILD1 obtains input signals from the AND gate ULD, which in turn is fed with count pulses from KLG, G26, on terminal C1. Count-stop signals (count-stop 1) from RDR for the first diameter are fed in on terminal C2 from K22, in FIG. 6. Corresponding count-stop signals (count-stop 2) for the other diameter are fed in on terminal C3 from M22 in FIG. 6. Further, the inverse set pulse is fed in form KLG (H23) to terminal C9 from there to the input of the OR gate OLD1. The end pulse from KLG (H28) is fed in on terminal O10. Stop pulses are fed in from KPR on the terminal C5 to input C of the member SLD4. Start pulses are fed in from the programming panel PL1 on terminal C4. Further, the diameter register DMR includes a second OR gate OLD2 and three memory means SLD1—3. The diameter limit value 1, i.e. in the present cast 5 inches, is fed out on the terminal C36. The second diameter limit value (diameter limit 2) is fed out on terminal C38. In the present case this value is 11 inches. A reserve is found on terminal C40 for an extra diameter limit value.

The outputs A from the flip-flops ILD4—9 are connected to terminals provided with even numbers and the outputs B from the same flip-flops are connected with terminals provided with odd numbers, within the terminal series C21—32. The members SLD1, SLD2 and SLD3 are fed from the programming panel PL2 in FIG. 3, over their respective terminals C11, C12 and C13, respectively.

The pulses used to step forwards the radii registers RDR1—4 pass simultaneously to the diameter register DMR in FIG. 7, which counts the total number of pulses taken to zero that pair of the two interconnected radii registers RDR1, 2 and RDR3, 4, respectively, which requires the least number pulses to be zeroed. The smallest diameter of that part of the trunk being sensed is determined in this manner.

The diameter measuring operation is started, for instance, at 12 feet from LDR (P2-C4) and is stopped by a signal from the programming panel PL1 (terminal C5). A simultaneous signal on the start and stop terminals represent one single reading. The result is registered in a number of memory means which indicate whether a certain diameter limit has been passed. These diameter limits are adjustable on the programming panel PL2. Simultaneous issuance of a start and a stop registering signal will only give registration of the first diameter measuring process. If it is desired to start up a new registering process the system must be reset.

An input signal on start terminal C4 issues a pulse to SLD4*a*, the memory element SLD4 being one-positioned, and generates an output signal. This starts the clock pulse generator KLG, over terminal C34. An inverted set pulse arrives from terminal C9 to OLD1, which is set to zero during the duration of said pulse, and zeros the pulse memories ILD1—ILD9 over OLD1B. Count pulses then arrive on ULD*a* from the terminal C1. The inputs *b* and *c* have signals (inverted count stop signals) as long as no pair of radii registers RDR1, 2 or RDR3, 4 have been counted down to zero, and the count pulses count up the content of the registering portion ILD1—9. As soon as the signal disappears on any of the inputs *b* and *c* the count pulses from the outputs on ULD are stopped. The value stored in the register portion ILD1—9 is then equal to the smallest diameter.

The stop signal on C5 resets SLD4, whereupon the signal KLG on terminal C34 ceases and KLG stops. When a signal is obtained simultaneously on C4 (start) and C5 (stop) a signal is also obtained on C34, which, however, disappears when the set pulse arrives on SLD4*b*. Thus, only one diameter measuring cycle is started.

If it is desired to register the result of a measuring operation this can be effected by programming certain diameter limits on the programming panel PL2 (FIG. 3). When any of these set limits are passed while the count pulses step the registering portion ILD1—9 forwards, a signal is obtained on respective terminals C11—C13. The limits are placed in order of magnitude from C11 onwards. When the first limit is passed a signal is obtained on SLD1*a* from C11. The memory member SLD1 is set to one and sends a signal on C36. When the nest diameter limit is passed SLD2 is set to one, etc. The memory means for the nearest lower limit is set to zero so that only one memory SLD1—3 is set to one when the measuring operation is completed.

The start signal on C4 sends a continuous output signal on C34, which has mentioned starts KLG, which gives a set pulse on H24 (short pulse). This pulse enters on terminal 14 of RDR1—4. When the pulse enters in RDR, the positions of the code means are read (which are represented on terminals 1—8). This value is read in to respective RDR. The registers RDR take in count pulses when RDR is not at zero, and said registers take in so many count pulses that they are at full capacity (first the one and then the other). The said count pulses also enter DMR (over C1), first from the first pair and then from the second pair of RDR. The first pair give stop signals (C2 or C3) and the minimum diameter is determinative, and is stored in DMR.

The following schedule concerns the setting on panel PL2:

	Signal on C	Not-signal on C
Diameter in inches:		
0.5	22	23, 25, 27, 29, 31
1	24	21, 25, 27, 29, 31
2	26	21, 23, 27, 29, 31
3	24, 26	21, 27, 29, 31
4	28	21, 23, 25, 29, 31
5	24, 28	21, 25, 29, 31
6	26, 28	21, 23, 29, 31
7	24, 26, 28	21, 29, 31
8	30	21, 23, 25, 27, 31
9	24, 30	21, 25, 27, 31
10	26, 20	21, 23, 27, 31
11	24, 26, 30	21, 27, 31
12, etc	28, 30, etc.	21, 23, 25, 31, etc.

DIAMETER LIMIT INDICATOR DGI (FIG. 8)

The diameter limit indicator DGI is used to control the tapering register AVR and sends an indication to said register each time a diameter value from DMR passes a half inch and one inch limit. The indicator starts from DMR and stops from AVR.

As can be seen from FIG. 8 DGI contains three memory elements ILG1, 2, 3 and three AND gates ULG1, 2, 3 and one OR combination OPG1, 2. Input signals are obtained on the terminals G1, G2, G3, G4 via the programming table PL2, FIG. 3, from the half-inch and full inch flip-flops in DMR. Stop signal from AVR is fed from F22 in FIG. 9 to terminal G7. An inverted end pulse is obtained from KLG (H27) on terminal G6. An end pulse from KLG (H28) is obtained on terminal G5. The half-inch-limit signal is sent from terminal G22 and full-inch-limit signal from G24 to AVR. The start signal is obtained on G8 from DMR.

The signals for passage of the diameter through a half-inch or full-inch limit is obtained on terminal G22 and G24, respectively. In the latter instance an output signal is obtained on both half-inch and full-inch limits. The indicator can be started and stopped from the programming panel OL2. This is also stopped automatically from the tapering register AVR, if this is started. Simultaneous connection of start signal on G8 and stop signal means that only one half-inch limit (which may at the same time be full-inch limit) sends an output signal on G22 (and possibly G24), whereafter the readout operation is stopped.

The start signal which arrives on ULG1*a* from G8 means that when an end pulse from G5 arrives on ULG1*b* the AND gate ULG1 obtains an output signal and sets ILG3 to one, the output signal of ILG3 being fed (over a delay circuit not shown) to ULG2 and ULG3 (input *c*).

The inputs G1 and G2 are connected to the impulse memory in DMR, which is switched for each half-inch, and G3 and G4 are connected to the impulse memory which is switched for each full-inch, i.e. ILD1 and 2, respectively. The inverted end pulse on G6 changes ILG1 and ILG2 to those positions which correspond to the positions adopted by the memories in DMR. If this is changed during a diameter measuring operation, i.e. one half-inch-limit or one full-inch-limit is passed, the position if ILG1, and possible also ILG2, is also changed. A signal (negative pulse) is then obtained on any of the inputs to OPG1, OPG2. The AND gates ULG2, and possibly ULG3, then obtain signals on all inputs during the duration of the end pulse and then send output pulses on their ourputs to G22 and G24, respectively.

The stop signal from AVR arrives on terminal G7 simultaneously with the end pulse at the first half-inch-limit. This signal is passed to ILG3*b*. When the next half-inch-limit arrives at AVR the stop signal disappears simultaneously with the end pulse, ILG3 being set to zero and blocks ULG2 and ULG3 while the signal on ULG2*c* and ULG3*c* disappears. The output signal from the terminals G22 and G24 also disappears.

TAPER REGISTER AVR (FIG. 9)

The taper register AVR starts from DGI when a half-inch-limit is passed, and is stopped at the next half-inch-limit. Length measurement pulses are passed from LDR and are counted by AVR between the half-inch-limits. When the number of such pulses between two half-inch-limits corresponds to a length which is less than a certain determined length, e.g. 3 feet, that is to say the taper is greater than a specific value, the cutting register is actuated to effect a cutting operation or a marking operation.

As can be seen from FIG. 9 the taper register AVR contains a series of impulse memories ILA1—ILA6, connected in cascade. Length measurement pulses from LDR arrive from D32 to terminal F1 and input *b* of ULA2. The start pulses are passed to terminal F2 and from there to the memory element SLA3. A stop signal is passed from terminal F22 to ULA2*a* for resetting the registering portion. The member SLA3 is also reset from the input B of a memory element ILA7 which is fed from the AND gate ULA1, which in turn is fed firstly on the input *b* from SLA3 and secondly on the input *a* from terminal F3 when the half-inch-limit value passage-signal from DGI (G22) is obtained. The last element within the registering portion, namely ILA6, controls the input *b* to the AND gate ULA4, which in turn feeds the input *a* to the memory element SLA2, the output of which is connected to the input *a* of the AND gate ULA6, which in turn feeds terminal F24 for taper limit 1, namely here corresponding to a taper of 0.5 inches on a 3 feet length of timber. A corresponding series of elements ULA3, SLA1 and ULA5, which are not shown as connected to the flip-flops ILA, feed terminal F26 which corresponds to a second taper limit (taper limit 2), which is held in reserve. The input *b* to SLA2 is fed, similar to the input *a* of SLA1, from the output A of the element ILA7. Further, the output B feeds the output *b* of ULA5 and ULA6 from ILA7.

The taper register AVR is started when a half-inch-limit is passed and is stopped on the next half-inch-limit. For this purpose a plug has been inserted in the start line for AVR. AVR starts, for instance, after 12 feet and awaits the next half-inch-limit. The taper measuring process then starts. By the term "inch-limit" is meant each multiple of 0.5 inches of the diameter. A full-inch-limit is thus at the same time a half-inch-limit. The registering portion ILA1—6 obtains length measurement pulses on F1 from LDR between said limits and counts the number of length measurement pulses to the next half-inch-limits. It is obvious that the higher the value reached by the registering portion the smaller the extend of taper in the wood. As mentioned in the foregoing two different taper limits can be set and signals are sent over PL1 to KPR simultaneously with the second half-inch-limit of the wood tapers to such an extent that any of the limits are passed.

Start signal on F2 sets the memory element SLA3 to one, said element sending signal to ULA1*b*. when a half-inch-limit is passed an input signal is obtained on F3 from DGI, which is simultaneous with the end pulse. ILA7 is set by the signal. A stop signal is sent from ILA7A to DGI on F22, which means that a further signal at the half-inch-limit is obtained from DGI, whereafter this is stopped. Signals on the output from ULA1 zero ILA1—6. The signal from ILA7A also passes to ULA2*a*, whereby the length measurement pulses from F1 go to ILA1. ILA1 changes position for each inch. ILA2 changes its position for every second inch, ILA3 changes its position for every fourth inch etc. If the taper is large the register has counted to the set position before the next signal from DGI. The inputs to ULA4 (ULA3) obtain a signal and the memory SLA2 (SLA1) is set to one. The output signal from SLA2 (SLA1) prepares the AND gate ULA6 (ULA5), so that when ILA7 is set to zero a short pulse is obtained from ULA6 (U-LA5) on terminal F24 (F26).

The memory member SLA2 (SLA1) is set to zero when the next measuring operation is started, and ILA7A obtains a signal. An input pulse on SLA2*b* (SLA1*a*) then reset the memory member SLA2.

PROGRAMMING PANEL

As can be seen from FIG. 3 the output lines D21—D30 pass to a programming panel PL1, where said lines are arranged vertically and intersect 10 horizontal lines P1—P10. The intersection points between the lines D and P can be interconnected by means of diode plugs for programming purposes. For instance, it can be established at which measured timber length (e.g. 12 feet) the diameter measuring operation shall begin. In the shown example plug connection takes place between the line P2 and the lines D21, 23, 26, 28, 29 in the manner shown by dots in FIG. 3, and an output pulse being obtained for 12 feet.

KPR, AVR, KKI, DMR and DGI are also connected to the programming panel PL1 in addition to LDR.

The programming panel PL2, which cooperates with DMR and DGI, is used to set the diameter limit values for the trunks.

Suitable combinations of 1/2, 1, 2, 4, 8 and 16 inches give signals on C11—C13. These signals are stored in DMR and are estimated on C36, 38, 40. They are used on PL1 which has three diameter limits, and a plug inserted for a certain limit transfers cutting signals to KPR.

The programming panel PL3 which cooperates with KPR is used to set the cutting delay, i.e. the distance between the measured position and the cutting position.

PROGRAMMING

The decision logic 13 functions according to the following predetermined program in the present example:

1. At the length of 10 feet a cutting signal is transmitted and the 6-feet-counter (for transport delay) is started. In the present instant 10 feet has been chosen as an example of pulp wood length. In the chosen example 6 feet corresponds to the distance between measuring position and cutting position.
2. Diameter measuring is based on 12 feet, which is the minimum length for saw timber.
3. If the diameter is greater than 5 inches but less than 11 inches a previous cutting signal is eliminated and repeated diameter measuring operations are started. Five inches is the minimum diameter for saw timber. Diameter classes are counted in half inches between 5 and 11 inches, while at diameters greater than 11 inches the diameter classes are counted in whole inches for saw tiber.
4. Taper measuring operation is started (subsequent to the pulp wood stage) at first whole or half-inch-limits when the 6-feet-counter has also been started.
5. If the taper (0.5 inches) is obtained within 3 feet length cutting is effected on the first whole- or half-inch limit.
6. If the taper (0.5 inches) is obtained after the 3 feet length cutting is effected on the second whole- or half-inch limit.
7. If the diameter is greater than 11 inches at the 12 feet length repeated diameter measuring operations are started and previous cutting signals are eliminated.
8. When the first whole inch limit has been passed the 6 feet counter is started for cutting.
9. The maximum timber length shall always be 18 feet, which is the same as the maximum length for saw timer.

The length measuring process starts a specific short period of time after the two limit contact switches (means including 77 in FIG. 1) have been actuated. When the value in LDR has reached 10 feet the memories for 2 feet (ILL6) and 8 feet (ILL8) are set to one and the remaining are set to zero. Thus output signals are present on D24 and D28 and inverted signals on D21, D25, D29, The line P1 is then energized and the voltage is fed in to cutting delay 1 (terminal E1) of KPR. This is normally set on 6 feet so that the cutting signal is set out for said length, provided that no new signal to KPR zeros the registering portion ILLK1—7 and starts a new delay operation.

The output signal on the line P2 is obtained at 12 feet (40+8feet). This signal starts DMR over C4, whereby the diameter measuring operations are started. The first of said diameter measuring operations is registered in the memories ILD1—ILD9. The first limit is set on 5 inches (4 + 1) and the second limit is set on the 11 inches (8+2+1). If none of these limits are reached during the measuring operation, i.e. the round wood is less than 5 inches, nothing happens but that the wood is cut at 10 feet. If the diameter lies between 5 inches and 11 inches signals are obtained on P4 from the diameter limit 1 (C36) to start terminal G8 of DGI. DGI starts immediately and searches for a half-inch-limit which sends signals out on G22 via P5 to the cutting delay 2 (E2). When the next half-inch-limit arrives from DGI on new cutting signal departs via program line P5. On the other hand, if the degree of taper is slight, i.e. limit 1 of AVR has been passed a signal is sent out on limit 1 (F26) and a new cutting signal is obtained on the cutting delay 2 (E2) over P6.

If the diameter is greater than 11 inches cutting should take place on a whole-inch limit, which is effected via G24 and P7 to E2 (cutting delay 2). It may be that no whole-inch limit is reached for 18 feet.

At 18 feet a signal is sent in on E4 (priority input) via P3, which means that earlier cutting signals cannot be reset by possible functions after this limit.

The method according to the invention will be described below by way of example, with reference to the specific program exemplified above.

START OF MEASURING OPERATION

When a tree trunk 11 is advanced to the first centering means 10 from the debranching or barking machine a signal departs from the measuring member 77 of said means via the line 78 to terminal D1 in the length register LDR (FIG. 3 and 5). When the trunk has reached to second centering means a corresponding signal is obtained from the measuring member 77 of said means over the line 78 to the terminal D2. (In FIG. 1 there is shown only one centering means 10, a measuring device 77 and a line 78). The said signals, which obviously represent a first and second limit position, respectively, are passed to an AND gate ULL in LDR (FIG. 5). An output signal is then sent from the gate ULL to terminal D31 for starting the rotators 35, which cause the rods 31 to advance into abutment with the surface of the trunk 11. The output signal from ULL is passed further to the input *a* of the AND gate UPL.

LENGTH MEASURING

The length measuring operation is started as soon as the measuring device, formed of the members 32, 39, 40, is in contact with the trunk 11. The pulse emitter 41 sends pulses in response to the length of trunk (e.g. for each inch of trunk length) represented by the distance rolled by the roller 32 along the trunk, over the line 44 to terminal D3 in the length register LDR. The pulses are sent to input *b* of the gate UPL which has already received a second input signal from the gate ULL. The gate UPL then sends corresponding pulses firstly via terminal D32 to the cutting register KPR and to the taper register AVR (terminal F1) and secondly to the input of the first flip-flop ILL1 within the registering portion in LDR. The flip-flops ILL1—9 are stepped forward in response to the length measurement pulses and the one and zero positioning of the same represents at each moment the advanced trunk length. As previously mentioned the signals represent said length in binary form, on various combinations of the output terminals D21—D30. These signals exist on the horizontal lines in the programming panel PL1. In the present example three length values have been set in PL1 on the lines P1—P3, corresponding to the length for pulp wood, 10 feet, the length where the diameter measuring operation is to begin, namely 12 feet, and the maximum length for saw timber; i.e. 18 feet.

At the first length-limit, 10 feet, the previously given combination of signals and not-signals is obtained on five of the terminals D21—D30. This combination sends signals to terminal E1 in KPR for the reason described below.

When the second length limit 12 feet is reached signals are obtained in an analogous manner over the line P2 to terminal C4 to the diameter register DMR for starting of the same.

In the case of the third length limit, 18 feet, signals are obtained analogously over the line P3 to input E4 of KPR for the reason described below.

The flip-flops ILL1—9 are set to zero from KPR, terminal E34, when the length measuring operation is to begin.

CUTTING AT 10 FEET

The cutting order signal which, in the case of the measured length 10 feet, enters on terminal E1 in the cutting register, is sent to ULK1*a* and is transferred (ULK1*b* has signal) to ILK8, which is one-positioned on its output. The signal is transferred to the gate OLK2, which via its output OLK2B zeros the flip-flops ILK1—7. The length measurement pulses from E5 step forward the flip-flops ILK1—7. Subsequent to passage of the cutting delay set in PL3 an input signal is obtained on E6 to the output from ILK8, the marking of which is prevented from actuating OLK1, by means not shown. Said output signal is obtained on E6 to the output from ILK8, the marking of which is prevented from actuating OLK1, by means not shown. Said output signal is then released to OLK1*a* and further to ZLK, which sends an input signal to UPK*a* over its output B. Further, OLK1 sends input signals to UPK*b* so that UPK sends output signals to terminal E33, i.e. cutting signal (marking signal) to the member **61** (**50**) in FIG. 1 for cutting (marking) at 10 feet on the trunk **11**. The output signal from UPK is also passed to the terminal E40 and further to control member **73** for actuating the sorting mechanism **19**. After the time set on ZLK has passed the signal on ZLKB disappears, and thus the input signal on UPK*a* ceases, whereupon UPK is set to zero and the signals on E33 and E40 cease. Simultaneously ZLKA obtains a signal, which gives an input pulse on OLK2*d*. The signal on OLK2*b* thereby disappears, and ILK8 is set to zero. The terminal E6 changes its potential and thereby OLK1 is set to zero. The input signal on ZLK disappearing and ZLK is set to zero. The input signal on UPK*a* reappears but there is no signal on UPK*b* and hence UPK remains in rest position.

The above described sequence takes place if the cutting signal is not eliminated by the diameter measuring operation at 12 feet, as described below.

If a new cutting order signal arrives at any of the terminals E1—E3 before a cutting signal has been issued from E33, those of the memories ILK1—ILK7 which are one-positioned are set to zero and a new function cycle starts in KPR.

CUTTING AT 18 FEET

If the described measuring operations regarding the diameter, tapering and crookedness of the sensed log result in such values that cutting is not effected before reaching the timber length 18 feet the cutting operation in the present example shall be effected unconditionally at 18 feet.

When the length 18 feet is measured in LDR a signal is obtained on line P3 from LDR, said signal being fed to terminal E4 in KPR. A signal is also on terminal E1 in KPR and this acts in the same manner as described above for cutting after the 6 feet delay. New, incoming cutting signals are prevented from acting in that the memory ILK11 is set to one by the pulse on E4. The input signal on ULK1*b*, ULK2*b*, ULK3*b* disappears, and thus the inputs E1—E3 are blocked. When the signal of the output from OLK1 disappears the signal on ILK11*a* ceases so that ILK11 is set to zero, whereby new signals can be received from the terminals E1—E3.

DIAMETER MEASURING

As mentioned above the diameter register DMR is activated by input signals from LDR on terminal C4 (FIG. 7). A signal is thereby obtained to terminal C34 from the memory element SLD4, for starting the clock KLG (input H1). KLG gives on terminal H24 a set pulse, firstly to RDR and secondly to KKR and KKI and inverted set pulse on terminal H23 to input C9 of DMR.

The set pulse goes to all RDR on terminal **14** through the gate OLR1, and further to the gate OLR2 and out on output OLR2A to the next RDR (terminal **24**).

When receiving the set pulse the means RDR take in signals from the digital code discs **38** on its terminals **1—8** over respective lines **43**. All RDR are thereby set in a position corresponding to the value of respective radii of the trunk at the sensed position. When respective flip-flops ILR1—ILR8 gives output signals the OR gate OLR3 is opened (firstly direct on the inputs *a* —*d* and secondly via OPR on input *e*). An output signal is obtained on OLR3A to terminal K22 and M22, respectively the signal being passed to terminal K12 and M12, respectively and terminal C2 and C3, respectively, in DMR. The inverse signal is obtained on the output OLR3B, and said signal is passed to terminal **21** and from there to K13 and M13, respectively and, as a stop signal, to terminal H2 and H3, respectively in the clock KLG.

Count pulses are passed from terminal H26 in KLG to input **11** of RDR and terminal C1 in DMR. The input **11** feeds input *a* of ULR. Input *b* of ULR is fed from terminal **22** when not all of the ILR are set to zero, whereupon ULR (with terminal **13** connected to negative potential) can thereby send count pulses to ILR1. These count pulses step forward all ILR to zero. When all the the flip-flops ILR are set to zero OLR3A looses its signal but OLR3B sends a stop signal to ULR so that its output is blocked and no count pulses can be sent from ULR to the registering chain ILR1—8.

When RDR1 has been set to zero the count pulses are released to RDR2, which counts with its ILR to zero in an analogous manner. The output signal from OLR3A to K12 and C2 in DMR ceases and DMR is stopped.

When all RDR are set to zero a stop signal from terminal **21** to KLH is obtained, either on input H2 or 3 according to which pair of RDR1, **2** or RDR3, **4** has been set to zero last. The first zeroed pair send the stop signal to DMR, whereupon stepping of said register is stopped and the smallest diameter value is found registered therein.

As mentioned above the diameter register DMR is started at the length limit 12 feet on terminal C4. The start signal starts, as mentioned, the clock over terminal C34 (FIG. 7). The inverted set pulse from the clock KLG arrives on terminal C9 to the OR gate OLD1, which zeros the pulse memories ILD1—ILD9 over OLD1B. Count pulses then arrive on terminal C1 from KLG. Inverted count stop from the terminals C2 and C3 is obtained provided that none of RDR have been counted down to zero, so that ULD passes count pulses to ILD1. As soon as the signal of any of ULD*b* and ULD*c* disappears the count pulses from ULD to the flip-flops ILD are stopped. The diameter values stored in the register portion ILD1—9 is then equal to the smallest diameter of the diameters determined by the pair of measuring devices **38**. This value is represented in binary form by output signals on six of the terminals C21—C32, according to the above table.

These values are fed from the lines C21—C32 on the terminals C11—C13 back to DMR. Two diameter limits have been assumed in the present instance, namely 5 inches and 11 inches.

If the limit 5 inches is not reached during the diameter measuring operation no input signals are sent to C11—C13 and no starting signals to DGI. The cutting order signal on terminal E1 in KPR remains and the cutting is effected, as described above, at the length 10 feet.

If the 5 inches limit is exceeded but not the 11 inches limit an input signal is obtained on C11 to SLD1, which sends output signal on C36 to the diameter limit indicator DGI over P4 in PL1 to terminal G8 and further to ULG1. Further, end pulses from H28 in DGI on terminal G5 arrive from KLG. The end pulse is passed to ULG1*b*, so that ULG1 sends a signal to ILG3, the output signal of which is fed to ULG2 and ULG3, input *c*. The end pulse from G5 is fed to the inputs ULG3*b*.

Further, an inverted end pulse is fed from KLG terminal H27 to G6, and further to the inputs *a* of ILG1 and ILG2.

Signals are fed in from the flip-flops ILD1 and ILD2 for 0.5 and 1 inch from the terminals C22, C21, C24, C23 to respective inputs G1, G2, G3 and G4. The inverse end pulse from G6 to the inputs *a* of ILG1 and ILG2 set the last mentioned in the same position as corresponding members ILD1 and ILD2 in DMR. If the positions of the last mentioned are changed, i.e. if during the diameter measuring operation a whole or half-inch limit is passed the position of ILG1 and possibly also ILG2 is thus changed. A signal is obtained on any of the inputs A to OPG1 and OPG2. In the present instance with a passage of 5 inch the signal is obtained on both the inputs of the same. The AND gate ULG2 and ULG3 then receive a signal under during the duration of end pulse on all inputs, namely on A from OPG1—2, on B through the end pulse and on C from ILG3. The gates ULG2 and ULG3 then send a signal to terminal G22 for the half-inch limits and terminal G22 for the whole-inch limit.

The gates ULG2 and ULG3 then send a signal to terminal U22 (for half-inch limit) and terminal G24 (for whole-inch limit). These signals are applied to terminal F in AVR and terminal E2 in KPR, respectively. KPR functions as previously described with regard to the length measurement pulses.

TAPER CALCULATION

In AVR terminal F2 has already received a start signal from LDR at 12 feet (P2-F2). The taper measuring operation can now begin.

The memory means SLA3 is set to one and sends a signal to ULA1*b*. When the first half-inch limit is passed a signal is obtained, as mentioned above, in on F3, whereby ULA1 is opened and sends a signal to ILA1, and thus the whole registry portion ILA1—6 is set to zero. Further, the output signal from ULA1 sets the memory element ILA7 and sends a stop signal over F22 to G7 of DGI. The signal from ILA7A also passes to ULA2*a*, whereby the length measurement pulses on terminal F1 from LDR (d32-F1) can be fed into ILA1 and advanced further through all the flip-flops ILA. If the degree of taper is too great, i.e. in this case 0.5 inch on less than 3 feet, a signal is sent to ULA4 and, via SLA2 and ULA6, to terminal F24, and from there to terminal E2 in KPR. KPR then actuates the cutting operation in the manner described above.

If the degree of taper on 3 feet is not too great, i.e. the half-inch limit has not been reached by the end of the 3 feet length no signal is obtained on terminal F3 and no signal is sent to KPR.

DIAMETER GREATER THAN 11 INCHES AT 12 FEET

If the 11 inch limit is exceeded at the 12 feet length set on the flip-flop ILL in LDR an input signal is obtained as a result of the combination C21, 24, 26, 27, 30, 31, passing to C12 and further to SLD2, which sends an output signal to C38 and further to DGI, terminal G8, to start DGI. In the above described manner signal is obtained on the terminals G22, G24 in DGI and further to KPR and AVR. The taper register functions in the corresponding manner as described above and controls KPR.

MEASURING THE STRAIGHTNESS OF THE TRUNK

The method in which this measuring operation is effected can be seen essentially from the above description of the bend indicator KKI. It is obvious that if the incoming log or tree trunk is too crooked it must be classified as pulp wood, even through the other factors such as cross dimension, length dimension and taper do not prevent it from being cut into saw timberlengths The presence of very acute bends in the tree trunk may result in certain pieces of the trunk being rejected altogether. The signal for the pulp wood limit is sent from KKI, terminal R2, to PL1, line P9, and further to KPR, terminal E1 where it functions analogously with the aforedescribed. If the wood curves to a lesser extent, so that it can be tolerated as saw timber, another signal is obtained from KKI, terminal R1, and line P9 to terminal P40 in KPR, where it prevents cutting from being effected.

CONTROL

To summarize: the data obtained above from means LDR, AVR, KKI and DGI are combined in the cutting register KPR, FIG. 4, which groups together said data and issues the orders defined by the same for marking and cutting at the indicated positions on the tree trunk, and sorting the separated logs to the indicated classes. The cutting register actuates for this purpose the actuators **14**, **15** and **16** in FIG. **1**. The cutting register obtains length measurement pulses from LDR on terminal E5 and said pulses step the register portion ILK1—ILK7 forwards. At the first length limit, 10 feet, an input signal is obtained from LDR on terminal E1. The cutting delay is set to 6 feet in the manner described above.

The register flip-flops ILK1—7 step forwards until the desired delay value has been reached, whereupon terminal E6 obtains a signal and, via OLK, controls the time delay member ZLK, which in turn controls the cutting signal out on terminal E33 and the sorting output E40. Cutting is thereby effected at 10 feet according to the set delay on 6 feet. This assumes that the minimum diameter 5 inches has not been reached at 12 feet during the diameter measuring operation.

If the minimum diameter 5 inches is reached during the measuring operation at 12 feet the cutting signal at 10 feet shall be canceled if the bend and taper measuring operations so permit. The signals on terminal E5 remain and step the register portion forward. The cutting delay signal is fed in from DGI, terminal G22, to input E2 on KPR and terminal E7 obtains an input signal.

When, after reaching 12 feet, the diameter measuring (or taper and bend measuring operation) gives an unallowed value, i.e. the limit 5 inches, a new signal is obtained on input E2 and cutting is effected at the nearest half-inch limit.

After reaching the 18 feet length, and if the limit values for diameter, taper and bending has not been passed, the input signal on terminal E1 will cooperate with the priority signal on terminal E4 to open UPK so that a cutting signal is immediately sent to terminal E33.

The incoming trunk is cut at the different diameters and when tapering to a too large extent the system functions in the above described manner in accordance with the previously set program, for the purpose of obtaining, by cutting at the best positions along the trunk, optimal use of the wood contain within said trunk.

The invention has been described in the aforegoing with reference to a special program and a special apparatus, but both the program and the details of the mechanical construction, and similarily the electrical circuitry may be varied within the scope of the following claims, to coincide with the conditions existing in practice in each particular case.

We claim:

1. A method of grading and classifying debranched tree trunks and similar roundwood according to the usefulness of the wood contained therein, the method comprising the steps of gathering information concerning corresponding cross and longitudinal dimensions of each trunk by automatically sensing magnitudes characteristic of these dimensions, and from said information proportioning the division of the trunk crosswise according to a predetermined yield program based on cross dimensions of the trunk and at least one of the properties of length, taper and degree of crookedness of said trunk.

2. A method according to claim 1, comprising marking the trunk at those positions at which it is to be divided crosswise.

3. A method according to claim 1, wherein division of the trunk is automatically controlled in dependence of the proportioning thereof.

4. A method according to claim 3, comprising sorting the logs which result from the crosswise division of the trunks in response to the proportioning thereof and controlling the sorting automatically.

5. A method according to claim 1, comprising determining the volume of wood in each trunk simultaneously with the proportioning thereof.

6. A method according to claim 1, comprising sensing properties characteristic of the extent to which each trunk tapers.

7. A method according to claim 1, comprising sensing properties characteristic of the extent to which each trunk is crooked.

8. An apparatus for grading and classifying debranched tree trunks and similar roundwood according to the usefulness of the wood contained therein, said apparatus comprising means for automatically sensing the magnitudes of properties characteristic of the corresponding cross and longitudinal dimensions of each trunk, and means controlled by said magnitude of the characteristic properties for proportioning the division of the trunk crosswise in dependence of a predetermined yield program based on cross dimensions of the trunk and at least one of the properties of length, taper and degree of crookedness of said trunk.

9. An apparatus according to claim 8, including means controlled by the proportioning means for marking each trunk at those positions where it is to be divided crosswise.

10. An apparatus according to claim 8, including means controlled by the proportioning means for automatically dividing the wood crosswise.

11. An apparatus according to claim 10, including means controlled by the proportioning means for automatically sorting the logs which result from the crosswise division of the trunks.

12. An apparatus according to claim 8, wherein the proportioning means includes means for determining the volume of wood in each trunk.

13. An apparatus according to claim 8, wherein the proportioning means includes means for sensing the magnitude of properties characteristic of the taper of each trunk.

14. An apparatus according to claim 8, wherein the proportioning means includes means for sensing the magnitude of properties characteristic of the extent to which each trunk is crooked.

15 An apparatus according to claim 8, wherein the sensing means is movable relative to the trunk to be sensed and includes arms capable of being brought into contact with the periphery of such trunk and the positions of which can be sensed.

16. An apparatus according to claim 15, wherein the arms are radially movable so that the radially inner ends thereof come into yielding contact with the periphery of the trunk being sensed.

17. An apparatus according to claim 15, wherein the arms are pivotally supported to be yieldingly swung so that one end thereof comes into contact with the periphery of the trunk being sensed.

18. An apparatus according to claim 15, wherein each arm has an end which comes into contact with the periphery of the sensed trunk and a roller at said end adapted to roll along the surface of the trunk,

20. An apparatus according to claim 15, comprising a bar pivotably mounted on each of the arms at the end thereof adjacent the sensed trunk, said bar having one end with a roller adapted to roll along the surface of the trunk and another end which carries means adapted also to come into contact with the periphery of the trunk.

19. An apparatus according to claim 18, comprising means for sending signals to the proportioning means in response to the rolling of at least one of the rollers of the arms along the trunk being sensed.

21. An apparatus according to claim 20, wherein said means on said arm comprises a second roller adapted to roll along the surface of the trunk and means are provided for sending signals to the proportioning means in response to the rolling of at least one of the rollers on said bars along the trunk being sensed.

22. An apparatus according to claim 20, comprising means for sensing the slope of said bars relative to the arms supporting the same.