April 28, 1953 H. E. BOVAY, JR., ET AL 2,636,601

LUMBER SORTER

Filed Nov. 10, 1949 3 Sheets-Sheet 1

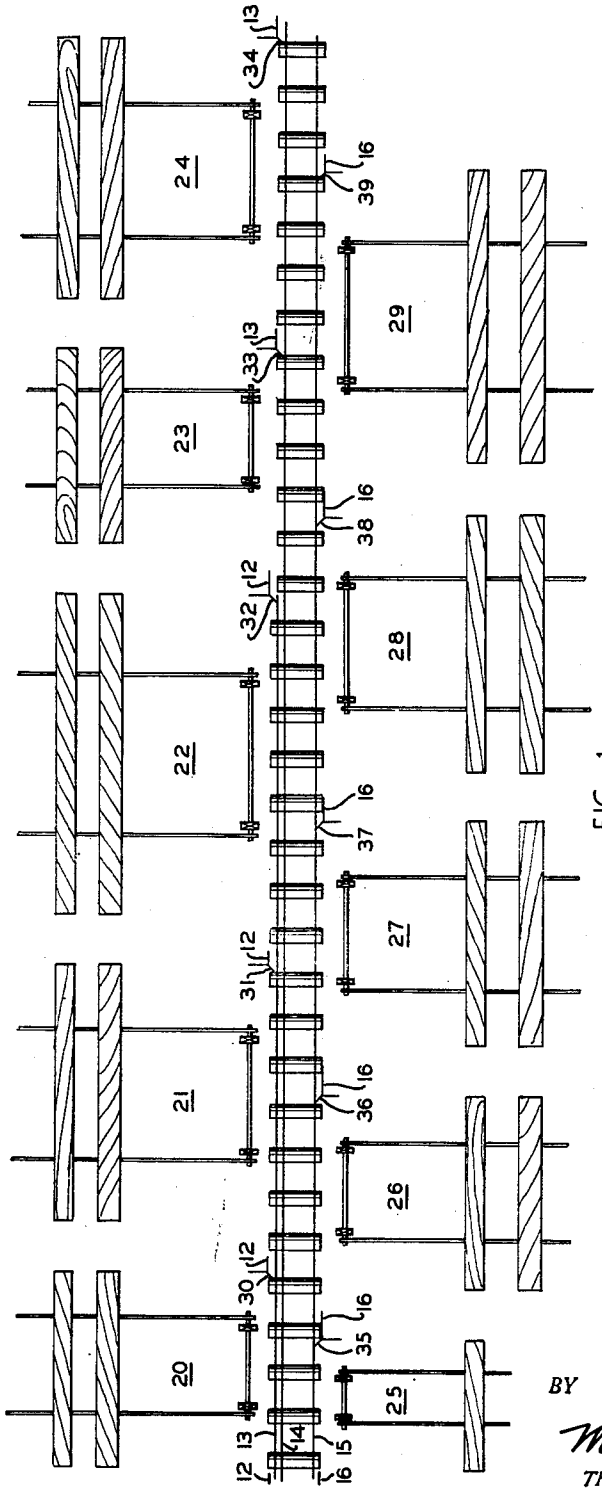


FIG. 1

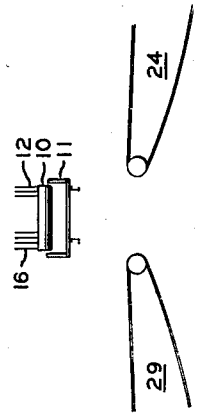


FIG. 2

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LUMBER SORTER

Filed Nov. 10, 1949 3 Sheets-Sheet 2

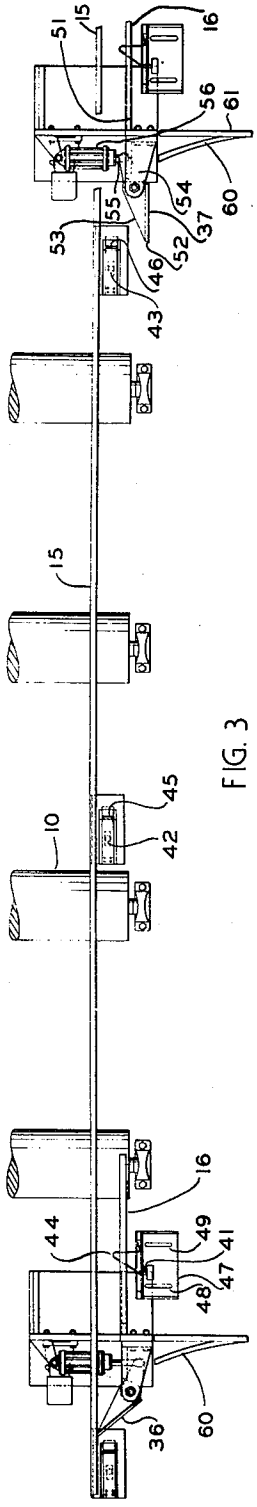


FIG. 3

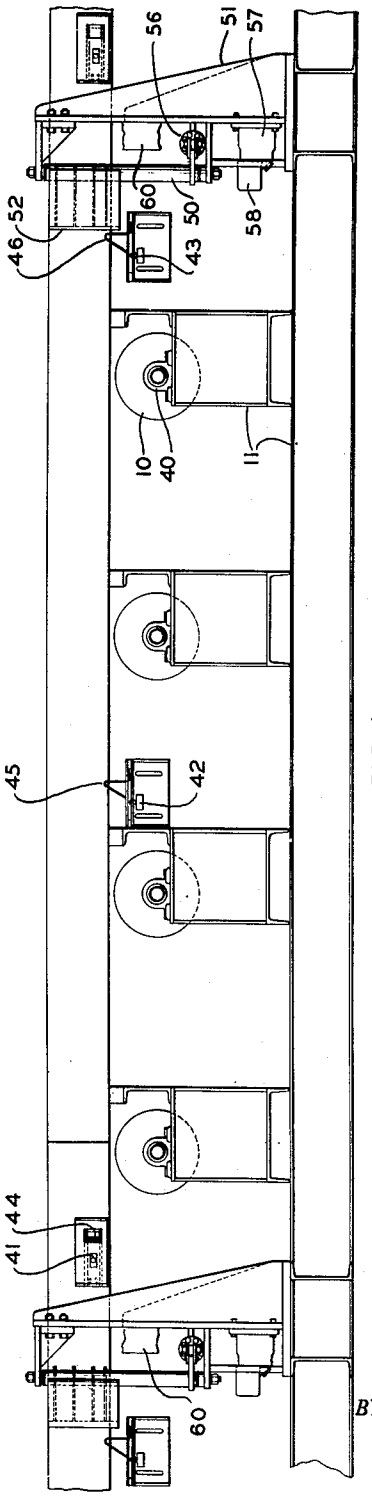


FIG. 4

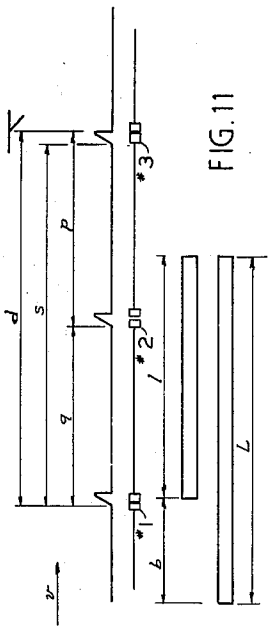


FIG. 11

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LUMBER SORTER

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3 Sheets-Sheet 3

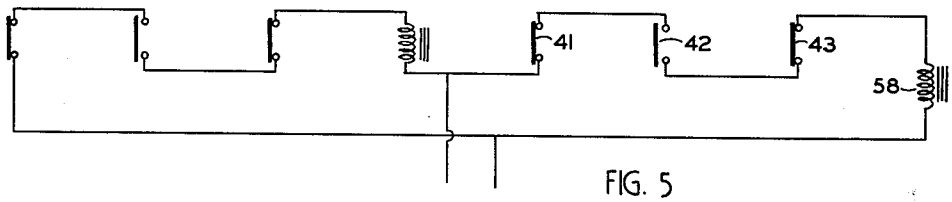


FIG. 5

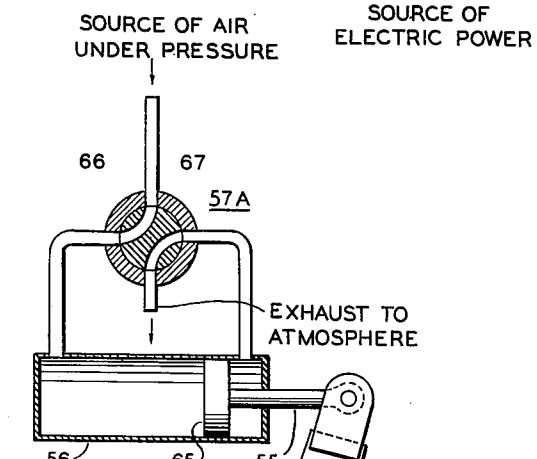


FIG. 6

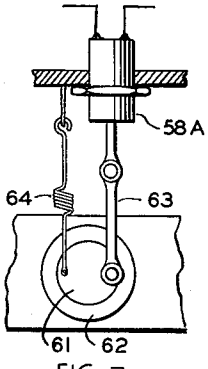


FIG. 7

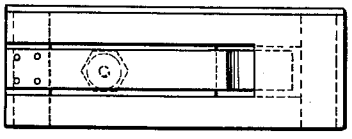


FIG. 9

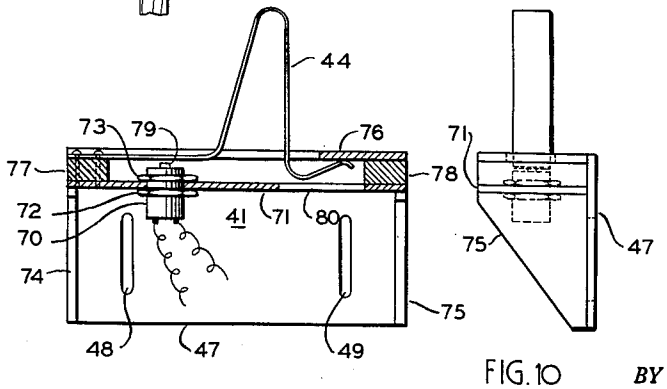


FIG. 8

FIG. 10

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UNITED STATES PATENT OFFICE

2,636,601

LUMBER SORTER

Harry E. Bovay, Jr., Charles A. Lawler, and Lionel H. Wheeler, Houston, Tex., assignors, by direct and mesne assignments, of one-half to Arthur Temple, Jr., Diboll, Tex., and one-half to H. E. Bovay, Jr., consulting engineers, a partnership

Application November 10, 1949, Serial No. 126,644

17 Claims. (Cl. 209—82)

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This invention pertains to the sorting of lumber according to its length. Certain features of the invention are applicable to the sorting of other things besides lumber and to sorting according to other dimensions than length and other functions or qualities than the dimensions of an article.

The invention is particularly adapted to sorting a mixture of lumber of different lengths in which one group of lumber differs in length from the remaining lumber by a predetermined minimum length.

The invention is further particularly adapted to sorting lumber as it is moved from the saws to the storage bays by means of a conveyor of the type shown in U. S. Patent 369,550, granted September 6, 1887, to H. B. Phillips and W. M. Whaley, such conveyor being commonly referred to as an edge sorter although the only sorting is performed manually by the operator who places different thicknesses, lengths and grades of lumber in different slots of the conveyor. According to the present invention instead of using as many slots as there are different combinations of size and grade, all of the lumber of one grade and thickness may be put in one slot and the sorting mechanism of the invention distributes the lumber of different lengths to the appropriate bays.

It is a principal object of the invention to provide a lumber sorter that is simple in construction, easy to operate, and inexpensive to use and maintain, yet which shall operate reliably and at a high speed.

It is a further object of the invention to provide a sorter which will have optimum operating characteristics, that is which can be operated at the maximum possible top speed with the components available for its construction and under the limitation that the sorter will operate properly independent of the speed of the conveyor within the range from zero speed up to the top speed of the conveyor at which the sorter will operate correctly.

Briefly described, a preferred embodiment of the invention may include an automatically operated gate disposed alongside a slot at the end of an opening in one side of the slot and adapted to move into a closed position diagonally across the slot to deflect lumber from the slot through the side opening into a storage bay or to remain in an open position in which the lumber in the slot can continue on past the gate to be delivered to a different bay. Three switch actuators are disposed along the slot so as to be actuated by

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the lumber passing by them, the switches in turn controlling the operation of the gate. The first switch actuated by the lumber as it travels along the conveyor in the slot is a normally closed switch. The next switch is a normally open switch. The last switch, whose actuator is close to the gate, is a normally closed switch. The three switches are in series in an electric circuit which may actuate a solenoid which in turn actuates a valve which controls the conduits supplying and exhausting compressed air from a cylinder within which is disposed a piston directly connected to the gate.

The middle switch actuator may be considered to be the gate operator. In order to close the gate, lumber must be present adjacent the middle switch actuator to close the circuit. The pair of switch actuators in advance of and beyond the middle switch actuator may be considered to be the measuring device. If the lumber is too long it will not be able to close the switch controlled by the middle actuator except when one of the other switches is open. When lumber shorter than a predetermined length travels down the slot it passes beyond the first switch actuator returning the switch to closed position while the lumber is still over the second switch actuator holding the switch in closed position and before the lumber reaches the third switch actuator so that the third switch is still in its normally closed position. With all three switches thus closed, the solenoid moves the valve so as to close the gate, and before the lumber can open the third switch and reopen the gate, the lumber hits the gate and is deflected out the open side of the slot into the bay. On the other hand, longer lumber will open the third switch before, or at least shortly after the first switch is reclosed so that the circuit will not be closed at all or at least not long enough to start to close the gate and the gate will remain open and the lumber will pass on through.

To make sure that such longer lumber does not fall off the conveyor out through the open side of the slot, the first switch actuator and the gate are constructed so as to help guide the lumber. The first switch actuator is disposed so as to project out from the side of the slot just ahead of the opening and to deflect the lumber toward the closed side of the slot. The gate is mounted so that in open position the free end is further removed from the opposite wall of the slot than is the end of the wall on which the gate is pivoted. The gate thus acts as a scoop to gather in the end of any piece of lumber that

has gotten somewhat out of line and to guide it back into the slot beyond the gate.

The gate is mounted so that in closed position its free end rests against the opposite wall of the slot. This relieves the actuating piston of any force due to deflection of the lumber. The free end of the gate is shaped so that when closed its leading corner lies against the slot wall in order not to leave an exposed edge which might split the lumber being deflected.

It is necessary that the distance between the first and last switch actuators be greater than the maximum length of the short boards that are deflected by at least an amount equal to the distance traveled by the board in the time needed for the gate to close after the board has left the first switch actuator less the time needed for the solenoid to move the air valve to position tending to reopen the gate after the board strikes the third switch actuator. Otherwise the gate will start to reopen before it is fully closed. It is also necessary that the distance between the first and third switch actuators be not greater than the minimum length of the long boards that are allowed to pass through without closing the gate plus the distance traveled by the board in the time for the solenoid to move the air valve to position to start to close the gate. Otherwise the long boards of minimum length will start to close the gate. For the system to operate at all speeds from zero speed to top speed, it is therefore necessary that there be a substantial difference between the maximum length of the boards deflected and the minimum length of the boards passed and that the conveyor be operated at no greater speed than that at which the distance traveled by the board in the time lag period of the gate (from time of release of switch actuator to time gate is fully closed) minus twice the time lag of the solenoid is equal to the minimum difference in length between short and long boards.

It is also necessary that the distance between the first switch actuator and the gate be greater than the maximum length of the short boards by at least an amount equal to the distance traveled by the board during the time taken by the gate to close after the first switch actuator has been released to reclose the switch in order that the gate be closed when the board gets there. It is further necessary that the distance between the first switch actuator and the gate be no greater than the distance between the first and last switch actuators plus the distance traveled by the board in the time for the solenoid to move the valve to position tending to open the gate after the third switch actuator has been depressed. Otherwise the gate would reopen before the board gets to it with the possibility of splitting the board or letting it go by altogether.

It is also necessary that the distance between the second switch actuator and the gate be at least as great as the distance traveled by the board during the time taken by the gate to close after the second switch actuator has been depressed in order that the gate be closed when the board gets to the gate. It is further necessary that the distance between the second switch actuator and the gate be no greater than the minimum length of the short boards plus the distance traveled by the board in the time for the solenoid to move the valve to a position tending to open the gate after the second switch actuator has been released in order that the gate not reopen before the board gets to it.

The requirements as to the position of the second switch actuator relative to the first and third switch actuators are merely that the second actuator be between the first and third in order that the gate be under the control not only of the middle or gate operating actuator but also the end or board measuring actuators, and that the middle switch actuator be a distance from the first actuator less than the minimum length of the short boards in order that the middle switch be closed when the first is reclosed so as to give a maximum time for the gate to close before the board strikes the third switch actuator.

The foregoing requirements concerning the distance between switch actuators and between the first and second switch actuators and the gate are, as stated, dependent upon the speed of operation of the sorter and upon the time for the solenoid to move the valve and for the piston to operate the gate. It has been found, however, and it will be shown hereinafter, that the net result is that for optimum operating characteristics the distance between first and last switch actuators should be equal to the minimum length of the long boards, the gate should be closely adjacent to the third switch actuator and the middle switch actuator should be spaced from the end switch actuators by at least the minimum difference between board lengths and preferably be midway therebetween. This allows the sorter to operate properly at the maximum top speed possible for the given minimum and maximum difference between board lengths and for the given speed of operation of the solenoid and the gate, and under the limitation that the sorter shall operate correctly at all speeds from zero speed up to top speed.

The sorter as just outlined is a single unit. By providing a plurality of units in series along the length of the slot, each comprising a set of switch actuators, solenoid, valve and gate, several groups of lumber, each differing in length from that of the adjacent groups by a minimum predetermined amount, can be sorted out from one slot.

For a detailed description of apparatus suitable for a preferred embodiment of the invention, reference will now be made to the accompanying drawings in which:

Figure 1 is a plan of a board sorter according to the invention,

Figure 2 is an elevation of the sorter;

Figure 3 is a plan on an enlarged scale of a single unit of the sorter;

Figure 4 is an elevation of the unit shown in Figure 3;

Figure 5 is a diagram showing the electric circuit of the switches and solenoid;

Figure 6 is a detail in plan and section of a gate and its actuating piston and cylinder together with a schematic representation of a four way valve suitable for actuating the cylinder;

Figure 7 is a detail in elevation of a solenoid and the valve of Figure 6;

Figure 8 is a front elevation, partly in section, of a switch and its guide-actuator suitable for use in the invention;

Figure 9 is a plan of the switch;

Figure 10 is a side elevation of the switch; and

Figure 11 is a diagram used in demonstrating the necessary positions of the switches and gate.

Referring now to Figures 1 and 2, there is shown a conveyor comprising a plurality of rollers 10 carried in a supporting framework 11 and above which are disposed vertical guides 12,

13, 14, 15 and 16 forming the side walls of three slots 12—13, 13—14 and 15—16. Additional space between guides 14 and 15 provides room for additional guides if needed for expansion of the capacity of the sorter. The conveyor rollers may be positively driven by any suitable means, for example a chain drive, as shown in the Phillips and Whaley patent, or the rollers can be disposed in a sloping plane so that lumber placed thereon will be carried along by gravity. In the latter case, however, means should be provided to limit the top speed of the rollers and the slope must be sufficient so that before the lumber reaches the first sorting unit it will be traveling at full speed. In any case, it is desirable that the speed be controllable.

On each side of the conveyor and at a lower level are disposed a number of temporary storage bays 20—29, each including a conveyor adapted to receive from the side of the conveyor 10 a particular assortment of lumber. The receiving conveyors in the bays 20—29 are shown as chain conveyors. The bay conveyors deliver the lumber to other conveyors which in turn carry the lumber to a stacker, storage, kilns, or loading platform for truck or rail shipment.

Each of the bays 20—29 is just below a single unit of the sorter or is at the end of a slot. Thus on the far side of the sorter as viewed in Fig. 1, the slot 12—13 has two units including gates 30, 31, above bays 20 and 21, and the end of the slot as represented by the fixed stop 32 is over bay 22. Slot 13—14, disposed just inside slot 12—13 and beyond the end of slot 12—13, is provided with a unit including gate 33 disposed above bay 23 and the end of slot 13—14 as represented by fixed stop 34 is over bay 24. On the near side of the sorter the slot 15—16 is provided with four units including the gates 35, 36, 37 and 38 disposed over bays 25, 26, 27 and 28, and the end of slot 15—16 as represented by fixed stop 39 is disposed over bay 29.

As indicated in the drawing, the boards sorted into each of the bays 20, 21 and 22 is of a different length, but having all come from the same slot 12—13, the boards in each of bays 20, 21 and 22, may contain a similar assortment of lumber as to other characteristics such as width, thickness, and grade, depending on what is placed in the slot by the operator. A different assortment of width, thickness, and grade is sorted according to length into bays 23 and 24. Another assortment is sorted out into bays 25—29. As many slots and as many sorting units as necessary can be provided. If desired, enough slots and units can be provided so that the lumber in each bay is of a single kind as regards not only its length but all of its specifications. The provision of the length sorting units along the slots will in any case reduce the total number of slots required from that needed in a system not embodying sorting units.

Referring now to Figures 3 and 4, there is shown the details of one unit of the sorter, which for example may be the unit over bay 27. The conveyor rolls 10 are journaled in bearings 40 supported on the framework 11. The guides 15 and 16 are supported on this framework too, as are also the gate 37 and the three switches 41, 42 and 43. The whole framework is supported well off the ground (as shown in Figure 2) so as to be above the level of the bays and their chain conveyors.

The switches 41, 42 and 43 are respectively controlled by actuators 44, 45 and 46. Actuator 44 projects into the slot 15—16 through an opening in guide 16. The extent to which it extends into the slot can be adjusted since the switch and actuator are mounted on a plate 47 having slots 48 and 49 therein through which pass the screws (not shown) holding the plate to the frame so that by loosening the screws the position of the plate on the frame can be changed. Switch actuator 44, as better shown in Figures 8–10, comprises a flat steel spring secured at one end to the switch support. The face of the spring disposed in the path of the boards is diagonally disposed so as to force the boards toward the guide 15 and away from the opening in guide 16.

Actuators 45 and 46 and the associated switches and mountings are preferably identical with actuator 44 and its switch and mounted so as to be interchangeable therewith.

Switch actuators 45 and 46 are mounted so as to project up from beneath the plane of the conveyor rollers 10. Actuator 46 is disposed slightly upstream from gate 37 in a position out of the path of travel of the gate. Actuator 44 is disposed upstream from actuator 46 a distance about equal to the minimum length of board that passes through without being deflected. Actuator 45 is about half way between actuators 44 and 46. Switches 41 and 43 are normally closed. Switch 42 is normally open. Lumber passing through slot 15—16 will force actuator 44 to one side causing switch 41 to open, then in passing over actuators 45 and 46, it will force them down to close switch 42 and open switch 43.

Gate 37 is secured to sleeve 50 which is rotatably mounted on a fixed shaft passing therethrough supported by bracket 51. The gate extends vertically from the top of the guides 15 and 16 to the plane of the rollers 10. The forward end of the face plate of the gate is beveled at 52 so as to rest flat against guide 15 when in closed position as illustrated by gate 36. The back of the gate is reinforced with triangular plates 53 which also serve to guide boards back into the slot.

The lower end of the sleeve 50 carries an arm 54 which is pivotally connected to piston rod 55 of the air cylinder 56 which is also secured to bracket 51. Below the air cylinder is mounted air valve 57 and solenoid 58 which preferably are a single fast acting unit of some type such as that shown in U. S. Patent 2,476,519—Van der Werff and which is only schematically shown in Figures 6 and 7.

On the near side of the slot as viewed in Figures 3 and 4 there is a stop 60 which is supported from the framework by a gusset plate 61. The stop 60 is shaped like a quadrant of an ellipse so that the near end lies in a plane perpendicular to the slot walls. When a piece of lumber has been deflected out of the slot by the gate it strikes the far end of the stop and gradually its forward motion is slowed until when it reaches the near end of the stop its forward motion is completely gone. In other words, the stop brings the lumber to a complete stop as far as forward velocity is concerned and the lumber falls to the bay immediately below instead of shooting off to a variable distance beyond the gate.

Referring now to Figure 5, there is shown the electric circuit for operating the solenoid 58. The solenoid 58 is in series with switches 41, 42 and 43 across a suitable source of electric power not shown. When all three switches are closed the solenoid will be energized. In the drawing there

are also shown the switches and solenoid of another unit. As many circuits as needed may be supplied in parallel from the single source of power.

Figure 6 shows how a four way valve 57A will control the movement of the piston 65 in air cylinder 56. Rotation of the movable central part 66 a quarter turn clockwise within the stationary part 67 will transfer the air pressure from the left side of the piston to the right side and connect the left side to the atmospheric exhaust, thus causing the piston to move to the left opening the gate 37. A stop not shown limits the movement of the gate in the open position, or alternatively the gate can be adjusted to be in full open position at the limit of travel of the piston. The guide 15 acts as a stop to limit travel of the gate to closed position as shown in the drawing.

Figure 7 shows schematically how the valve 57A may be connected to the solenoid 58A. When the solenoid is energized its core is drawn in and the core in turn pulls on the link to turn the valve one way. The spring 64 returns the valve to its normal position when the circuit through the solenoid is broken.

Figures 8–10 show a switch such as switch 41 adapted to be opened by actuator 44. Switch 41 is a switch that is moved from one position to another by a very slight motion, such as a limit switch. The switch is mounted in a threaded nipple 70 which is held in a hole in plate 71 by means of nuts 72 and 73. Plate 71 is welded to plate 49 and braced by gussets 74 and 75. Plate 76 is also welded to plate 47 and is supported from plate 71 by spacer bars 77 and 78, all being welded together. Actuator spring 44 is screwed at one end to bar 77, the other end of the spring normally rests against plate 76, exerting a considerable force against it so that the spring does not oscillate back and forth after a board has passed by it. Depression of the spring by a board causes part of it to push the bottom 79 to move the switch, opening it in the case of switch 41. An opening 80 in plate 71 permits the free end of spring 44 to move in as the spring straightens out after actuating the switch and as the board passes by it.

As mentioned previously, the construction of switches 42 and 43 and their actuators 45 and 46 are identical to that of switch 41 and its actuator 44 in order that they may be interchangeable, but if desired in particular installations they might be different. However, the actuators 45 and 46 must extend well up into the slot in order to be sure to contact warped lumber, and actuator 44 must extend well out into the slot to serve as a guide so that the requirements for the different switches and their actuators are similar and usually they can be constructed alike.

It has already been indicated that for optimum operating characteristics the distance between the leading edges of actuators 44 and 46 should be about equal to the minimum length of boards that are to pass through the unit rather than to be deflected by it, that the leading edge of gate 37 should be near the leading edge of actuator 46 and that the leading edge of the middle switch actuator must be spaced from the end actuator by at least a distance equal to the minimum difference between board lengths. This was found to be true by experiment but can also be proved by analysis as follows:

First, it will be assumed that the system is symmetrical as far as movements in the gate opening and gate closing directions are concerned, that is, that the time for complete movement in each direction after the movement has been initiated is the same. That this is substantially correct is evident from the fact that the inertias of all the parts are constant at all times, their distances of travel from open to closed position and vice versa are equal except for the spring actuators (and here the time involved is negligible compared to other times because of short distance of travel and light parts), and the forces involved are the same on both opening and closing except perhaps in the case of the solenoid which is moved to the gate closing position by magnetic force and to gate opening position by a spring (but even here it is usual to make these forces about equal). There is no effect of gravity because all the parts move in horizontal directions. If it should be desirable for any reason to mount the solenoid or the piston for vertical travel, gravity could still be neglected for the force of gravity on the core and valve is small compared to the magnetic and spring forces exerted thereon, and the force of gravity on the piston is small compared to the force of the air pressure used. Furthermore, if desired the force of gravity in each instance could and usually would be balanced out.

For assistance in understanding the analysis reference may now be had to Figure 11.

In the material set forth below, the following symbols will be used:

$=$ equals

$+$ plus

$-$ minus

$\leq$ equal to or less than

$\geq$ equal to or greater than

Let

v= velocity of board travel

t=time for solenoid to move from one position to the other after board has depressed or released switch actuator

T=time for gate to move from one position to the other after valve has been moved from one position to the other

$k=vt$=distance board travels in time t

$K=vT$=distance board travels in time T

p=distance from leading edge of second switch actuator to leading edge of face of gate

q=distance between leading edges of first and second switch actuators

s=distance between leading edges of first and third switch actuators

d=distance from leading edge of first switch actuator to leading edge of face of gate

l=maximum length of board removed

L=minimum length of board passed

$b=L-l$

Consider first the conditions concerning the spacing of the first and third switch actuators and the position of the gate relative thereto:

$$s \geq l+k+K-k$$

so that the gate will close before it starts to reopen;

(1) $$s \geq l+K$$

(2) $$s \leq l+b+k$$

so long board will never start to close gate;

(3) $$d \geq l+k+K$$

so gate will close before board gets to it;

(4) $d \leq s+k$

so gate won't reopen before board gets there.

Applying the limitation that the sorter shall operate independent of the speed up to top speed gives:

At zero speed (when $k=K=0$):

(5) $l+b \geq s \geq l$ from (1) and (2)

(6) $s \geq d \geq l$ from (3) and (4)

At top speed (when $k=k$ top; $K=K$ top):

(7) $l+b+k \text{ top} \geq s \geq l+K \text{ top}$ from (1) and (2)

(8) $s+k \text{ top} \geq d \geq l+K \text{ top}+k \text{ top}$ from (3) and (4)

The quantities k and K vary directly with the speed. The right halves of (7) and (8) show that by making d and s larger K top and k top can be increased which corresponds to increased top speed. The left halves of (5) and (6) show that $l+b$ is the upper limit of both s and d. Hence for optimum operation corresponding to operation independent of speed up to top speed and a maximum top speed under that limitation:

(9) $l+b=d=s=l+K \text{ top}+k \text{ top}=L$

In actual practice in order to keep the third switch actuator out of the path of the gate so that the gate may extend all the way down to the plane of the conveyor, it is desirable to make d slightly greater than s. However, this will only affect operation at very low speeds when k is less than $d-s$ and at such low speeds a slight opening of the gate before the board gets there will not be harmful.

Considering now the middle switch actuator and assuming that the maximum length of board removed equals the minimum length of the board removed

(10) $p \geq K+k$

so that gate will close before the board hits the gate;

(11) $p \leq l+k$

so that the gate will stay closed until the board hits the gate.

Applying the limitation that the sorter shall operate independent of the speed up to top speed gives:

At zero speed (when $k=K=0$):

(12) $p \leq l$ from (11)

At top speed (when $k=k$ top; $K=K$ top):

(13) $p \geq K \text{ top}+\text{top}$ from (10)

Applying Equation 9 to Equations 12 and 13 gives:

(14) $l=L-b \geq p \geq b$

or otherwise expressed the middle switch actuator should be spaced from both end switch actuators by at least the distance b. To the foregoing it may be added that the l of Equations 11 and 12 is really the minimum length of board removed so that if this does not equal the maximum length of board removed as above assumed, Equation 14 does not follow, but if the maximum and minimum lengths of board removed are equal so that Equation 14 does hold, the minimum length of board that will permit optimum operation is one such that

(15) $l=L-b=p=b$

or otherwise stated, the sorting unit will give optimum operation for a minimum board length if the middle switch actuator is half way between the end switch actuators. In an actual case, however, the value of b is usually one, two or four feet, which is considerably less than l which starts at about six, eight or ten feet. Therefore, the middle switch actuator in these cases can be placed anywhere between the end switches as long as it is at least a distance b from the nearest end switch actuator. To avoid difficulty in specifying the position of the middle switch in the claims, the statement therein that the middle switch actuator is disposed "approximately midway between" the end switch actuators is here defined to mean that it lies within the range specified by condition (14), that is, it is spaced from both end switch actuators by at least the distance b.

From the foregoing description it will be apparent that apparatus has been provided achieving the stated objects of the invention. It will also be apparent that since the apparatus is designed for use in sorting lumber comprising at least two groups having a certain minimum difference of length, that certain phases of the invention comprise a new method of sorting such groups of lumber. While a preferred embodiment of the invention has been illustrated and described in detail, it is obvious that many modifications thereof could be made by one skilled in the art without departing from the spirit of the invention and it is desired to protect by Letters Patent all forms of the invention falling within the scope of the following claims.

We claim:

1. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, said slot having an opening in one of its side walls, said opening extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch having an actuator disposed in the slot near the gate, a second normally closed switch having an actuator disposed in the slot at a distance from the first mentioned switch actuator on the side thereof furthest from said end of the opening, a third switch normally open having an actuator disposed in the slot approximately midway between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, whereby lumber made up of a group of boards whose minimum length equals the distance between the first and third switch actuators and a group of boards

whose maximum length is less than said distance by a certain increment moving along the slot in the direction from the actuator for the first switch toward the gate at any speed from zero up to that equal to said distance increment divided by the time for said gate to close after said circuit is closed will be sorted one group from the other, each board in the shorter group moving the second actuator while said first and third actuators are free thereby to close the circuit to close the gate causing the board to be deflected out of the slot and each board in the longer group moving the first switch actuator to open circuit position to keep the circuit open when the board first moves the second switch actuator and moving the third switch actuator to open circuit position soon enough to keep the gate open after the board leaves the first switch actuator so that the board passes the gate without the gate ever closing.

2. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, said slot having an opening in one of its side walls, said opening extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open end of the slot and an open position in which it is clear of the path through the slot and its face nearest the slot, that is, its back face, extends in a line diagonally directed with respect to the slot with its end farthest away from said end of the slot opening disposed at a distance away from the slot and its end nearest said end of the slot opening disposed near the side of the slot, a normally closed switch having an actuator disposed in the bottom of the slot near the gate, a second normally closed switch having an actuator disposed in the side of the slot having said opening therein and in that portion of said side furthest from said end of the opening, the second said actuator extending diagonally at least part way across said slot in a direction similar to that of the line of said gate when in open position, said actuator being movable out of the path through said slot but being resiliently urged into the path through said slot, a third switch normally open having an actuator disposed in the bottom of the slot approximately midway between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and switches in series, whereby lumber moving along the slot in the direction from the actuator for the first switch toward the gate will be sorted according to length and lumber entering that portion of the slot adjacent the opening will be guided toward the closed side of the slot by the second said actuator and lumber leaving that portion of the slot adjacent the opening will be guided into the closed part of the slot by the back face of the guide.

3. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, a plurality of side wall openings spaced apart along the length of the slot, each of said openings extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a fixed guide lying diagonally across one end of the slot adjacent to the end of one of said openings, said guide having its end furthest from said side wall of the slot disposed furthest from the end of the slot, and guide means disposed adjacent each of the remainder of said openings in the side wall of the slot, each of said guide means comprising a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch having an actuator disposed in the slot near the gate, a second normally closed switch having an actuator disposed in the slot at a distance from the first mentioned switch actuator on the side thereof furthest from said end of the opening, a third switch normally open having an actuator disposed in the slot approximately midway between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, the distance between tthe first and second mentioned switch actuators of each of said guide means being smaller by the same certain increment than that between the like pair of actuators of the adjoining guide means on the side thereof nearest the fixed guide, i. e., the downstream side, and larger by the same certain increment than that between the like pair of actuators of the adjoining guide means on the other side thereof, i. e., the upstream side, whereby lumber made up of a plurality of groups of boards equal in number to the number of said guide means, each group of boards being approximately of one length equal to the distance between a different one of said pairs of actuators and a further group of boards approximately of one length equal to the distance between the pair of said actuators that are the shortest distance apart minus said certain increment of distance when moving along the slot in downstream direction at any speed from zero up to that equal to said increment of distance divided by the time for each of said gates to close after its circuit is closed will be sorted one group from the other, boards in each group passing through all guide means whose pairs of actuators are no further apart than the length of the boards without closing the gates thereof but being deflected out of the slot by the gate of the first guide means whose pair of actuators is spaced farther apart than the length of the boards, or in the case of the largest group by the fixed guide means.

4. A sorting machine adapted to sort a mixture of groups of boards each of which groups differs in length from the next longer board by a predetermined minimum increment, said sorting machine including a slot comprising a pair of spaced apart substantially parallel vertical walls forming the sides of the slot, said slot having as many side wall openings spaced apart along the length of the slot as there are groups of boards, said openings extending from the

slot bottom at least to the height of a board placed in the slot, motor driven means of adjustable speed in the slot bottom for conveying the boards along the slot, a sorting unit adjacent each opening comprising an actuator, a normally closed switch actuated thereby, said actuator being adjustably disposed in the slot, a second actuator, a normally closed switch actuated thereby, said second actuator being disposed in the slot upstream from the first actuator an adjustable distance, a third actuator, a normally open switch actuated thereby, said third actuator being disposed in the slot between said first and second actuators, a gate mounted for movement between a closed position in which it shunts boards out of said slot through the opening in the slot wall and a position in which it is out of the path of board travel through said slot, electric means in series with said switches for controlling the movement of said gate, the position of the first switch actuator being adjusted so that it is disposed closely adjacent said gate, the position of the second switch actuator being adjusted so that it is disposed a distance upstream from the gate equal to the minimum length of the boards of those groups which are to pass through the unit without being shunted out of the slot, the speed of said motor driven means being adjusted so that the speed of board travel along the slot is not greater than the ratio of the smallest of said increments divided by the time required for actuation of the gate from one of said positions to the other after said switches have been moved between a circuit closing position and a circuit opening position.

5. A sorting machine adapted to sort a mixture of groups of boards each of which groups differs in length from the next longer board by an equal predetermined minimum increment, said sorting machine including a slot comprising a pair of spaced apart substantially parallel vertical walls forming the sides of the slot, said slot having as many side wall openings spaced apart along the length of the slot as there are groups of boards, said openings extending from the slot bottom at least to the height of a board placed in the slot, motor driven means of adjustable speed in the slot bottom for conveying the boards along the slot, a sorting unit adjacent each opening comprising an actuator, a normally closed switch actuated thereby, said actuator being adjustably disposed in the slot, a second actuator, a normally closed switch actuated thereby, said second actuator being disposed in the slot upstream from the first actuator an adjustable distance, a third actuator, a normally open switch actuated thereby, said third actuator being disposed in the slot between said first and second actuators, a gate mounted for movement between a closed position in which it shunts boards out of said slot through the opening in the slot wall and a position in which it is out of the path of board travel through said slot, electric means in series with said switches for controlling the movement of said gate, the position of the first switch actuator being adjusted so that it is disposed closely adjacent said gate, the position of the second switch actuator being adjusted so that it is disposed a distance upstream from the gate equal to the minimum length of the boards of those groups which are to pass through the unit without being shunted out of the slot, the speed of said motor driven means being adjusted so that the speed of board travel along the slot is equal to the ratio of said predetermined minimum increment divided by the time required for actuation of the gate from one of said positions to the other after said switches have been moved between a circuit closing position and a circuit opening position.

6. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, said slot having an opening in one of its side walls, said opening extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch having an actuator disposed in the slot near the gate, a second normally closed switch having an actuator disposed in the slot at a distance from the first mentioned switch actuator on the side thereof furthest from said end of the opening, a third switch normally open having an actuator disposed in the slot between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, said electrically controlled means comprising a piston connected to the gate, a cylinder in which said piston moves, a four-way valve controlling the admission and exhaust of fluid under pressure to and from said cylinder on opposite sides of the piston, and a solenoid connected to the valve and controlled by said switches.

7. In combination, a slot having an opening in its side wall, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch having an actuator disposed in the slot near the gate, a second normally closed switch having an actuator disposed in the slot at a distance from the first mentioned switch actuator on the side thereof farthest from said end of the opening, a third switch normally open having an actuator disposed in the slot between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, each of said actuators comprising a member normally extending into said slot and means resiliently urging said member further into the slot and a stop limiting the motion of said member into the slot under the influence of said means urging the member into the slot so that said member normally presses against said stop, whereby after said member of any one of said actuators has been moved in a direction out of said slot and thereafter released said resilient means will return the member to its original position against said stop where the member will come to rest

without oscillation back and forth in and out of the slot.

8. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor to actuate each of said switches once by all lumber on the conveyor passing thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, and control means in series with said circuit to actuate said ejection means when said circuit is closed through said switches to energize said control means and to return said ejection means to its deactuated position when said circuit is opened by any one of said switches, said circuit being the sole circuit through which said control means can be energized, said two actuating means for the normally closed switch actuators being spaced apart a distance equal to the minimum length of lumber that will pass by said two actuating means without actuating said ejection means and said actuating means for the normally open switch being disposed between said two actuating means and spaced therefrom by at least the minimum difference in length between lumber that will pass by all of said actuating means without actuating said ejection means and lumber that is to be caused to leave the conveyor by said ejection means.

9. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor to actuate each of said switches once by all lumber on the conveyor passing thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, said ejection means including a gate mounted so as to be movable between a position preventing lumber from passing along the conveyor in which position the lumber is forced off the conveyor and a position in which the gate is out of the path of travel of the lumber, and control means in series with said circuit to actuate said ejection means when said circuit is closed through said switches to energize said control means and to return said ejection means to its deactuated position when said circuit is opened by any one of said switches, said circuit being the sole circuit through which said control means can be energized.

10. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor to actuat each of said switches once by all lumber on the conveyor passing thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, said ejection means including a gate mounted so as to be movable between a position preventing lumber from passing along the conveyor in which position the lumber is forced off the conveyor and a position in which the gate is out of the path of travel of the lumber, said gate being disposed adjacent the one of said switch actuating means that is furthest downstream with respect to motion of lumber along the conveyor, and control means in series with said circuit to actuate said ejection means when said circuit is closed through said switches to energize said control means and to return said ejection means to its deactuated position when said circuit is opened by any one of said switches, said circuit being the sole circuit through which said control means can be energized.

11. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyer to keep lumber on the conveyor forming the side walls of the slot, said slot having an opening in one of its side walls, said opening extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position in which its face nearest the other end of said opening, that is, its front face, lies diagonally across said slot with the end of said front face of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of said front face of the gate nearest the open end of the slot and an open position in which it is clear of the path through the slot and its face nearest the slot, that is, its back face, extends in a line diagonally directed with respect to the slot with the end of said back face of the gate farthest away from said end of the slot opening disposed at a distance away from the slot and the end of said back face of the gate nearest said end of the slot opening disposed near the side of the slot, and means for opening and closing said gate according to the length of lumber moving along the slot toward the gate so that the gate is closed to deflect shorter lumber out of the slot through said opening and so that the gate is open to pass longer lumber along the slot, the back side of the gate when in open position guiding said longer lumber into the slot as it leaves that portion of the slot adjacent said opening in the side wall thereof.

12. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, said slot having an opening in one of its side walls, said opening extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position in which it lies diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open end of the slot and an open position in which it is clear of the path through the slot, and means for opening and closing said gate according to the length of lumber moving along the slot toward the gate from the portion of the slot near the other end of said opening, said means including an actuator disposed in the side of the slot having said opening therein and in that portion of said side farthest from said end of the opening, said actuator extending diagonally at least part way across said slot in a direction transverse to that of the upstream face of the gate when in closed position, said actuator

being movable out of the path through the slot but being resiliently urged into the path through the slot whereby lumber moving along the slot in the direction from said actuator toward said gate and entering that portion of the slot adjacent the opening will be guided toward the closed part of the slot by said actuator.

13. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, a plurality of side wall openings spaced apart along the length of the slot, each of said openings extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, and guide means disposed adjacent each of said openings in the side wall of the slot, each of said guide means comprising a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch having an actuator disposed in the slot near the gate, a second normally closed switch having an actuator disposed in the slot at a distance from the first mentioned switch actuator on the side thereof furthest from said end of the opening, a third switch normally open having an actuator disposed in the slot approximately midway between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, the distance between the first and second switch actuators of each of said guide means being smaller by the same certain increment than that between the like pair of actuators of the adjoining guide means on the downstream side thereof, downstream referring to motion along said conveyor in the direction from the second said switch actuators toward the first said switch actuators, and larger by the same certain increment than that between the like pair of actuators of the adjoining guide means on the other side thereof, i. e., the upstream side.

14. A device for sorting lumber including in combination a slot comprising means to convey lumber forming the bottom of the slot and means at each side of the conveyor to keep lumber on the conveyor forming the side walls of the slot, a plurality of side wall openings spaced apart along the length of the slot, each of said openings extending from the bottom of the slot to a height at least equal to that of the lumber as placed in the slot to be separated, and guide means disposed adjacent each of said openings in the side wall of the slot, each of said guide means comprising a gate disposed adjacent one end of said opening, said gate being movably mounted for travel between a closed position lying diagonally across said slot with the end of the gate nearest the closed side of the slot being farther away from said end of the opening than the end of the gate nearest the open side of the slot and an open position in which it is clear of the path through the slot, a normally closed switch, an actuator for said normally closed switch disposed in the slot near the gate, a second normally closed switch, an actuator for said second normally closed switch disposed in the slot at a distance from the first mentioned switch actuator on the side thereof furthest from said end of the opening, a normally open switch, an actuator for said normally open switch disposed in the slot between the first and second mentioned switch actuators, electrically controlled means for opening and closing the gate, and electric conducting means connecting said electrically controlled means and said switches in series, the distances between said first and second switch actuators of each of said guide means being successively longer progressing along said slot in the direction from the second mentioned switch actuators toward the first mentioned switch actuators.

15. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor to actuate said switches whenever lumber on the conveyor passes thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, and control means in series with said circuit to actuate said ejection means when said circuit is closed through said switches to energize said control means and to return said ejection means to its deactuated position when said circuit is opened by any one of said switches, said two actuator means for the normally closed switch actuators being spaced apart a distance equal to the minimum length of lumber that will pass by said two actuating means without actuating said ejection means and said actuating means for the normally open switch being disposed between said two actuating means and spaced therefrom by at least the minimum difference in length between lumber that will pass by all of said actuating means without actuating said ejection means and lumber that is to be caused to leave the conveyor by said ejection means.

16. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor, said actuating means being disposed in a line with each other parallel to the length of said conveyor so as to actuate each of said switches once by all lumber on the conveyor passing thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, means responsive to closure of said circuit to actuate said ejection means, and means at all times responsive to opening of any one of said switches to return said ejection means to its deactuated position, said actuators for said normally closed switches being spaced apart a distance equal to the length of the shortest lumber that will pass thereby on the conveyor without closing said circuit.

17. In combination, a lumber conveyor, two normally closed switches, one normally open switch, an electric circuit connecting said switches in series, actuating means for each of said switches disposed adjacent said conveyor to actuate said switches whenever lumber on the

conveyor passes thereby, the actuating means for the normally open switch being disposed between the other two actuating means with respect to the direction of travel of a stream of lumber on said conveyor, ejection means for causing lumber to leave the conveyor, said ejection means including a gate mounted so as to be movable between a position preventing lumber from passing along the conveyor in which position the lumber is forced off the conveyor and a position in which the gate is out of the path of travel of the lumber, said gate being disposed adjacent the one of said switch actuating means that is farthest downstream with respect to motion of lumber along the conveyor, means responsive to closure of said circuit to actuate said ejection means, and

means responsive to opening of said circuit to return said ejection means to its deactuated position.

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