United States Patent

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[33] **Sweden**
[31] **No. a836/66**

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[54] **PHOTOELECTRIC CLASSIFIER USING MOVEABLE CURTAIN OF RADIATION**
16 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **250/236,** 250/219, 250/224
[51] **Int. Cl.** **G01b 11/02**
[50] **Field of Search** 250/219S, 222, 219Lth, 219W, 219th, 224, 235, 236

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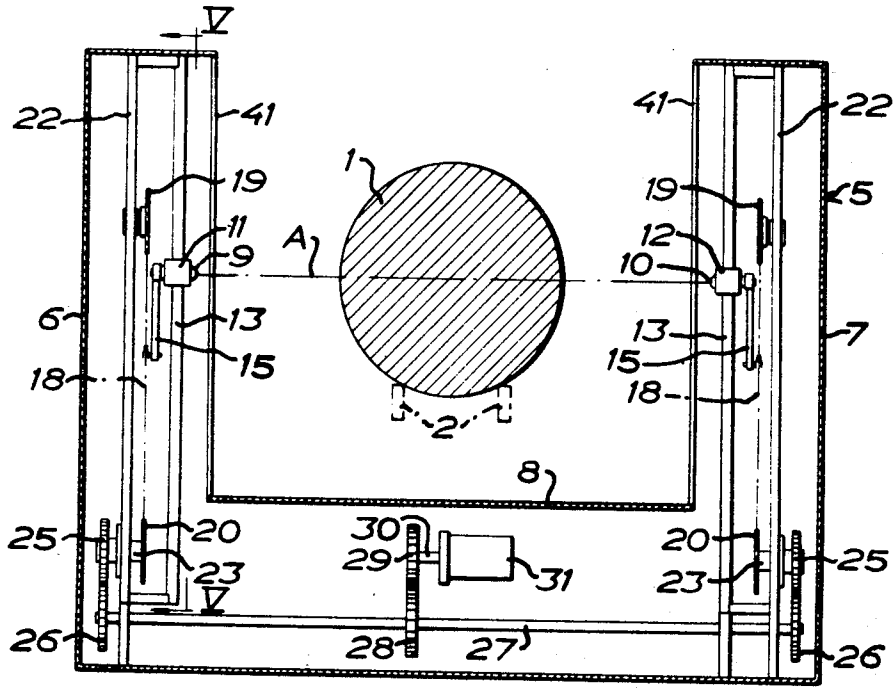
ABSTRACT: A method of and apparatus for automatically controlling, by continuous classification of articles, the working and other treatment of said articles which are conveyed by a conveyor and moved through a curtain of radiation between a source of radiation and a radiation receiver for continuous adjustment of the working machine. The source of radiation and the radiation receiver and thus the curtain of radiation are caused to perform a parallel movement, whereby the curtain of radiation is repeatedly moved towards, across and away from the article to be classified in each particular classification case.



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SHEET 1 OF 6

FIG.1

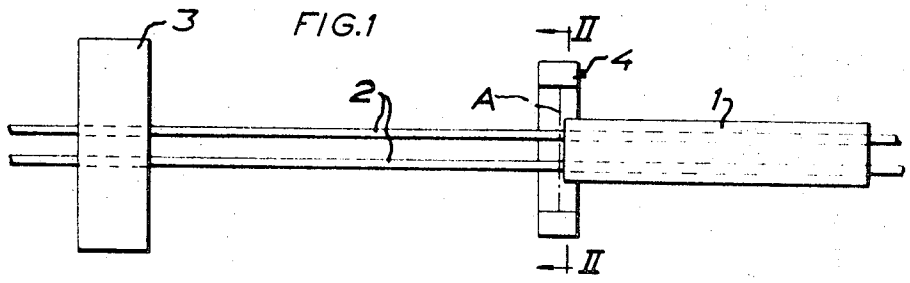
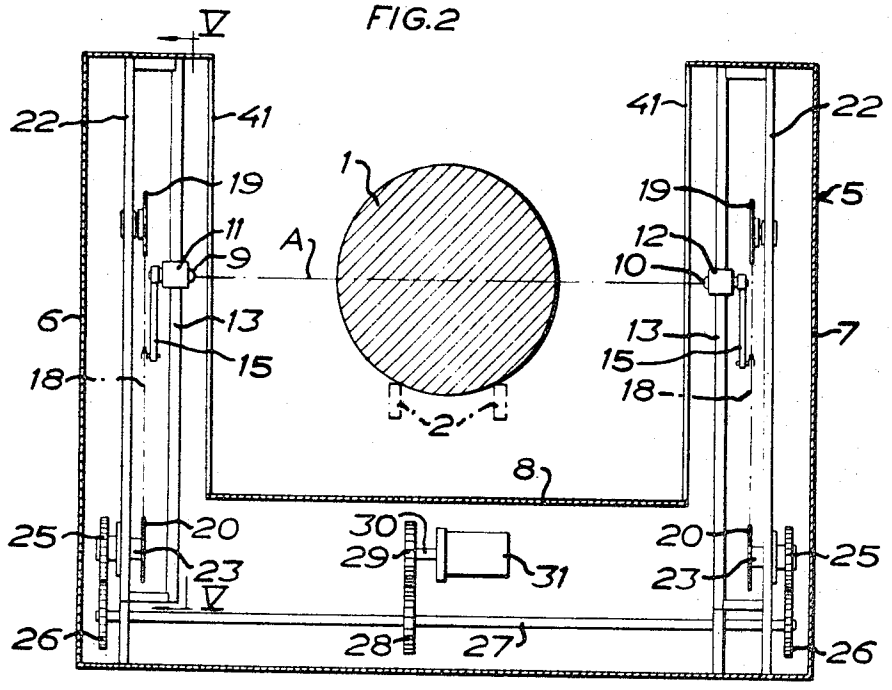


FIG.2



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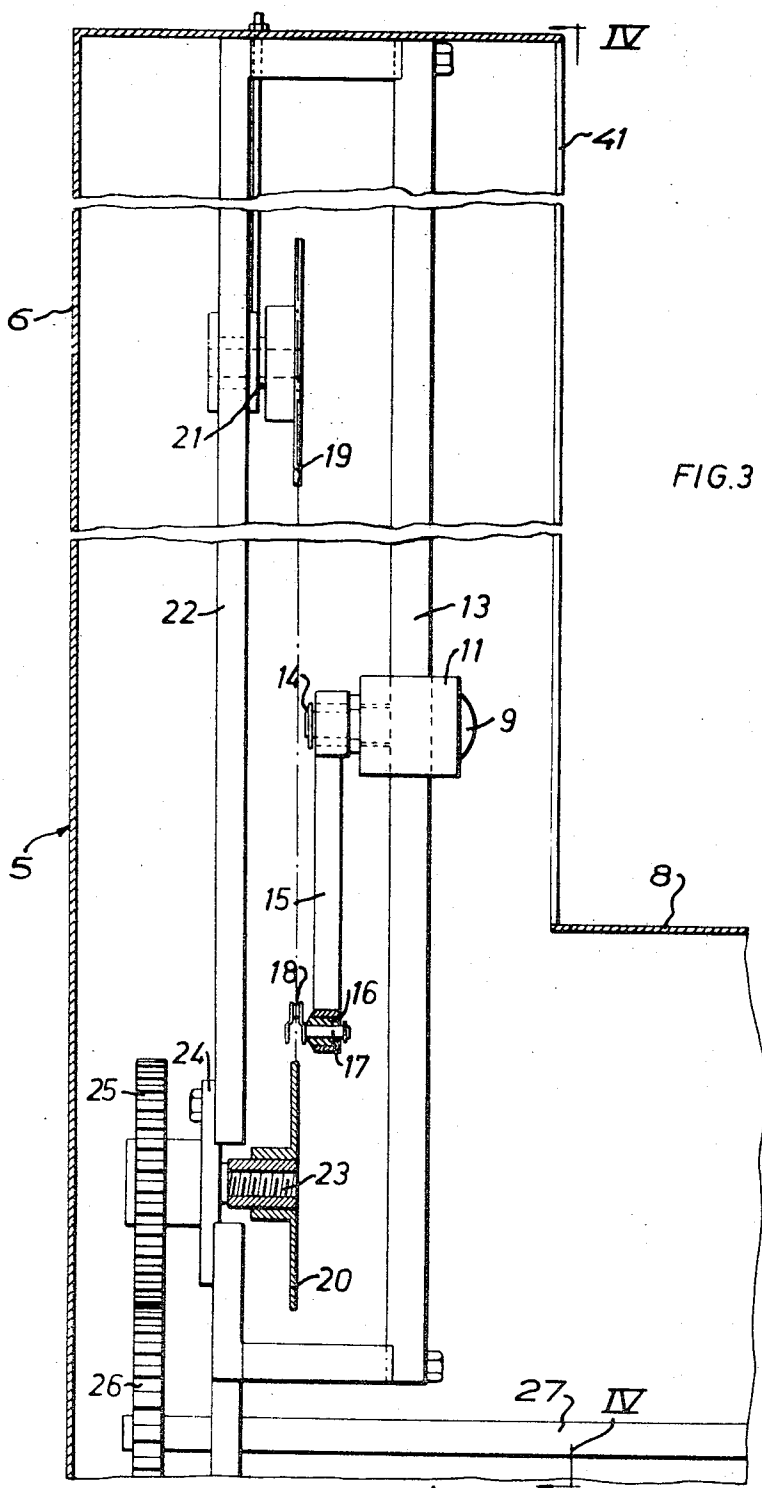

FIG.3

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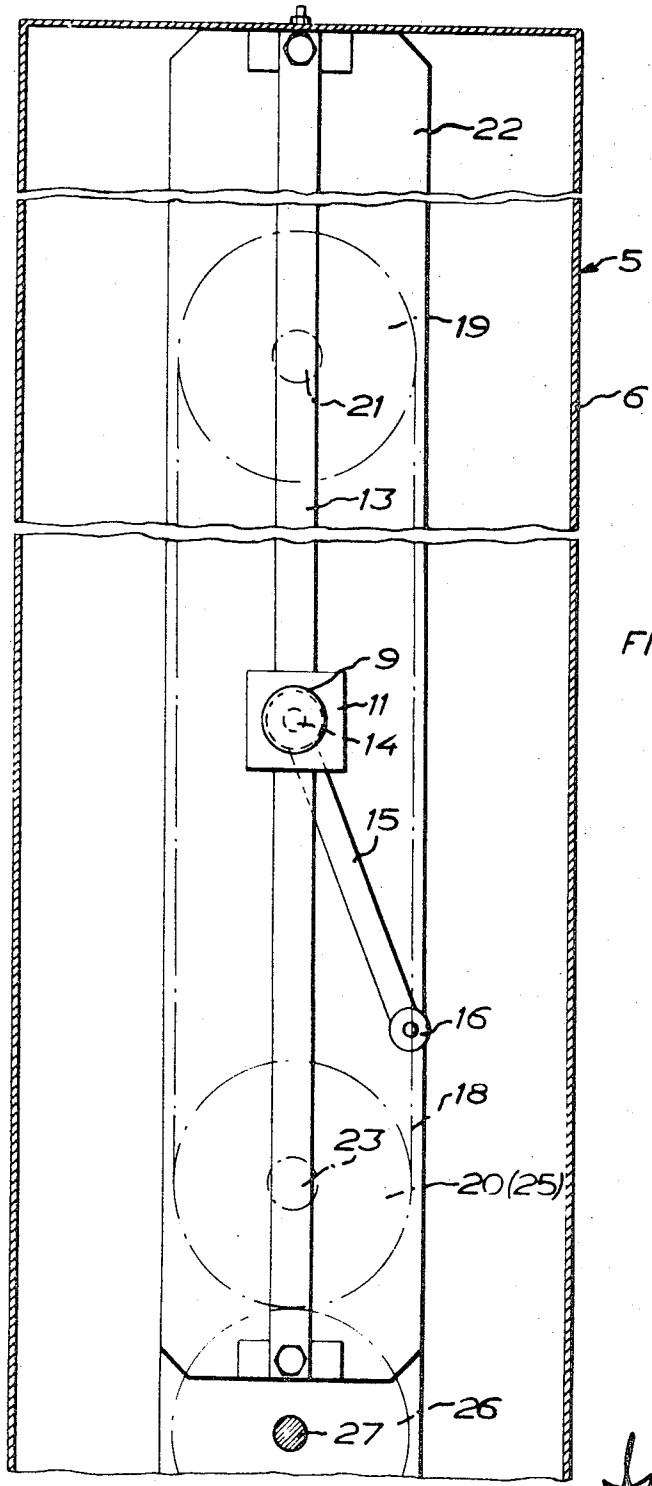

FIG. 4

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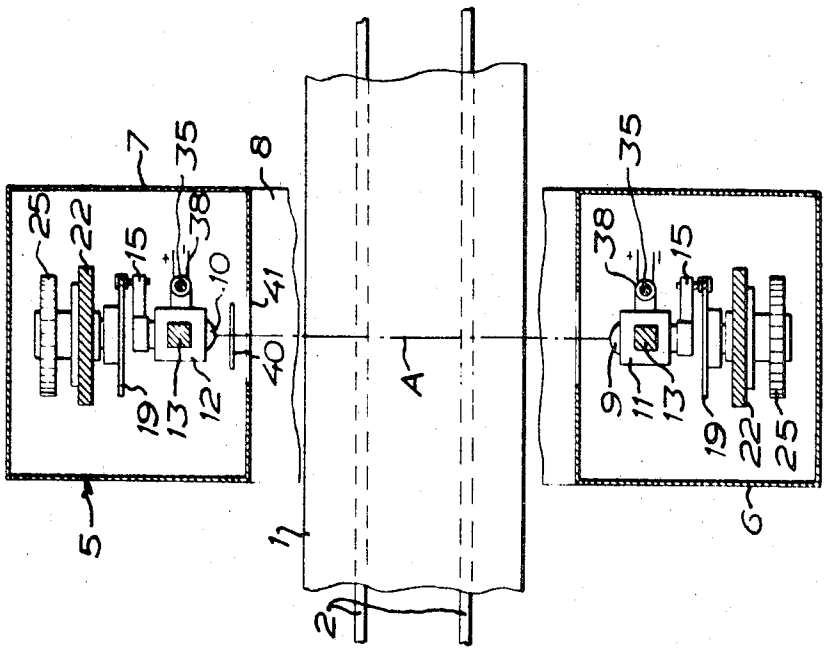
FIG.6



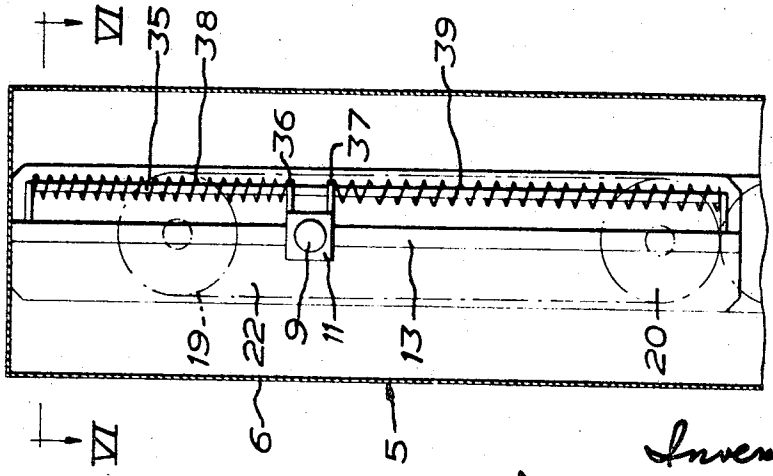


FIG.5

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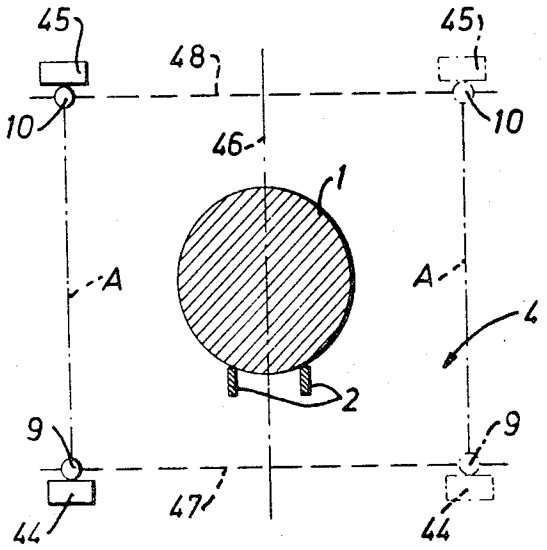

FIG. 7

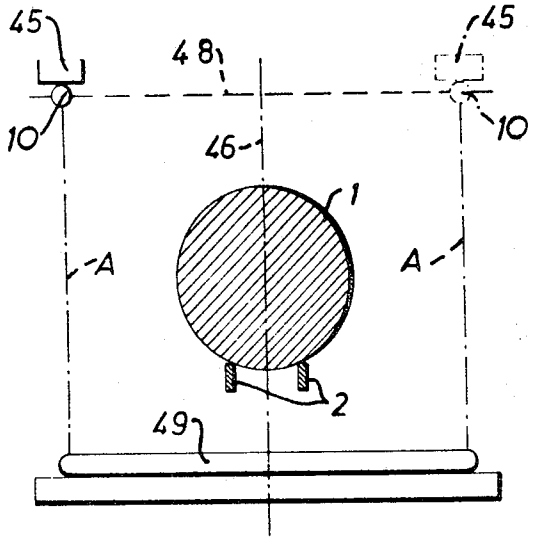

FIG. 8

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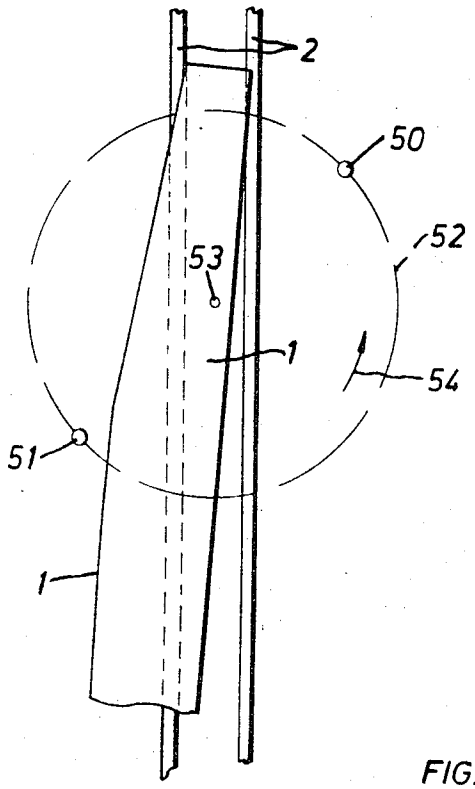
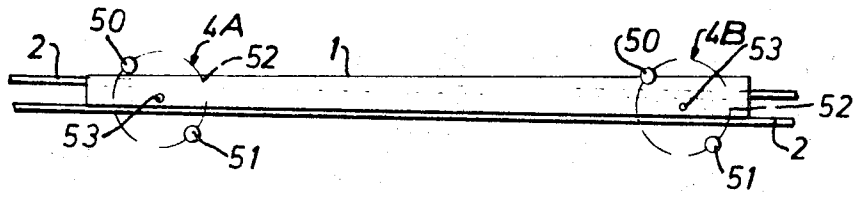


FIG. 9

FIG. 10



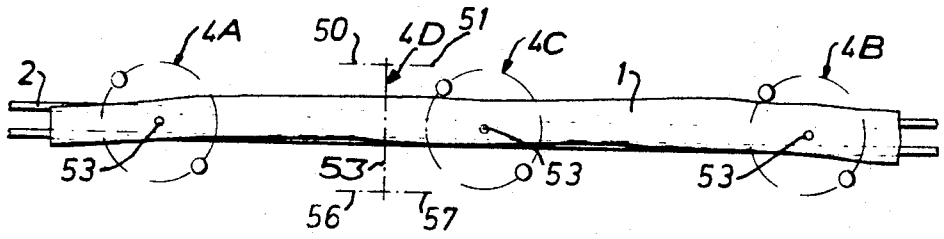


FIG. 11

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PHOTOELECTRIC CLASSIFIER USING MOVEABLE CURTAIN OF RADIATION

This invention relates to a method of and apparatus for the classification of articles, such as log sections, which are continuously or intermittently conveyed by a conveyor to a station for automatic working or other arbitrary treatment thereof, such as sawing the log sections into boards, at the execution of which dimensional differences, such as differences in thickness and width, and/or the orientation of the articles on the conveyor, or the shape of the articles are of importance. In the inventive method and apparatus, use is made of pulses which are generated in that the articles during their conveyance along the conveyor are moved through a curtain of radiation extending between a source of radiation and radiation receivers and having its main plane positioned at right angles to the direction of motion of the conveyor, said articles thus moving within a region the boundaries of which are determined by the source of radiation and the radiation receiver, whereby the articles repeatedly interrupt and reestablish a larger or smaller portion of said curtain of radiation.

For working among other things sawn timber in a plant of automatic or broadly automatic operation it is imperative that the log sections be automatically classified, for instance by measuring the width of the logs, and that the result of the measuring in the form of pulses be transmitted to working machines for their adjustment and adaption to the logs to be worked. In such plants the logs are conveyed in their longitudinal direction by means of a conveyor to the working station and are classified in a classifying station ahead of said working station. This classification has been effected hitherto by moving the logs on the conveyor between a stationary source of radiation and a number of likewise stationary radiation receivers. Moving past the source of radiation and the radiation receivers and through the curtain of radiation between said source and said receiver, which curtain has its main plane positioned at right angles to the direction of motion of the conveyor, the logs will shield—for instance by reason of their diameter—a larger or smaller portion of the curtain of radiation which widens in fan shaped from the source of radiation and the radiation receivers, said shielding effect and the pulses thereby generated in the radiation receivers being exploited in a suitable manner for adjustment of the working machine in the working station. When moving through the curtain of radiation the logs will throw a shadow which diverges towards the radiation receivers and which, when the log is of irregular shape, may give a misleading picture in the radiation receivers and incorrect adjustment of the working machine. One has tried to eliminate this inconvenience by arranging the radiation receivers along a curved line having its center in the source of radiation, or a mirror by which the radiation from the source of radiation is transmitted to the radiation receivers. This solution, however, has not either proved satisfactory.

In accordance with the invention, the curtain of radiation is caused to perform a parallel movement and as a consequence is repeatedly moved towards, across and away from the log to be classified in a plane perpendicular to the direction of travel of the log in each particularly case. By reason of the repeated parallel movement of the curtain of a radiation in the transverse direction thereof and during movement of the log in the longitudinal direction, there is obtained an exact picture of the log, which can be exploited for very exact adjustment of the working machine and/or the log for the working thereof.

These and further features of the invention will become apparent from the following specification in which reference is made to the accompanying drawings, in which:

FIG. 1 is a horizontal detail view of a conveyor arranged with the apparatus according to the invention;

FIG. 2 is a vertical section on line II–II in FIG. 1 of an embodiment of the invention;

FIG. 3 is a view of part of FIG. 2 on a larger scale;

FIG. 4 is a section on line IV–IV in FIG. 3;

FIG. 5 is a section on line V–V in FIG. 2;

FIG. 6 is a section on line VI–VI in FIG. 5;

FIG. 7 is a diagrammatic view of another embodiment of the invention;

FIG. 8 is a diagrammatic view of a modification of the invention;

FIG. 9 is a view of still another embodiment of the invention;

FIG. 10 is a diagrammatic plan view of an apparatus according to the invention utilized for checking the position of the log on the conveyor; and

FIG. 11 is a diagrammatic plan view of the apparatus according to the invention for the orientation of a bent log on the conveyor.

In a plant for working log sections 1 (FIG. 1) a log 1 is conveyed in its longitudinal direction on a conveyor 2 to a station 3 for working the log, for instance sawing it into boards. Prior to introduction of the log 1 into the station 3, it moves through a classifying station 4 and through a curtain of radiation generated in said station and indicated by a dash-and-dot line A. At the passage of the log, said curtain produces pulses that are utilized for controlling and adjusting a working machine (not shown) in station 3 and/or checking the position of the log 1 on the conveyor 2. As shown in FIG. 2 and in detail drawings of FIGS. 3—6 classifying station 4 includes a U-shaped stand 5, and the conveyor 2 is passed through the vertical uprights 6 and 7 thereof. The part 8 of the stand 5 interconnecting the uprights 6 and 7 is arranged horizontally beneath the conveyor 2. A source of radiation 9, for instance in the form of a light source, is disposed in the upright 6 while a radiation receiver 10, for instance in the form of a photo cell or diode, is disposed in the upright 7 of the stand 5. The source of radiation 9 and the radiation receiver 10 are mounted in a carriage 11 and 12, respectively, which is vertically movably mounted on a bar 13 extending longitudinally of the respective uprights 6 and 7 of the stand 5. As shown in enlarged drawings of FIGS. 3—4 respective carriage 11, 12 has a pin 14 for one end of an arm 15, the other end of which is provided with a bearing 16 for a pin 17 which projects laterally from a chain 18 which is passed over two upper and lower sprocket wheels 19 and 20, respectively, disposed opposite the bar 13. The upper sprocket wheel 19 is freely rotatable on a shoulder 21 which is mounted in the upper portion of a frame 22 which also forms a fastening for the bar 13 in the respective uprights 6 and 7 of the stand. Referring again to FIG. 2 lower sprocket wheel 20 is secured to a shaft 23 which is mounted in the frame 22 and at its end opposite the sprocket wheel carries a gear 25 meshing with another gear 26 secured to the end of a shaft 27 which extends from one upright 6 through the part 8 of the stand 5 to the other upright 7 and which thus on both its ends carries a gear 26. The shaft 27 is provided approximately at its middle with a gear 28 which meshes with a gear 29 on a shaft 30 of an electric motor 31. The source of radiation 9 is connected in a manner not shown to a suitable source of current, and the radiation receiver 10 is connected, in a manner that will appear from the following, to the station 3 for controlling the working machine (not shown) in said station.

When the described classifying apparatus is in operation, the motor 31 rotates the shaft 30 and thereby the gears 29 and 28 and the shafts 27. The gears 26 on the shaft 27 are thereby rotated, and via gears 25, the shafts 28, chains 18, arms 14 and carriages 11 and 12 the source of radiation 9 and the radiation receiver 10 are moved up and down on the bars 13. The ratio of the transmission between the motor 31 and the two carriages 11 and 12 being the same, the source of radiation 9 and the radiation receiver 10 will move up and down in opposite and synchronic relationship. The curtain of radiation A extending between the source of radiation and the radiation receiver 10, which is indicated by dash-and-dot lines, will perform a reciprocatory parallel motion. This parallel motion is repeated a relatively large number of times during the conveyance of the log 1 past the classifying station 4 within that region thereof whose boundaries are determined by the source of radiation 9 and the radiation receiver 10. The log 1 will interrupt and reestablish a larger or smaller portion of the cur-

tain A during the repeated reciprocatory parallel motion thereof and parallel with the boundaries of said region, said curtain moving repeatedly towards, across and away from the log in opposite directions from both above and below the log.

The embodiment of the invention illustrated in FIGS. 5 and 6 largely corresponds to the embodiment described in the foregoing, except that the latter embodiment has a guide 35 of electrically nonconductive material which extends beside and parallel with the bar 13. Two arms 36 and 37 of electrically conductive material extend from the respective carriage 11 and 12 and bear against the one ends of two coil springs 38 and 39 which have their other ends connected to the negative and positive pole, respectively, in an optional source of current and working station, respectively. This embodiment also comprises a screen 40 in the upright 7 inside a slot 41 in the side face of the upright 7 facing the conveyor 2 said screen extending at least throughout the path of motion of the radiation receiver 10. Owing to said screen 40 the curtain of radiation A will be interrupted and reestablished during its reciprocatory motion at definite intervals determined by the mesh size of the screen 40, and as a consequence a definite number of times during the forward motion and the return motion, respectively. Going past the log 1 which is moving through the station 4, the curtain of radiation A will be shielded, and a given number of intervals or radiation sections will be interrupted. The pulse intervals are stored in counters so that the pulses from the upward movement of the curtain of radiation A are entered into a counter, while the pulses from the downward movement of the curtain of radiation are entered into another counter. These counters are connected to a digital comparator which picks out the smallest number of pulses, zeroizes the counters, and puts the smallest value into a memory unit for the adjustment of the working machine, whereupon a new counting operation is ready to start when the carriages 11 and 12 then again move up and down.

In the modification of the invention diagrammatically illustrated in FIG. 7, the source of radiation 9 is disposed in the diagrammatically shown supporting device 44, and the radiation receiver 10 is disposed in a diagrammatically shown supporting device 45. These supporting devices 44 and 45 are spaced the same radial distance from a rotary shaft 46 on which said devices are rotated at the same speed with the aid of means (not shown). As a result, the source of radiation 9 and the radiation receiver 10 will move in synchronism in paths 47 and 48 shown by dotted lines and lying in parallel horizontal planes, and the radiation curtain A will effect a translatory movement in a closed path, thereby moving towards, across and away from the log 1 which is conveyed on the conveyor 2 between the paths of movement 47 and 48 described by the source of radiation 9 and the radiation receiver 10, and thus within the boundaries determined by said source of radiation 9 and said radiation receiver 10.

In the embodiment shown in FIG. 8, the source of radiation 9 is in the form of a stationary fluorescent tube 49 constituting a closed ring and conforming in shape and extension to the path 48 described by the radiation receiver 10. Also in this case, the effective radiation curtain A between the source of radiation 9 and the radiation receiver 10 will effect a parallel movement which moves the curtain towards, across and away from the log 1.

In the embodiment illustrated in FIG. 9, the apparatus comprises two diametrically arranged radiation receivers 50 and 51 and corresponding sources of radiation (not shown). The radiation receivers 50 and 51 are caused to rotate in synchronism about an axis or center 53 in the path 52 indicated by a dash line. If, as shown in the drawings, the log 1 takes an oblique position on the conveyor 2 and in such position cannot be worked in the contemplated manner, and the radiation receivers 50 and 51 rotate in the direction of the arrow 54, this arrangement will result in that the radiation receiver 51 will be earlier shielded than the radiation receiver 50, which can be exploited for the manipulation of devices that adjust the position of the log 1 so that the longitudinal direction of the log coincides with that of the conveyor 2 and so that the longitudinal median plane of the log 1 coincides with the vertical median plane of the conveyor 2. This embodiment of the invention can also be used in such a way that not entirely straight logs are subjected to suitable treatment.

In the apparatus illustrated in FIG. 10 and based upon the apparatus according to FIG. 9, use is made of two classifying stations 4A and 4B located along a straight portion of the conveyor 2 and spaced apart a suitable distance determined by the length of logs which are conveyed past the stations 4A and 4B. Each of these stations includes, on one hand, the two radiation receivers 50 and 51 disposed on one side of the conveyor 2 in opposite relation and rotatable in the path 52 (see also FIG. 9) on the shaft 53, and, on the other hand, sources of radiation (not shown) which are disposed on the opposite side of the conveyor 2 and conformed to a common path 52 of the radiation receivers 50 and 51 in the respective stations. The movements of the radiation receivers 50 and 51 in the stations 4A and 4B are synchronous or asynchronous so that they rotate at the same or different speeds on shafts 53. If, as shown in FIG. 10, the log 1 is laterally offset in relation to the main plane of the conveyor 2 which coincides with the axis 53, the shielding of the radiation receivers 50 and 51 will not coincide by reason of the log 1 being offset, which can be exploited for reorientation of the log 1 on the conveyor 2.

The apparatus illustrated in FIG. 11 comprises two further stations 4C and 4D in addition to station 4A and 4B, all such stations being mutually spaced apart along the conveyor 2. As will appear from FIG. 11, the station 4D is turned through 90° with respect to the other stations 4A—4C, and the radiation receivers 50 and 51 and the sources of radiation 56 and 57 in said station 4D are adapted to rotate in paths, the main planes of which extend in parallel with the vertical main plane of the conveyor 2, i.e. the plane of said conveyor that coincides with the shafts 53 of the stations 4A—4C. This arrangement permits a bent log 1 to be automatically oriented in such a way that the bend of the log is turned upwards, a position which is desirable at the first frame saw or band saw of a frame saw mill and band saw mill, respectively, for sawing the log into boards. In the apparatus according to FIG. 11, the log 1 is centered on the conveyor 2 by means of stations 4A and 4B and is turned on the conveyor 2 by means of stations 4C and 4D. Other combinations of stations are also possible.

The source of radiation and/or the radiation receiver 10 can be closed to move continuously at an optional speed on its path. However, the movement may also be intermittent and take place in step with the movement of the logs past the classification site.

Classification articles other than logs are conceivable.

Modifications are possible within the scope of the appended claims.

I claim:

1. A method for continuous classification of articles which are to be conveyed by a conveyor to a station for automatic working or other arbitrary treatment thereof, for the execution of which dimensional differences are of importance, in which method use is made of pulses which are generated in that the articles during their conveyance along the conveyor are moved through a curtain of radiation extending between a source of radiation and radiation receivers, and the articles thus move within a region, the boundaries of which are determined by the source and the radiation receiver, comprising causing the curtain of radiation to perform a parallel movement in which it is repeatedly moved towards, across and away from the article to be classified in each particular classification case, said articles thereby interrupting and reestablishing a larger or smaller portion of said curtain of radiation.

2. A method as set forth in claim 1, comprising causing the curtain of radiation to perform said parallel movement in a closed path within the boundaries of said region.

3. An apparatus for carrying out the method set forth in claim 1, comprising a source of radiation and a radiation receiver which are disposed on either side of a conveyor for

elongated articles, such as timber to be sawn, for the conveyance of the articles in their longitudinal direction to a position for continuous automatic working thereof, and mounted in supporting devices, wherein the supporting device at least of the radiation receiver is connected to a drive and transmission assembly which is adapted to cause the supporting device and thereby the radiation receiver to perform a parallel movement, the path of which extends outside the article to be classified on two opposite sides thereof in planes at right angles to the longitudinal direction of the articles, and where the radiation source is in a path conforming to that of the radiation receiver.

4. An apparatus as set forth in claim 3, wherein the supporting devices of the radiation receiver and the source of radiation are connected to the drive and transmission assembly.

5. An apparatus as set forth in claim 4, wherein each respective supporting device is movable along a guide and is hingedly connected by means of an arm hinged to the supporting device to an endless chain which is passed over sprocket wheels that are connected by gears to a drive shaft common to the two supporting devices and connected to an electric motor.

6. An apparatus as set forth in claim 5, wherein the gears, the chain transmissions and the gear transmissions are mounted in the uprights of a U-shaped stand, and the motor and the drive shaft are disposed in the member of the stand interconnecting the stand uprights, the conveyor extending within the uprights of the stand.

7. An apparatus as set forth in claim 3, wherein the respective supporting device includes two arms of electrically conductive material which engage in a guide of electrically nonconductive material extending in parallel with the guide for the respective supporting device, and said guide of electrically nonconductive material being surrounded by coil springs disposed between the respective arm and the adjacent end of the guide of electrically nonconductive material in order to serve as conductors.

8. An apparatus as set forth in claim 3, wherein the supporting device of the radiation receiver and as a consequence the radiation receiver proper is adapted to be rotated on a shaft coinciding with a rotating shaft for the supporting device of the source of radiation, and in a path corresponding to that of the last mentioned supporting device.

9. An apparatus as set forth in claim 3, wherein the supporting device of the source of radiation and as a consequence the source of radiation proper is stationary and has a shape substantially conforming to the path described by the supporting device of the radiation receiver and thus by the radiation receiver proper.

10. An apparatus as set forth in claim 3 having two or more classifying stations spaced mutually apart along a straight section of the conveyor, each of said stations including on one hand two radiation receivers disposed on one side of the conveyor in opposite location and rotatable in a path on a shaft, and on the other hand sources of radiation disposed on the opposite side of the conveyor and conforming to the common path of the radiation receivers.

11. An apparatus as set forth in claim 10, wherein at least one station is turned through 90° in relation to the other stations, the radiation receivers and the source of radiation in said station being adapted to be placed in rotation in paths, the main planes of which extend in parallel with the main plane of said section of the conveyor but are angularly offset through 90° with respect to the paths of the radiation receivers and sources of radiation in the other stations.

12. A method for continuous classification of articles moving on a conveyor as to their dimensional differences in thickness and/or width, and/or the orientation of the articles on said conveyor comprising the steps of:

conveying the article to be classified past the station at which classification is performed between at least one set of radiation source and radiation receiver; and

repeatedly displacing said radiation receiver of said at least one set from a position to receive radiation from said source uninterrupted by said article to a position having the radiation interrupted by said article, and then to a position on the opposite side of said article with the radiation from said source uninterrupted by said article.

13. The method of claim 12 further characterized by moving said radiation receiver in a closed path and moving a second radiation receiver in the same closed path simultaneously with said first radiation receiver.

14. Apparatus for continuous classification of elongated articles as to their dimensional differences and/or orientation of the articles comprising:

conveying means to move the article along a longitudinal path in relation to the article;

a source of radiation and a radiation receiver disposed on opposite sides of said conveying means and mounted on supporting means; and

driving means connected to at least the portion of said supporting means supporting said radiation receiver to displace said radiation receiver in a reciprocating movement relative to the article from a position uninterrupted by the article in a path between said radiation source and said radiation receiver to a position interrupted by the article in a path between said radiation source and said radiation receiver and then to a position on the opposite side of the article uninterrupted by the article in a path between said radiation source and said radiation receiver.

15. The apparatus of claim 14 wherein said driving means is also connected to said supporting means supporting said radiation source and drives both said radiation source and said radiation receiver in parallel paths.

16. A method for continuous classification of articles which are to be conveyed by a conveyor to a station for automatic working or other arbitrary treatment thereof, for the execution of which dimensional differences are of importance, in which method use is made of pulses which are generated in that the articles during their conveyance along the conveyor are moved through two curtains of radiation extending between sources of radiation and two radiation receivers, and the articles thus move within a region, the boundaries of which are determined by the said sources and the said receivers, comprising causing two curtains of radiation to perform a movement in one and the same closed path in which they are repeatedly moved towards, across and away from the article to be classified in each particular classification case.