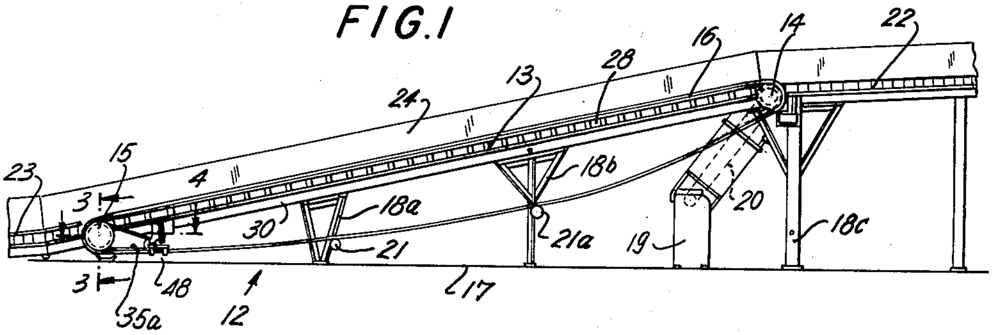
Jan. 5, 1965 R. L. HALL 3,164,247

APPARATUS FOR GUIDING WIDE BELTS

Filed Nov. 14, 1961

4 Sheets-Sheet 1

FIG. 1



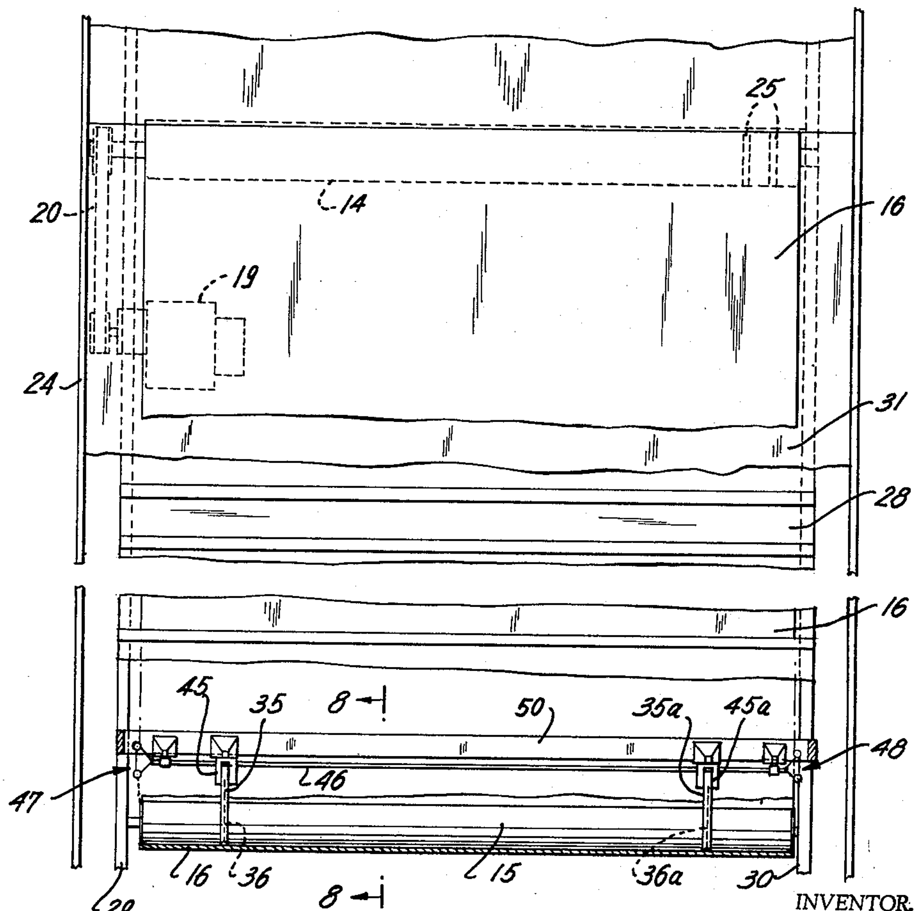


FIG. 2

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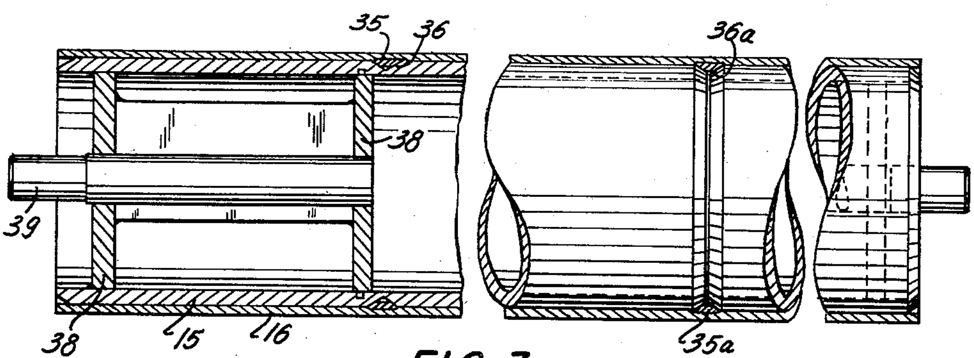


FIG. 3

FIG. 4

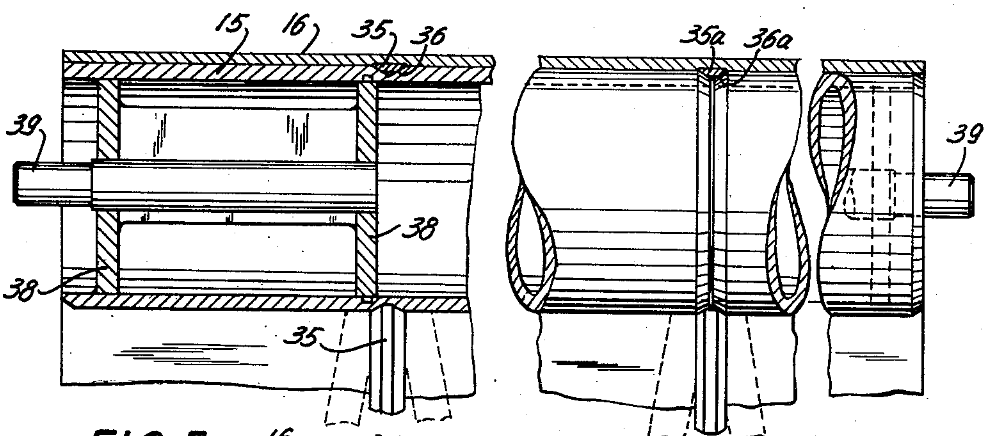
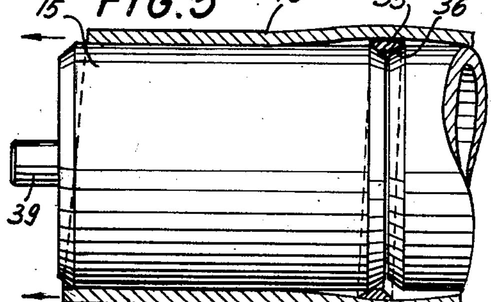


FIG. 5



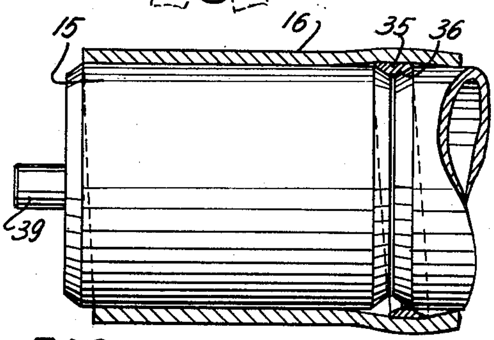


FIG. 6

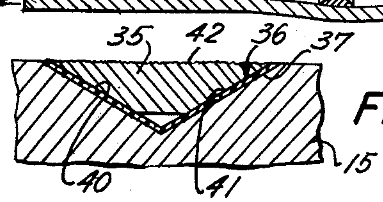


FIG. 7

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APPARATUS FOR GUIDING WIDE BELTS

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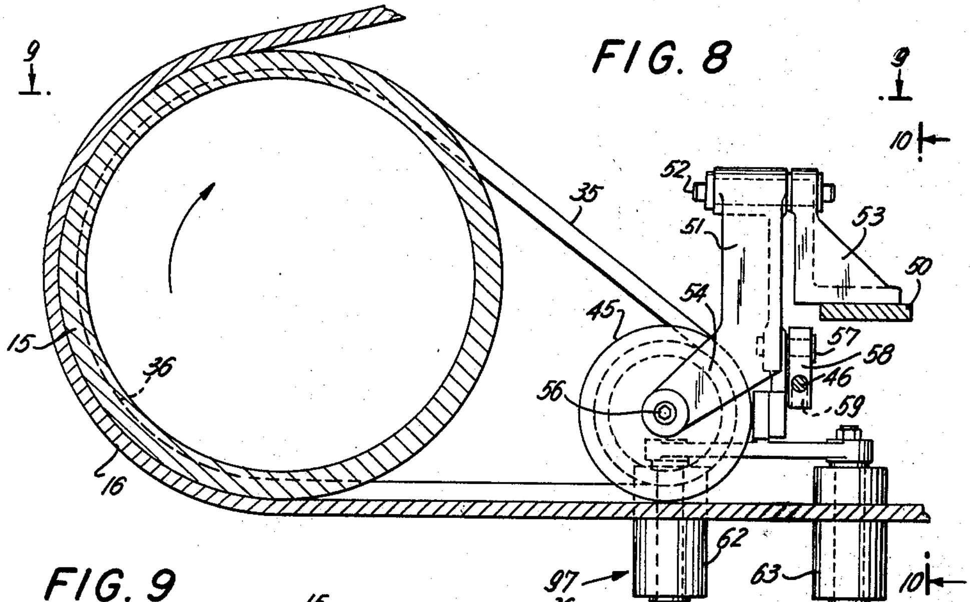

FIG. 8

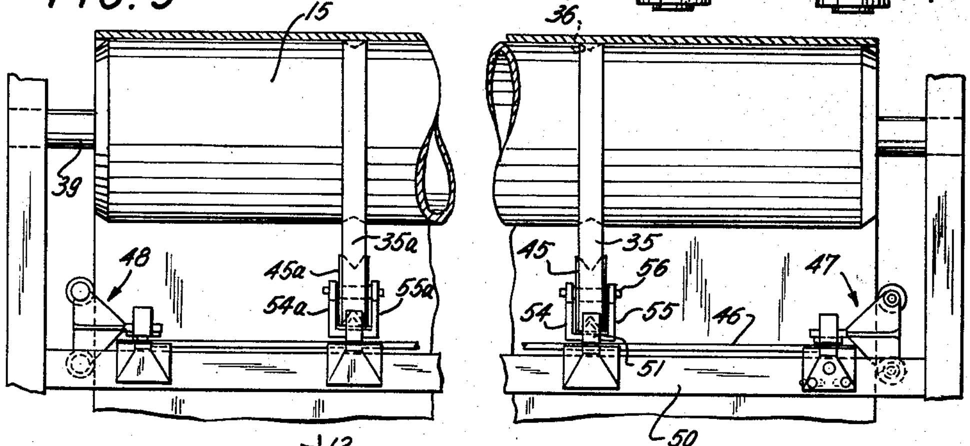

FIG. 9

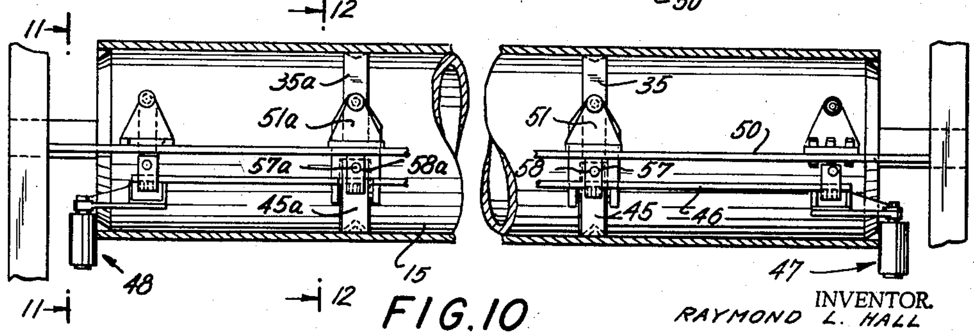

FIG. 10

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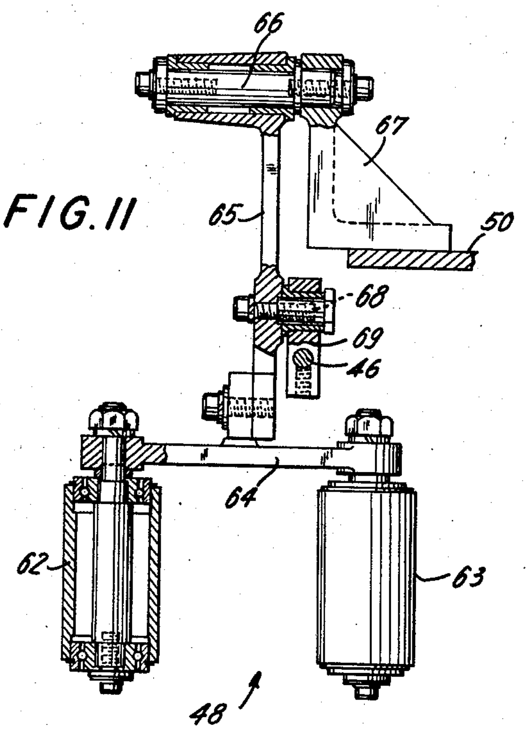

FIG. 11

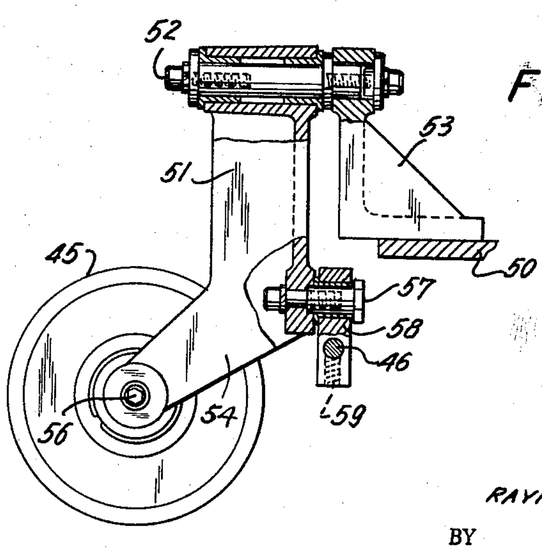

FIG. 12

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United States Patent Office

3,164,247

Patented Jan. 5, 1965

3,164,247

APPARATUS FOR GUIDING WIDE BELTS

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Filed Nov. 14, 1961, Ser. No. 152,303

9 Claims. (Cl. 198—202)

The present invention relates to a method of and apparatus for controlling a continuous moving web and more particularly to an improved apparatus for maintaining a wide belt in a substantially straight path.

While the present invention may have other uses it is particularly adapted for and is shown applied to an apparatus for simulating a natural ski slope. The artificial ski slope comprises an inclined deck and a continuous belt of a material having a low coefficient of friction, such as a nylon pile fabric, which moves up the deck at a substantial rate of speed. The belt is mounted on rollers at the top and bottom of the slope and thus forms a continuous web. The belt has a considerable width of, for example, sixteen feet and a length of, for example, thirty feet. The total weight of such belt is approximately fifteen hundred pounds and moves at speeds which may vary between five and twenty miles an hour at the option of the skier. Such an artificial ski slope gives the person skiing on the belt a sensation of moving down the slope which simulates actual skiing on a natural ski slope. A person using the ski slope may perform conventional maneuvers, such as "plowing" to reduce speeds, "Christiana turns," jump turns, and the like, and such maneuvers are apt to produce a resultant force on the belt tending to move it laterally in one or the other of two directions. In addition, the belt may have an inherent characteristic tending to cause it to drift laterally in either direction.

Conventional methods of belt control, such as crowned pulleys, tilting rollers and the like, were found to be unsatisfactory in controlling a belt of such width and weight. Automatically operated jacks for tilting a supporting roller were found to require continuous adjustment, tended to overcompensate, required considerable horsepower because of the weight involved and did not operate satisfactorily to maintain the belt in a substantially straight path.

One of the objects of the present invention is to provide an improved method of and apparatus for controlling the path of movement of a continuous web which utilizes the energy in the moving web itself to provide the force required to change its direction.

Another object is to provide a method of and apparatus for maintaining a moving belt in a substantially straight path by directing an auxiliary control belt between it and a groove in a supporting roller and in a direction opposite the direction that the wide belt tends to move.

Another object is to provide a method of and apparatus for controlling the moving belt of an artificial ski slope by directing an auxiliary control belt at an angle to the moving belt so that it will be cammed laterally as it moves into a slot in a supporting roller and bodily shift the moving belt laterally by its frictional engagement therewith.

Still another object is to provide a belt aligning apparatus of the type indicated which is of simple and compact construction, economical to manufacture and one which is reliable in performing its intended function.

These and other objects will become more apparent from the following description and drawings in which like reference characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings:

FIGURE 1 is a side elevational view of an artificial ski slope incorporating the novel web controlling device of the present invention;

FIGURE 2 is a plan view of the simulated ski slope, partly in section, and showing a plurality of auxiliary control belts operating between the main belt and V-grooves in a supporting roller to maintain the main belt in a substantially straight path;

FIGURE 3 is an enlarged sectional view of the lower roller in side elevation and showing the auxiliary control belts seated in the grooves between the main belt and its supporting roller when the main belt is tracking properly;

FIGURE 4 is a sectional plan of the lower roller and showing the three different directions that the auxiliary control belts may feed toward the V-grooves in the supporting roller;

FIGURE 5 is a sectional view of a portion of the left hand end of the supporting roller and showing one V-groove and the manner in which the upper course of the main belt is shifted toward the right when the auxiliary control belt feeds from the left toward the right;

FIGURE 6 is a view similar to FIGURE 5 showing the manner in which the upper course of the main belt is shifted toward the left when the auxiliary control belt feeds from the right toward the left;

FIGURE 7 is an enlarged sectional view through one of the grooves to show the smooth lining of an anti-friction material on the inclined sides of the groove;

FIGURE 8 is a transverse sectional view taken on line 8—8 of FIGURE 2 to show an auxiliary control belt between the main belt to be controlled and supporting roller and the guide pulley mounted for lateral movement.

FIGURE 9 is a sectional plan view of the lower supporting roller as viewed in FIGURE 8;

FIGURE 10 is a longitudinal sectional view as viewed from the right hand side of FIGURE 8 to show the plurality of pivotally mounted depending arms for the guide pulleys and feelers;

FIGURE 11 is a section taken on line 11—11 of FIGURE 10 to show the bracket for mounting the depending pivoted arm carrying the feelers at one end of the sliding control bar; and

FIGURE 12 is a partial sectional view taken on line 12—12 of FIGURE 10 to show the bracket for pivotally mounting one of the depending arms mounting a guide pulley.

The method of the present invention comprises the steps of sensing any change in the direction of movement of a web to be controlled, such as the wide belt of an artificial ski slope, and utilizing such change in direction to change the position of a belt guide for guiding one or more narrow control belts between the belt to be controlled and a V-shaped groove in a web supporting roller and at an angle to the direction of movement of the main belt. For example, if the belt tends to move toward the right, the narrow control belt is guided at an angle to the direction of movement of the main belt from the right toward the left; if the belt tends to move toward the left, the narrow belt is guided at an angle to the main belt from the left toward the right; and if the belt is tracking properly the control belt is guided in a direction parallel to the main belt. The angular movement of the auxiliary control belt is then utilized to bodily shift the main belt to a corrective position and the rate of shifting is controlled by the degree of the angle of the auxiliary belt.

The V-shaped grooves in the supporting roller have smooth inclined sides to present a minimum frictional resistance. To this end, the sides of the grooves may be coated with material having a low coefficient of friction, such as Teflon, but the outer periphery of the control belt has a surface with a high coefficient of friction for contacting the belt to be controlled. Thus, by guiding each auxiliary control belt at an angle to the path of movement of the belt to be controlled, the frictional contact of the periphery of the auxiliary control belt with the belt to be controlled produces a lateral force on the latter as the sides of the control belt are forced downwardly into the V-shaped groove on the roller and laterally by the inclined side thereof. Stated another way, the belt to be controlled forces the control belt to seat in the V-shaped groove as it wraps around the roller and to be cammed laterally by the inclined side of the groove, but the frictional contact of the periphery of the control belt with the belt to be controlled causes the latter to move laterally with the auxiliary belt.

It will be observed that the method of controlling in accordance with the present invention untilizes the energy in the web or belt itself to control and change its direction of movement. As a belt to be controlled moves toward and around a supporting roller it drives the auxiliary control belt with it in the same direction and the force and weight of the main belt wrapping around its supporting roller forces or jams the auxiliary control belt in to the V-shaped groove in the supporting roller. Such movement of the auxiliary control belt inwardly along the inclined side of the groove cams it laterally and the lateral movement is transmitted by the frictional engagement of its outer periphery with the belt to be controlled to, in turn, change the direction of movement of the latter. The greater the resistance of the auxiliary control belt to movement into its groove, the greater will be the frictional force between the belts and the radial force on the control belt causing it to be jammed into its groove and to bodily shift the main belt laterally. Thus, all of the force required to control the belt is supplied from the belt itself without increasing the power required to drive the belt.

Referring now to the drawings, an apparatus for carrying out the method of the present invention is shown applied to an artificial ski slope 12. As shown in FIGURES 1 and 2, the ski slope comprises an inclined deck 13 having pulley rollers 14 and 15 at the top and bottom and a continuous belt 16 supported by the rollers and movable up the surface of the inclined deck. Deck 13 is supported from a floor 17 by spaced stanchions 18, 18*a*, 18*b* and 18*c* and the upper roller 14 is driven from a combined motor and variable speed transmission 19 through a belt 20. Roller 14 drives the upper course of the belt 16 upwardly over the top of the deck 13 and the roller has friction strips 25 between it and the belt. The lower course of belt 16 underlies the deck and is supported by rollers 21 and 21*a* on the stanchions 18. Horizontal platforms 22 and 23 are provided at the upper and lower ends of the deck 13 and the ski slope has side rails 24, only one being shown in FIGURE 1, at the sides of the moving belt 16.

The deck 13 comprises channels 28 extending between beams 29 and 30 at the sides of the slope. Overlying the channel plates is a deck plate 31 and overlying the deck plate is the upper course of belt 16. The beams 29 and 30 are supported by the stanchions 18 and the latter are cross braced to provide a rigid structure. Belt 16 comprises a material having a low coefficient of friction, such as nylon pile fabric, so that it slides relative to the skis of a skier using the slope. The deck may be inclined at an angle of, for example 11° to the horizontal and may be driven at a speed of, for example nine miles per hour.

In accordance with the present invention the control means comprises at least one auxiliary control belt 35 between the main belt 16 and a groove 36 in one of the rollers 14 and 15 supporting the belt. The outer periphery of the auxiliary control belt 35 frictionally engages the belt 16 to be controlled so that it, in effect, forms a depending rib on the main belt, but without rigid attachment thereto. Control belt 35 is cammed laterally in one direction or the other by the inclined sides of the groove 36 depending upon its angular direction with respect to its path of movement of the belt to be controlled. The direction of movement of the auxiliary control belt 35, in turn, is changed in response to any lateral movement of the main belt to guide the auxiliary control belt at the desired angle to the path of movement of the main belt 16. Thus, immediately upon any lateral movement of the belt 16 the auxiliary control belt 35 is adjusted so as to advance at an angle to the direction of movement of the main belt which is opposite to the direction in which the main belt tends to drift. The angular movement of the control belt then bodily moves the main belt to a corrective position by the fritcional engagement of the two belts. In the illustrated embodiment a plurality of the auxiliary belts 35 are provided with corresponding grooves 36 in the supporting roller 14.

As shown more in detail in FIGURES 3 to 9, the grooves 36 and 36*a* in the periphery of the lower roller 15 are V-shaped with a relatively wide angle of slope. The sides of the grooves 36 are inclined inwardly toward each other and have a smooth anti-friction surface. Preferably, the sides of the grooves 36 are lined with an anti-friction material 37, such as Teflon, to offer a minimum resistance to the sliding movement of the sides of the belt as it seats in a groove. The rollers 14 and 15 may be formed of pipe sections with the grooves 36 formed in the wall of the roller 15, or a thin walled tube may be built-up with a wrapping into which the grooves are cut, or cylindrical sections may be slid into position over the outer periphery of the pipe sections and welded thereto with the sections being so shaped as to form the grooves. As shown in FIGURES 3 to 5, the hollow rollers 14 and 15 have discs 38 welded therein and mounting axles 39 at its opposite ends.

The auxiliary control belts 35 are of a narrow V-shaped form in cross-section so that the inclined sides cooperate with the smooth sides 40 and 41 of the groove 36 and have a peripheral friction surface 42, see FIGURE 7. The auxiliary control belts 35 are in the form of a continuous loop which is captured between the main belt 16 and groove 36 in the supporting roller 15. Each auxiliary belt 35 is driven by the main belt 16, due to the frictional engagement of its periphery 42 therewith, and is jammed into its respective groove 36 by the force of the surrounding belt 16, but the smooth sides 40 and 41 of the groove 36 cause the sides of the auxiliary belt to freely slide into and seat in the groove. When the main belt 16 is tracking properly each auxiliary control belt 35 moves into its groove 36 parallel to the direction of movement of the main belt, as shown in FIGURE 3. However, the auxiliary control belts 35 may be actuated in unison to move at an angle to the direction of movement to the main belt, as shown in FIGURE 4. When an auxiliary control belt 35 is directed toward its groove 36 in an angular direction from the left toward the right, as shown in FIGURE 5, it is jammed into its groove 36 and is cammed to the right to bodily shift the main belt 16 to the right. FIGURE 6 illustrates the manner in which the main belt 16 is shifted toward the left when the auxiliary control belt is directed toward its groove 36 from the right toward the left in an angular direction to the path of movement of the main belt.

FIGURE 2 illustrates the manner in which one or a plurality of auxiliary control belts 35 are guided to control the angular direction in which they move toward their respective grooves 36. In the illustrated embodiment the guide means for guiding the auxiliary control belts 35 comprises a grooved pulley 45 for each control belt 35, but other forms of guides may be used. Each pulley 45 is mounted to rotate and is engaged by an auxiliary control belt. The plurality of grooved pulleys 45 and 45*a* for the auxiliary belts 45 and 45*a* are connected together for movement as a unit by a connecting bar 46. Bar 46, in turn, has depending feelers 47 and 48 at its opposite ends engaged by the opposite edges of the lower course of the belt 16 to be controlled. Thus, any lateral movement of the belt 16 in either direction is transmitted to the bar 46 which moves the pulleys 45 and 45*a* in the same direction that the belt tends to drift. Such movement of the pulleys 45 and 45*a* then directs the auxiliary control belt 35 at an angle to the direction of movement to the belt 16 and in a direction opposite the direction which the main belt tends to drift. Thus, the auxiliary control belts 35 depend from the main belt 16 at an angle to the direction of movement of the main belt and are cammed laterally by the grooves 36 in the roller 15 to bodily move both belts laterally due to their frictional engagement.

Guide pulleys 45, bar 46 and feelers 47 and 48 may be mounted in any suitable manner for operation by any suitable sensing mechanisms. In a preferred form of construction illustrated in FIGURES 8 to 12, the guide pulleys 45, 45*a*, etc. are mounted on a transverse frame plate 50 extending between beams 29 and 30 below the deck 13. As shown most clearly in FIGURES 8 and 12, each grooved guide pulley 45 is mounted at the lower end of a depending arm 51 pivotally mounted at its upper end on a pin 52 projecting forwardly from a bracket 53 on the horizontal frame plate 50. The lower end of the depending arm 51 is bifurcated to form a fork having side arms 54 and 55 straddling its pulley 45 and mounting a pivot pin 56 on which the pulley rotates. Each arm 51 has a pivot pin 57 projecting from one side on which a cross head 58 pivots. The cross heads 58 for the plurality of arms 51 are connected by the bar 46 extending through the cross heads and attached thereto by set screws 59. Thus, when the bar 46 moves laterally in one direction it acts through the pins 57 to swing the arms 51 on pivots 52 and move the groove pulleys 45 in unison to one side or the other.

The feelers 47 and 48 at opposite ends of the bar 46 each comprises a pair of rollers 62 and 63, as shown in FIGURES 8 and 11. The rollers 62 and 63 are mounted to rotate on and depend vertically from a plate 64, and the plate is attached to the lower end of a swinging arm 65 generally similar to the arm 51 for the groove pulleys 45. Thus, lateral movement of the lower course of belt 16 acts on a feeler 47 or 48 at opposite ends of the bar 46 and moves the bar laterally in the direction of movement of the main belt. Such movement of the bar 46 is transmitted through the depending arms 51 and 65 to move the grooved pulleys 45 and feelers 47 and 48 as a unit. For example, if the feeler 47 is moved to the left, as viewed in FIGURE 2, it moves the guide pulleys 45 and 45*a* to the left and thereby directs the auxiliary control belt toward its groove 36 from the left toward the right to move the belt back to its proper tracking position. If, on the other hand, the feeler 48 is moved to the right the bar 46 and guide pulleys 45 are moved to the right to direct the control belts 35 toward the grooves 36 at an angle from right to left to correct the direction of movement of the main belt. One form of construction having now been described in detail, the mode of operation is next explained.

Assuming for the purpose of description that the ski slope 12 is in operation with the belt 16 being driven by the motor 19 through belt 20 and upper roller 14 and that a person is skiing on the moving belt. If the upper course of the belt 16 moves laterally at any time during operation, the lateral movement is transmitted to the lower course so that the edge of the belt actuates feeler 47 or 48 laterally as, for example, to the left, as shown in FIGURE 5. Feeler 47 fast on bar 46 moves the latter to the left, see FIGURE 2, and the bar acting through the cross heads 58 and rearwardly projecting pins 57 rocks the arms 51 and guide pulleys 45 thereon to the left. When guide pulleys 45 are pulled to the left they direct the auxiliary control belts 35 at an angle to the direction of movement of the belt 16 to be controlled and more specifically in an angular direction from the left toward the right.

As shown most clearly in FIGURE 8, each guide pulley 45 is located to position the outer periphery of the auxiliary control belt 35 in contact with or closely adjacent the inside of the lower course of the main belt 16 to be controlled. Thus, as the auxiliary control belt 35 moves toward its groove 36 in roller 15 its outer periphery frictionally engages the main belt 16 to form a projecting rib extending at an angle to its direction of movement. As the wrap of each auxiliary guide belt 35 is located in its groove 36, the angular portion approaching the groove tends to move in a straight line and ride up on the left hand side of the groove. However, the auxiliary guide belt 35 immediately slides down the smooth side 40 of the groove as it is jammed into the groove by the surrounding wrap of the main belt 16. The belt 16 to be controlled is much larger and heavier than the auxiliary control belt 35 so that it jams the auxiliary belt into the groove, and as the periphery of the auxiliary control belt is in tight frictional contact with the outer belt the inclined side of the groove 36 cams both belts to the right as a unit in the manner illustrated in FIGURE 5. In some instances the corrective shifting of the main belt 16 may occur between the guide pulley 45 and roller 15 and in other instances the corrective shift of the belt may occur only at the wrapped portion of the auxiliary control belt 35 as it seats in its groove 36. In either case, the auxiliary guide belt 35 bodily moves the main belt 16 in the opposite direction, or to the right, from the direction in which it tends to drift.

Such corrective movement of the main belt 16 then runs through the upper course and lower course and actuates the feeler 48 to move the bar 46 in the opposite direction or to the right as viewed in FIGURE 2. Such movement of the bar is transmitted through the depending arms 51 and guide pulleys 45 to move them back into a path parallel to the direction of movement of the main belt, as illustrated in FIGURES 2 and 3. When the main belt 16 and auxiliary control belts 35 move parallel to the direction of the main belt the auxiliary control belts tend to hold the main belt in a straight path.

If the main belt 16 tends to drift in the opposite direction, or to the right as viewed in FIGURE 2, the feeler 48 is actuated laterally to the right and moves the guide pulleys 45 to the right to direct the auxiliary guide belts angularly to the direction of movement of the main belt from right to left. Such an angular relation of the auxiliary control belts 45 then cooperate with the main belt 16 and grooves 36 in the manner previously described to bodily shift the main belt toward the left to correct the drift of the main belt. Following such corrective movement the auxiliary control belts are moved back into parallel relation with the main belt to be controlled.

It will now be observed that the present invention provides an improved apparatus for maintaining a continuous web in a substantially straight path by utilizing the energy of the web itself to provide the force required to change its direction of movement. It also will be observed that the present invention provides an improved apparatus for maintaining the alignment of a relatively wide belt by directing an auxiliary control belt between it and a groove in a supporting roller in a direction opposite the direction that the belt to be controlled tends to drift. It will further be observed that the present invention provides an improved apparatus for tracking the moving belt of an artificial ski slope which utilizes any lateral movement of the belt to be controlled to change the angular direction of movement of an auxiliary control belt between the main belt and groove and cam it laterally by its engagement with the opposite inclined smooth sides of the groove. It will still further be observed that the present invention provides an improved belt aligner of the type indicated which is of simple and compact construction, economical to manufacture and one which is reliable in performing its intended function.

While a single embodiment of the invention is herein illustrated and described, it will be understood that changes may be made in the construction and arrangement of elements without departing from the spirit or scope of the invention. Therefore, without limitation in this respect, the invention is defined by the following claims.

I claim:

1. Apparatus for controlling a continuous web comprising a roller in contact with the web and having at least one groove therein with smooth sides inclined inwardly towards each other, an auxilary belt mounted for movement between the web and groove in the roller, said belt having opposite sides adapted to contact and slide on the smooth sides of the groove and a friction surface at its outer periphery for frictional contact with the web to be controlled, and a guide spaced from the roller for guiding the auxiliary belt at an angle to the path of movement of the web to produce a lateral force on the web as the auxiliary belt is jammed into the groove along an inclined side thereof.

2. Apparatus for controlling a continuous web to cause it to track in a substantially straight path comprising a roller in contact with the web and having at least one groove therein with smooth opposed sides inclined inwardly toward each other, an auxiliary belt mounted for movement between the web and groove in the roller, said auxiliary belt having opposite sides adapted to contact and slide inwardly on the smooth sides of the groove and a friction surface at its outer periphery for frictional contact with the web to be controlled, a belt guide spaced from the roller, and means responsive to the lateral movement of the continuous web and connected to the belt guide for moving the latter laterally in the same direction as the web.

3. Apparatus for controlling a wide continuous belt supported at one end by a roller, said roller having at least one V-shaped groove therein with smooth sides, a V-shaped control belt between said wide belt to be controlled and groove in the supporting roller, the inclined sides of said V-shaped control belt being adapted to slide downwardly on the inclined sides of the V-shaped grooves in the roller and said control belt having a friction surface at its periphery to frictionally grip the belt to be controlled, a guide pulley for said control belt having a V-shaped groove and mounted to move laterally, and means connected to the guide pulley and responsive to lateral movement of the wide belt to be controlled for moving the guide pulley in the same direction whereby to move the wide belt to be controlled in the opposite direction by the friction grip between it and the control belt as the latter moves toward and into the groove in the roller.

4. In an apparatus for simulating a ski slope comprising an inclined deck having rollers at the top and bottom, a wide belt of a material having a low coefficient of friction and prime mover means for driving one of the rollers to cause the wide belt to move upwardly along the top of the deck, the combination with said apparatus of belt aligning means for maintaining the wide belt in a substantially straight path comprising a V-shaped groove in one of the rollers, an auxiliary V-belt between the wide belt and groove in the roller, said groove and auxiliary control belt having relatively smooth sides to adapt the auxiliary belt to slide downwardly into the groove and said auxiliary belt having a friction surface at its periphery, and a guide spaced from the groove in the roller for directing the auxiliary control belt toward the groove in the same and opposite angular directions to the path of movement of the wide belt to be controlled, and means responsive to lateral movement of the wide belt for moving the auxiliary belt guide guide laterally relative to the V-groove in the roller.

5. An apparatus in accordance with claim 4 in which the upper roller is driven from said prime mover to drive the wide belt and the lower roller is driven by the belt, the V-shaped groove being provided in the lower roller, and the auxiliary control belt being driven by the frictional engagement of its periphery with the moving belt to be controlled so that the latter provides the force required to change its lateral direction of movement.

6. An apparatus in accordance with claim 4 in which the sides of the grooves are covered with an anti-friction material whereby to adapt the auxiliary control belt to slide freely into the groove as it moves toward the groove at an angle to the path of movement to the main belt and thereby move the main belt in the same direction by its frictional engagement therewith.

7. An apparatus in accordance with claim 4 in which the guide is a pulley having a V-shaped groove, means for mounting the pulley for movement laterally, and said means for moving the guide pulley being connected to move the pulley in the same direction as the main belt tends to drift.

8. An apparatus in accordance with claim 7 in which a bar is mounted to slide laterally, means connecting the guide pulley to the bar for lateral movement therewith, and said means responsive to the lateral movement of the guide belt comprising guide rolls at each end of the bar and contacting opposite edges of the wide belt to be controlled.

9. An apparatus in accordance with claim 4 in which the supporting roller for the wide belt is provided with a plurality of spaced V-shaped grooves, an auxiliary control belt for each of the grooves, and the means responsive to lateral movement of the wide belt comprising a control bar mounted to move laterally, said bar having a guide for each control belt, and said means responsive to lateral movement of the wide belt being connected to move the control bar in the same direction.

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