Aug. 25, 1970 B. B. FAGAN 3,525,989

SLALOM SIMULATOR HAVING ROPE ACTUATED SWITCH

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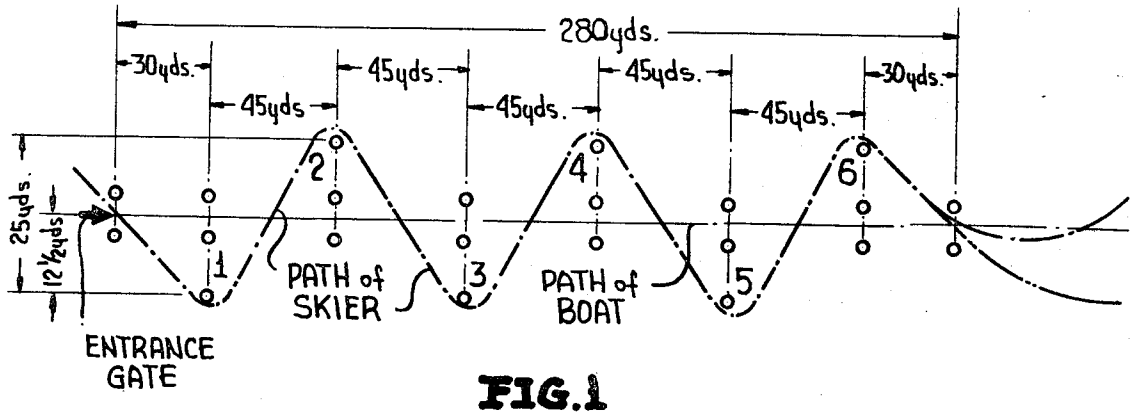


FIG.1

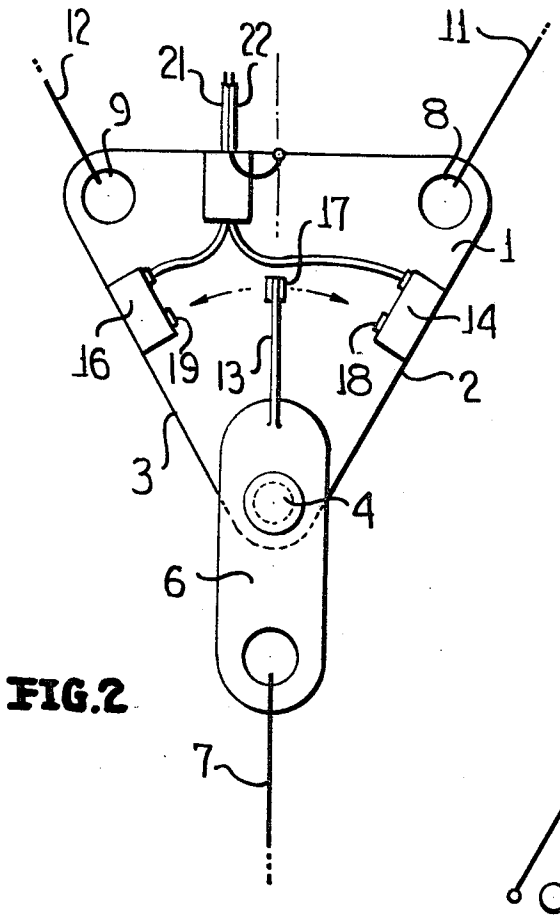


FIG.2

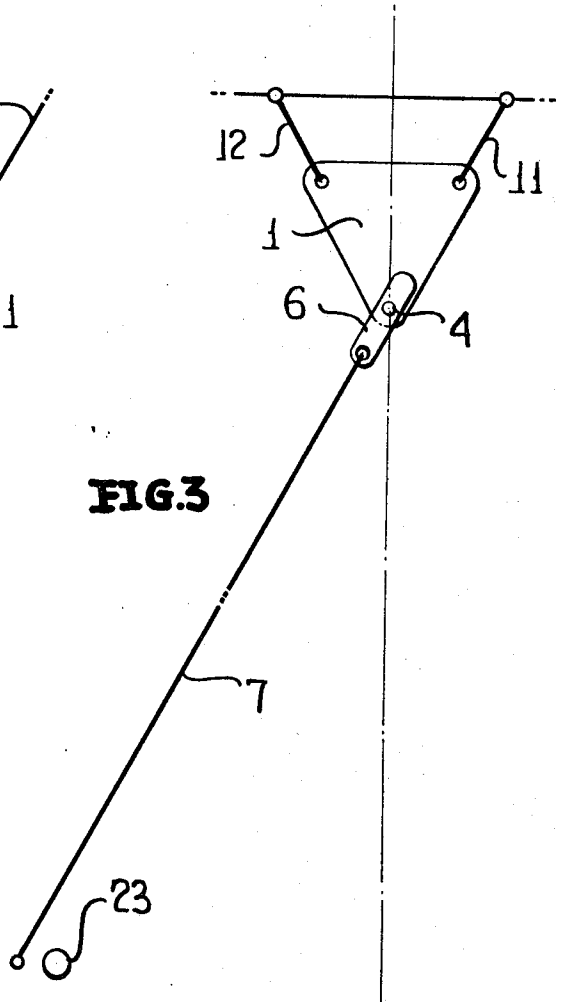


FIG.3

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SLALOM SIMULATOR HAVING ROPE ACTUATED SWITCH

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FIG.4

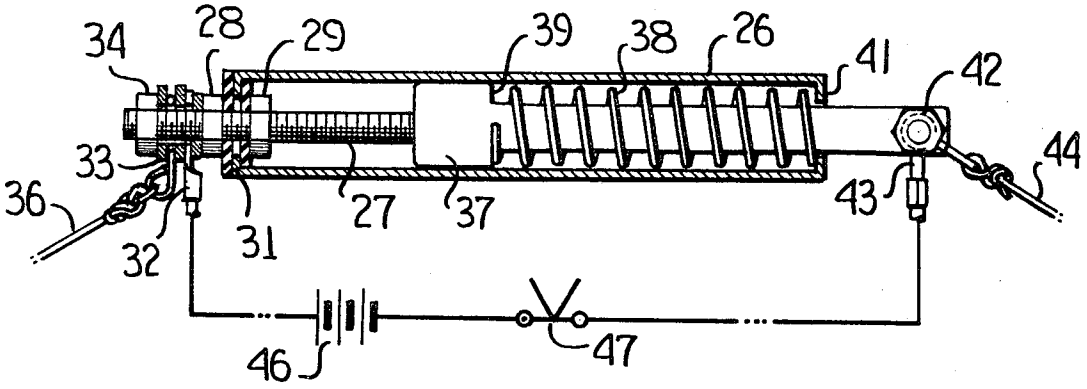


FIG.5

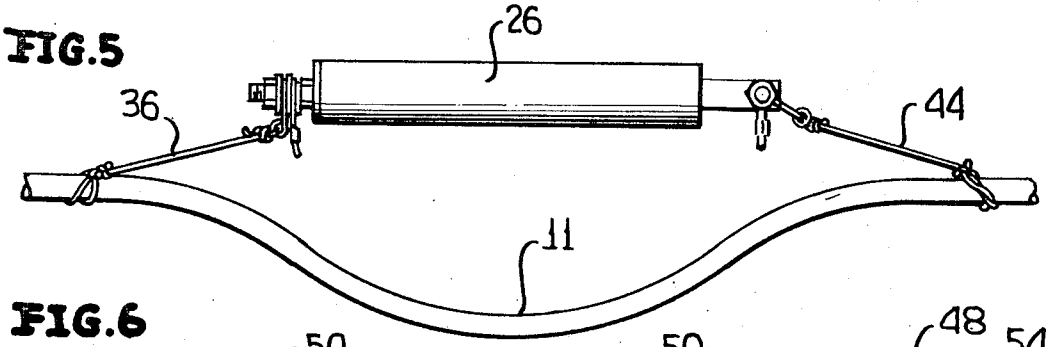


FIG.6

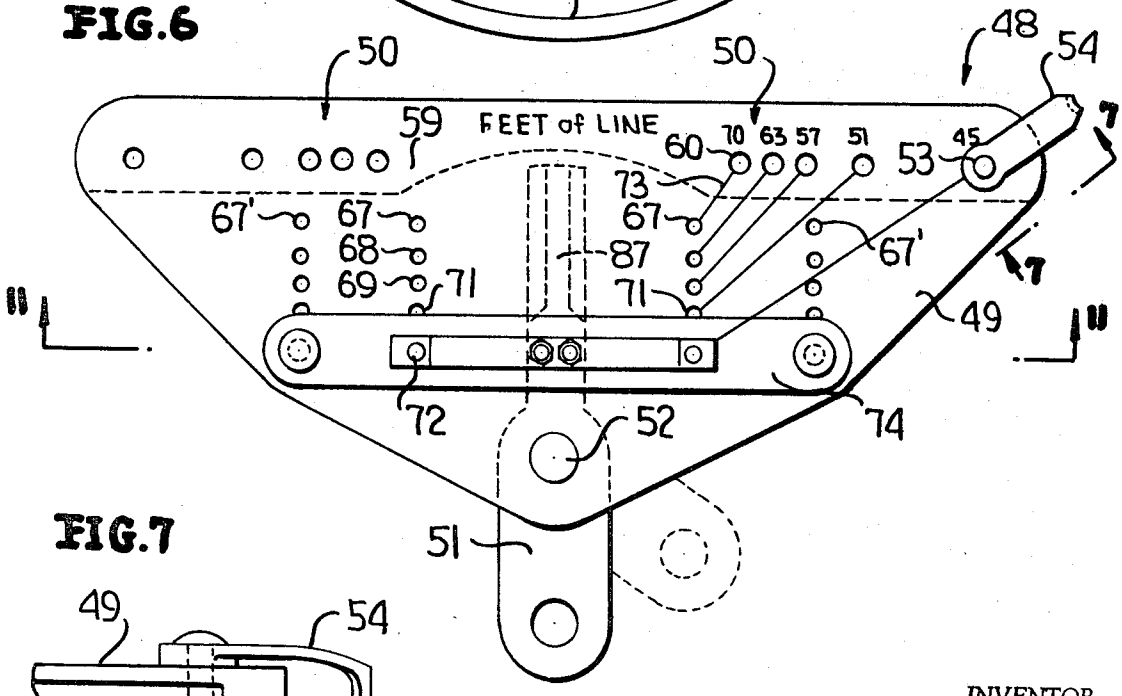
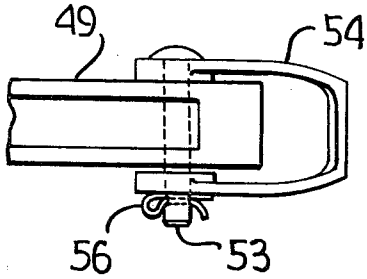


FIG.7



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SLALOM SIMULATOR HAVING ROPE ACTUATED SWITCH

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FIG.8

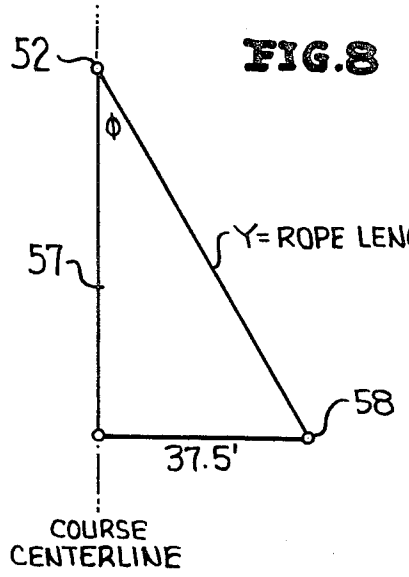
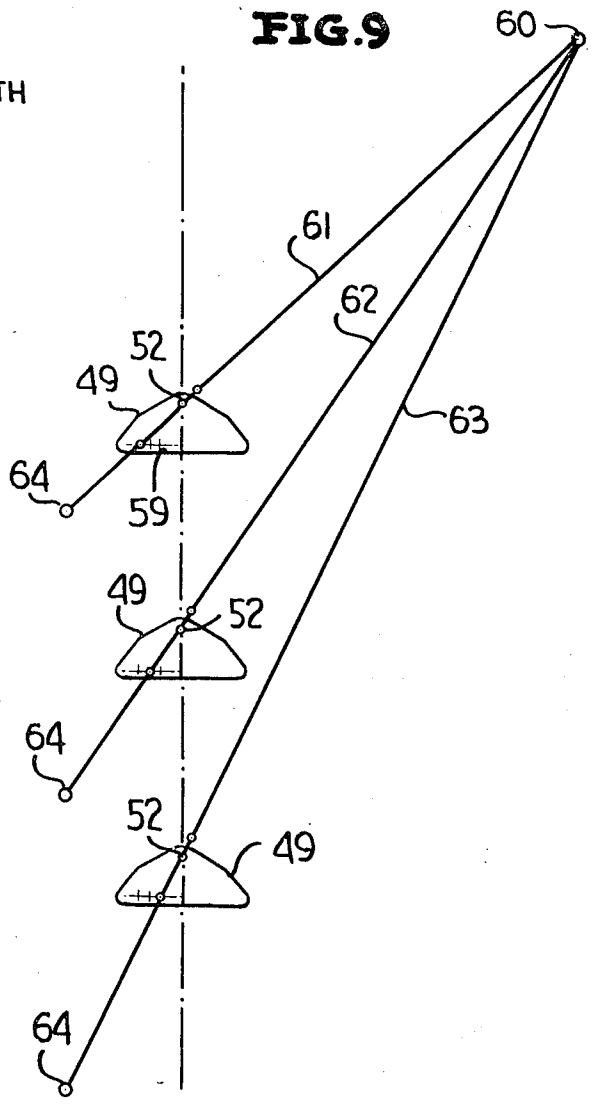


FIG.9



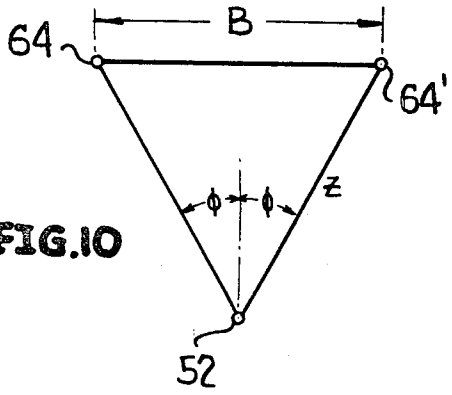
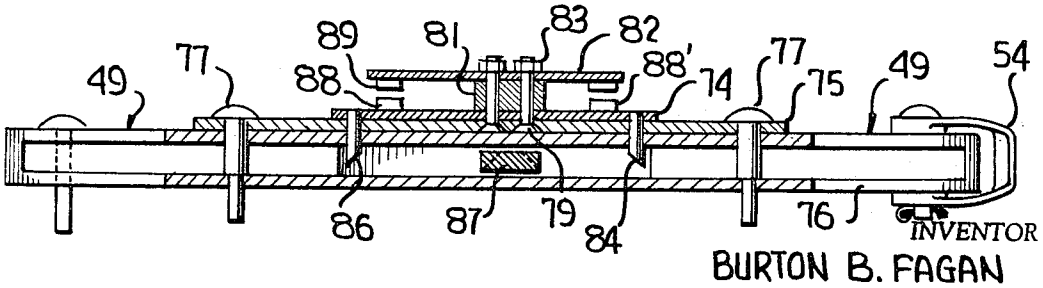


FIG.10

FIG.11



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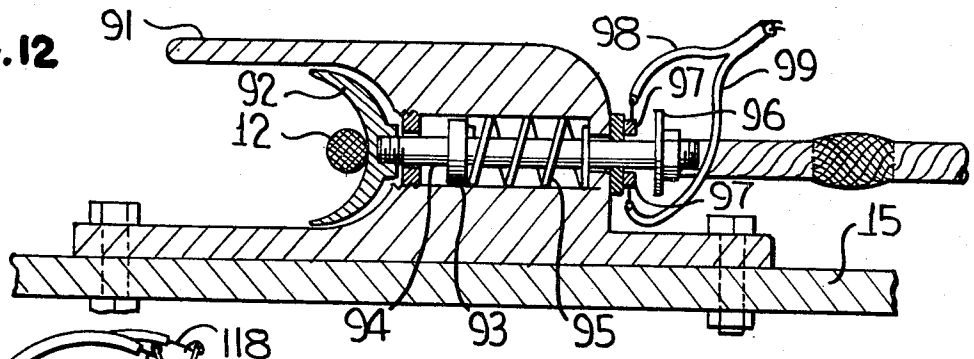
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SLALOM SIMULATOR HAVING ROPE ACTUATED SWITCH

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FIG. 12



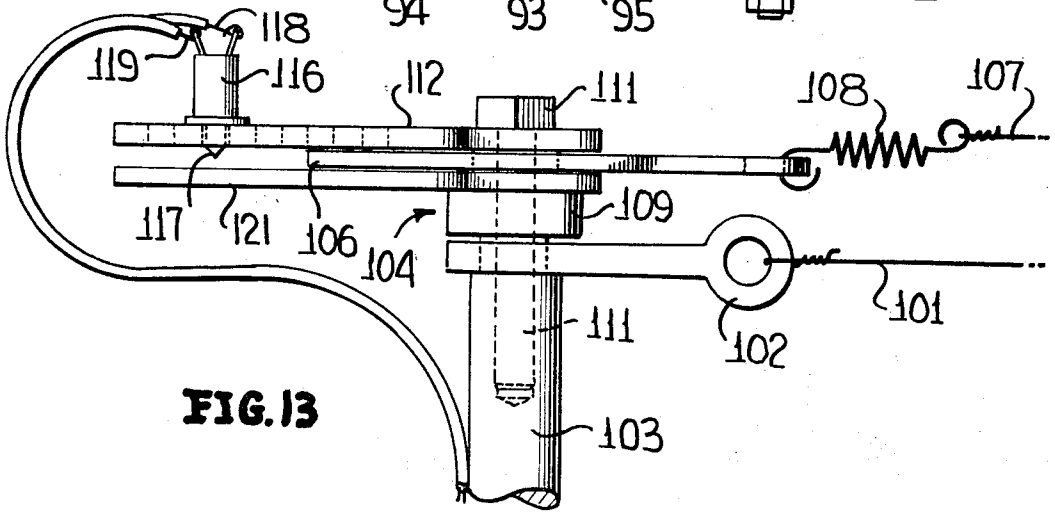


FIG. 13

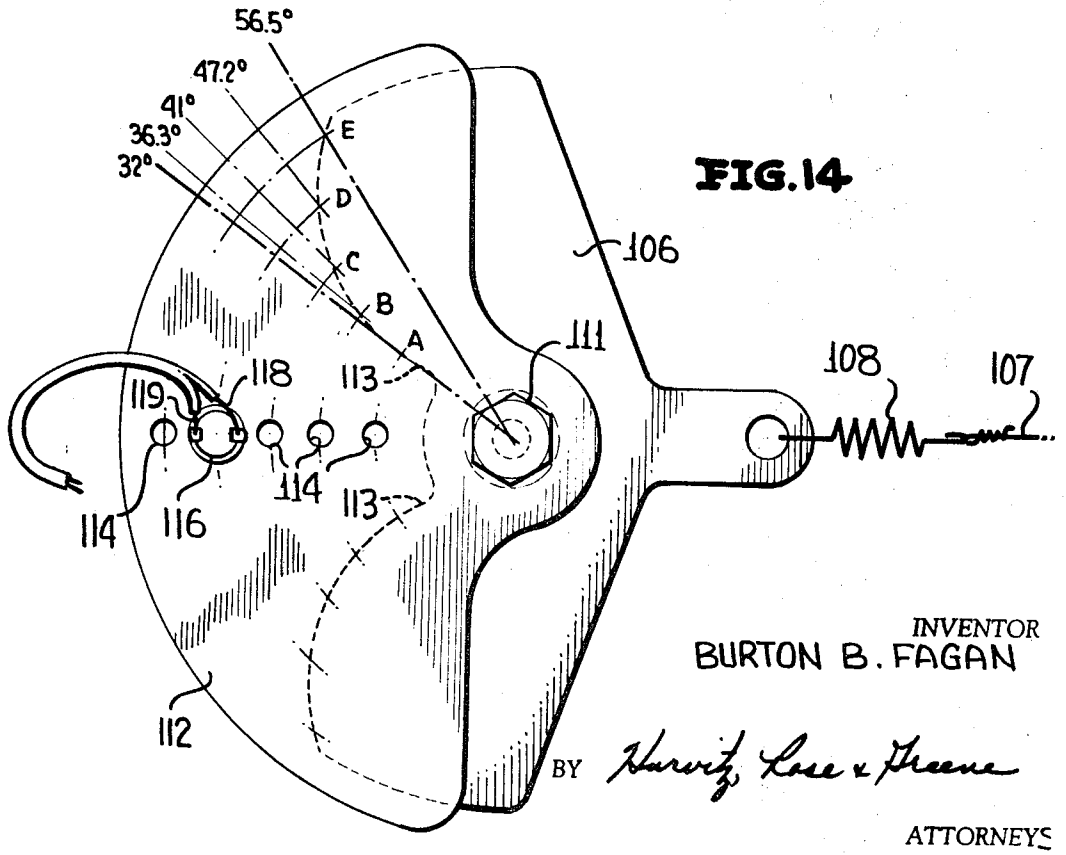


FIG. 14

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United States Patent Office

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SLALOM SIMULATOR HAVING ROPE ACTUATED SWITCH

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Int. Cl. G08b 21/00
U.S. Cl. 340—286 11 Claims

ABSTRACT OF THE DISCLOSURE

A slalom simulator provides means for practicing slalom runs on water skis without requiring positioning buoys to establish a slalom course. The simulator provides means for measuring the angle between a ski tow rope, extending between a skier and the tow boat, and the centerline of the slalom course. When the skier has deviated from the course centerline by a distance sufficient for the skier to pass around a buoy, if one were present, the simulator activates an alarm indicating obtainment of the required deviation.

The present invention relates to slalom simulators and, more particularly, to apparatus for providing successive indications to a water skier that he has deviated a sufficient distance from the centerline of a simulated slalom course to pass around the marker buoys normally employed to define a slalom course for water skiing.

In the United States, the American Water Ski Association establishes all standards for official water skiing events. The present invention, as indicated above, relates particularly to slalom events, and referring to FIG. 1 of the accompanying drawings, there is illustrated an official six-buoy slalom course. The six buoys are located alternately on opposite sides of the centerline of the course, each buoy being spaced twelve and one-half yards from the course centerline; the buoys being spaced forty-five yards downstream from one another. The course is entered through an entrance gate consisting of two buoys disposed symmetrically on opposite sides of the course centerline three yards apart. The entrance gate is located thirty yards upstream from the first buoy of the course, and an exit gate is similarly located downstream with respect to the last buoy and the centerline of the course.

The association also prescribes the rules concerning the time of the run, or more particularly, the speed of the boat in traversing the course, as well as the length of tow line to be employed for each run. The tow line has a maximum length of seventy feet, and initially four runs are prescribed at thirty, thirty-two, thirty-four and thirty-six miles per hour with the seventy foot tow line. The rules set forth herein are for boys and men. Similar rules apply to other classes. A second run is conducted at thirty-six miles per hour with a fifty-seven foot tow line. A third run is conducted at thirty-six miles per hour with a fifty-one foot tow line, and again at thirty-six miles per hour with a forty-five foot tow line.

The official course is quite difficult to establish accurately. It involves a considerable amount of equipment and entails an equally considerable amount of maintenance. The buoys and gates must be accurately located to provide the skier with a true feel for the official tournament course, and the buoys must be maintained.

The present invention is intended to provide the individual water skier or small groups of water skiers who do not have sufficient funds or time to establish and maintain an official slalom course, with the ability to practice for the improvement of their skill, as well as for tournament competition, without having to establish an official slalom course.

The tow rope which pulls the skier through the water is generally attached to the boat by one of two means. In the more common scheme, ropes known as transom ropes are attached to each side of the transom and brought together at a common point on the centerline of the boat at some distance aft of the transom. This common point is called herein the tow rope attachment point.

A more sophisticated attachment scheme employs a vertical pylon on the centerline of the boat thus providing a single point for bringing the load from the tow line into the boat.

Slalom simulators are a series of devices which provide the means to measure and indicate deviations of a skier from the track of a straight running variable speed tow boat which correspond to the positions of buoys on a slalom course and make possible time measurements corresponding to the timing of an official slalom run.

The slalom simulator of the invention actually determines the angle (the "buoy angle") between the tow rope and the centerline of the course and provides some type of indication when a prescribed angle has been equalled or exceeded. The buoy angle for a given length of tow rope is a constant for all courses since the buoys are always located at the same distance from the course centerline. Thus, the length of two sides of a triangle, the tow rope and the perpendicular from course center to buoy are defined and, in consequence, all sides and angles of the triangle are fully defined.

The various devices of this invention relate to the measurement of these angles and the conversion of the measurement to signals for the direct use, in various ways, of the skier and for timing his progress along a simulated course.

Slalom simulators of the present invention which depend for the measurement capability upon the geometry and length of the transom ropes are referred to herein as slack-type simulators.

Slalom simulators of the invention which depend for the measurement capability on a direct measurement of the angle between the tow rope and a line bisecting the angle between two transom ropes are referred to herein as plate-type simulators.

Slalom simulators of the invention which are used with pylon equipped boats and which measure the buoy angle are referred to herein as pylon-type simulators. Pylon-type simulators can be either of series or parallel configuration, depending upon whether the force of towing the skier is carried through the simulator (series type) or around the simulator (parallel type).

The slalom simulators of the invention are located at the transom rope attachment point, on the transom ropes or on the pylon of the tow boat and are provided with buoy angle sensing means of one form or another to indicate to a skier when he has deviated from the centerline of a course sufficiently to have cleared a buoy of the official course.

In operation, the boat which is towing the skier establishes one of the speeds required by the official rules, and

the water skier passes across the centerline of the course behind the boat on his way toward clearing the first simulated buoy. As he crosses the centerline of the boat, an observer in the boat starts a stop watch which is stopped after the skier has completed six deviations to each side of the boat in alternation from one side to the other and then returned across the centerline of the boat. Each deviation which is sufficient to clear a buoy produces a visual, audible or tactile signal, and the total course elapsed time is indicative of whether the skier has completed the course within the official time limit; specifically that time which is equal to the time that would be required by a skier to have gone through the entrance gate, around the six buoys, and through the exit gate (if such had existed), at the particular speed at which the boat is proceeding through the course. For instance, if the boat is traveling at thirty miles per hour down the course illustrated in FIG. 1, the skier should then complete the course in 19.4 seconds, this being based on a total course distance along the path of the boat of two hundred eighty-five yards.

One of the apparatus of the present invention, the plate-type simulator, generally comprises an isosceles triangular shaped plate having a pintle pivoted adjacent to the vertex of the equal sides of the device, the skier's tow rope being attached to the pintle. The apparatus is secured to the boat by two ropes extending between two points adjacent to the other two vertices of the plate, and to two hooks or eyes secured to the transom or hull of the boat. In one embodiment of the invention, an apparatus is provided for detecting the angle of the pintle relative to the centerline of the plate. When the skier has deviated from the centerline of the course the proper distance, there is defined a specific buoy angle for the particular length of tow rope being employed and this buoy angle may be measured. When the proper buoy angle is obtained, a circuit is closed and a visual, audible or tactile alarm is activated. This signal simulates to the skier the rounding of a buoy and indicates that he should cross the track of the boat to round the next buoy on the other side of the boat track.

Similarly, when the skier deviates sufficiently to pass around a buoy on the other side of the centerline of the course, the visual, audible or tactile alarm is again activated, directing the skier to another track crossing. The individual in the boat may observe the signals, and when the skier has activated six alarms when proceeding along a course such as in FIG. 1 and recrossed the boat track, he may record the time required for the skier to have effected six indications, therefore determining whether the skier is actually completing the course in the prescribed time.

Various types of mechanisms for indicating the buoy angle may be employed. For instance, in one embodiment of the plate-type simulator of the invention, a switch contact is carried on the inner end of the pintle, and stationary switch contacts are located at the proper angle or displacement from the centerline of the plate, such that when the skier has deviated at the proper angle, the movable contact on the pintle contacts one of the stationary contacts.

In another embodiment of the plate-type simulator, cams of various shapes may be made part of the pintle so that a circuit is closed by the operation of the cam at each deviation of the pintle to the appropriate buoy angle on each side of the centerline of the boat.

In another embodiment of the invention, use is made of the fact that, if the length of the two ropes from the transom to the transom rope attachment point are properly selected, when the skier has deviated a proper distance from the centerline of the course, then one of the two ropes becomes slack (this phenomenon to be described subsequently in greater detail). Tension switches connected in parallel are located on both of the transom ropes, and initially, when the skier begins to proceed down the course, the tensioning on the rope opens both of the switches. However, when the skier has deviated to the buoy

angle, one of the ropes becomes slack, the tension switch closes and the appropriate indication is provided.

Tension switches can be incorporated as part of the hooks which are used to attach the transom ropes to the hull of the boat.

Still another aspect of the invention relates to operation of the device with different lengths of tow line. Intuitively, it can be seen that as tow line shortens, the angular deviation or buoy angle required of the skier becomes greater. Specifically, if the skier is trailing the boat by seventy feet, he must deviate twelve and one-half yards from the centerline of the course, the angle between the tow line and the centerline of the course, is less than if a forty-five foot line is employed.

For both the plate-type simulator and the slack type simulator, the transom rope length must be varied as the length of the tow rope is varied such that the included angle between the transom ropes at the transom rope attachment point is equal to twice the buoy angle.

The points of attachment of the transom rope to the plate-type simulator must be varied such that the included angle between the points of attachment and the pintle pivot is equal to twice the buoy angle.

It is an object of the present invention to provide a slalom simulator permitting a water skier, in the absence of an actual slalom course layout, to practice slalom skiing and permit a determination of proper execution of the course with different lengths of tow line and different boat speeds as prescribed in the official rules.

It is another object of the present invention to provide a slalom simulator for water skiing which is readily adaptable to different lengths of tow line so that all of various prescribed slalom events may be practiced by using a single simulator.

Still another object of the present invention relates to a slalom simulator for water skiing which measures the angle between a skier's tow rope and the centerline of a slalom course and provides an indication whenever the skier has deviated from the course centerline by a prescribed distance.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of several embodiments thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a diagrammatic view of a slalom course for water skiing;

FIG. 2 is a top view of one embodiment of the apparatus of the present invention;

FIG. 3 is a diagrammatic illustration of the apparatus of FIG. 2 under a specific condition during use for its intended purpose;

FIG. 4 is a side view partially in section of a tension sensing switch which may be employed in place of the switch assembly incorporated in the apparatus of FIG. 2;

FIG. 5 illustrates the manner of use of the tension sensing switch of FIG. 4;

FIG. 6 is a top view of another embodiment of the present invention;

FIG. 7 is a side view in elevation of the rope attachment device employed in FIG. 6;

FIGS. 8–10 are diagrammatic view of the angular relationships involved in determining locations of various rope attachment positions of the device of FIG. 6;

FIG. 11 is a side view in elevation of the apparatus of FIG. 6;

FIG. 12 is a side view in elevation of a slack-type simulator incorporated in fitting which attaches transom ropes to boat structure;

FIG. 13 is a side view in elevation showing the pylon slalom simulator of the parallel type; and

FIG. 14 is a top plan view of a pylon slalom simulator of the parallel type.

Referring now specifically to FIG. 2 of the accompanying drawings, there is illustrated a plate type slalom

simulator generally designated by the reference numeral **1** comprising a generally isosceles triangular plate having two equal length sides **2** and **3**. The plate is provided with a pivot **4** for a pintle **6** adapted to receive a tow line **7**. The plate **1** is apertured at **8** and **9** adjacent the vertices opposite the location of the pivot **4**, apertures **8** and **9** being adapted to receive ropes **11** and **12**, respectively, which are secured to appropriate anchoring mechanisms or eyes on the transom of the tow boat.

The pintle **6** is provided with a longitudinally extending arm **13** directed away from the end of the pintle adapted to receive the tow rope. Two insulating contact supporting blocks **14** and **16** are disposed respectively on the right and left sides, as illustrated in FIG. 2, of the plate **1** in the path of movement of a contact **17** carried on the end of the arm **13**.

When the pintle **6** is rotated through a predetermined angle, the contact **17** engages appropriate contact members **18** or **19** secured to the blocks **14** and **16**. The contacts **18** and **19** are connected to a common return wire **21** and the contact is electrically connected via arm **13**, pintle **6** and pivot **4** to the plate **1**; the plate **1** being connected to a ground or return wire **22**. Thus, the leads **21** and **22** are electrically connected to one another whenever the contact **17** engages one of the contacts **18** or **19**.

The slalom simulator illustrated in FIG. 2 is designed for a specific length of tow rope, for instance, a seventy foot rope. If the included angle **9–4–8** and the length of ropes **11** and **12** are properly selected for a seventy-foot tow rope, the apparatus does not require stops for the pintle **6** to prevent damage to the arm and contact mechanism **13** and **17**. To more fully explain this feature of the present invention, reference is made to FIG. 3 of the accompanying drawings. In FIG. 3, it is assumed that the tow line **7** is seventy feet long and that the skier has deviated from the centerline of the course by the prescribed distance to clear a buoy which is designated by reference numeral **23**. When the deviation is as illustrated in FIG. 3, the tow line **7**, pintle **4** and the rope **11** lie along a common straight line and the contact **17** engages the contact **18**. Further deviation of the skier away from the centerline of the course or to the left as illustrated in FIG. 3 maintains exact alignment between the elements **4**, **7** and **11** while the line **12** becomes slack. Thus, no further movement of the arm **13** relative to the block **14** can occur and thus no damage is sustained by the contact mechanims. The phenomena of one of the transom ropes becoming slack when the angle which the tow rope makes with the track of the boat is slightly greater than one-half the included angle between the transom ropes may be employed to provide a different type of sensing mechanism for proper deviation of the skier. This is known as the slack-type simulator. Specifically, since one of the ropes **11**, **12** becomes slack when the skier has deviated from the course centerline by the prescribed distance, tension sensing mechanism may be employed for making the determination of appropriate deviation of the skier.

Referring now specifically to FIG. 4 of the accompanying drawings, there is illustrated a type of tension sensing switch which may be employed for sensing the tension in the ropes **11** and **12** of FIGS. 2 and 3. The device comprises a generally cylindrical body **26** having a bolt **27** extending through one end thereof. The bolt is held in place by two nuts **28** and **29** which engage the left end **31** of the hollow cylindrical device **26** but are electrically insulated therefrom by means of fibrous insulating washers. Electrical lead **32** and a metal ring **33** are disposed about the bolt **27** outwardly of the hollow cylinder member **26** and held thereon by means of a nut **34** and appropriate washers. The ring **33** is secured to a rope or more properly a string **36** in a well known manner.

The bolt **27** extends a predetermined distance into the hollow cylindrical member **26** where it is normally abutted by a plate **37**. The plate **37** is biased toward the bolt **27** by means of a relatively heavy compression spring **38** which extends between the shoulder **39** on the plate **37** and right end **41** of the hollow cylindrical member. The plate **37** is fitted with a nut and a bolt arrangement as generally designated by reference numeral **42** which is used to secure a wire **43** and a rope **44** to the plate **37**.

In order to provide for instance an audible alarm, the electrical leads **32** and **43** are returned to the boat and are connected in series with a circuit comprising a battery **46** or other suitable source of electrical energy and an enunciator **47** which is illustrated as a horn. Of course, the horn can be replaced by any other audible alarm or for that matter, visual or tactile alarm.

In operation, the ropes **11** and **12** are made slack or a one-inch loop may be put in the rope and the strings **36** and **44** are tied across the loop somewhat similarly to the arrangement illustrated in FIG. 5 of the accompanying drawings. It is apparent that, so long as the rope is slack as illustrated in FIG. 5, the compression spring **38** of FIG. 4 maintains the plate member **37** in contact with the bolt **27**. However, when tension due to the towing of the skier is applied to the rope **11**, the plate **37** is pulled away from the bolt **27** against the force of the compression spring **38**, opening the circuit between wires **32** and **43**.

Returning now to FIG. 3 of the accompanying drawings, it can be seen that when a water skier is being towed and is along the centerline or close to the centerline of the course both of the ropes **11** and **12** are in tension and the electrical circuit illustrated in FIG. 4 is open due to disengagement of the member **37** from the bolt **27** on both tension switches. However, when the skier has deviated sufficiently to clear a buoy as illustrated in FIG. 3, the line **11** becomes slack, the compression spring closes the plate against the bolt **27** and the alarm is sounded. Two devices of the type illustrated in FIG. 4 are required, one being secured to each rope. Electrically, the devices are wired in parallel, see switch **40** of FIG. 4, so that the alarm is sounded if either switch is closed. Also a switch **45** may be employed to open the alarm circuit when not in use.

As previously indicated, the apparatus in the form illustrated in FIG. 2 is useful with one particular length of rope or tow line. When a different length of tow line is employed improper indications would be given if the device were not altered since the angles to be sensed change.

Reference is now made to FIG. 6 of the accompanying drawings wherein is illustrated an apparatus that may be employed with each of the various prescribed lengths of tow rope and provide a proper indication for each such length of rope. The apparatus which is generally designated by reference numeral **48** again comprises a pair of spaced, parallel, generally triangular plates **49** and **76** having a pintle **51** pivoted about a pivot **52** adjacent one of the vertices of each of the members **49** and **76**. The bases of the plates opposite the aforesaid pivot point are provided with five groups **50** of two holes each with the holes of each group disposed on opposite sides of the centerline of the plate by equal distances. Each hole is adapted to receive a pin **53** which extends through ears formed on the two ends of a generally U-shaped member **54**. This arrangement is more clearly illustrated in FIG. 7. The pin is provided with an aperture opposite the head end thereof to receive a cotter pin **56** for locking the pin in place. One end of rope is adapted to pass around the base of the member **54** and the other end is secured to the transom of the boat.

Each pair of holes **50** is to be employed with a tow rope of a prescribed length. As previously indicated in the introduction of this application, the prescribed lengths of rope for men and boys are forty-five, fifty-one, fifty-seven, sixty-three and seventy feet. When a tow rope of one of these lengths is employed, the pin and rope holder arrangements **53** and **54** are attached to the plate **49** at the

locations indicated by the specific rope length being employed. The location of the various holes in which the members **54** are to be secured may be determined by use of triangulation as illustrated in FIG. 8 of the accompanying drawings. Each buoy is located twelve and one-half yards from the centerline of the course.

In FIG. 8, the centerline of the course is designated by the reference numeral **57**. A buoy is indicated by reference numeral **58** and the pivot point of the pintle **51** is designated by the reference numeral **52** as in FIG. 6. The rope length is designated by the letter Y and the angle between the tow rope Y and the centerline **57** is designated by ϕ. In the table below, the angle ϕ and the sine of the angle ϕ are listed for each length of the tow rope.

TABLE I

Y=rope length	Sin ϕ	ϕ (°)
70'----------	.535	32.4
63'----------	.595	36.5
57'----------	.658	41.1
51'----------	.735	47.2
45'----------	.834	56.5

If the angle ϕ for each length of two rope is laid out on the plate **49** with the pivot **52** at the vertex and the centerline of plate **49** as the reference leg of the angle, each of the lines designating the outer leg of an angle intersects a baseline **59** on the plate **49** at the location of each of the holes for the specific length of tow rope. Actually, two angles are laid out for each value of ϕ, an angle for each side of the centerline so as to indicate the location of each hole **50** to each pair of holes.

The length of the ropes extending between the plate **49** and the transom of the boat must be changed for each length of tow rope if one of the ropes is to become slack when proper deviation is achieved.

The length of the transom ropes can readily be determined from FIG. 9 of the accompanying drawing which illustrates the location of the boat's transom, more particularly an anchor point on the boat's transom, and the location of the plate **49** of the simulator of the present invention with different length tow ropes, relative to a buoy of a fixed distance from the course centerline. Specifically, a buoy which is designated by the reference numeral **60** is at a fixed location along a course. Lines **61**, **62** and **63** represent tow lines of lengths, for instance forty-five, fifty-seven and seventy feet respectively. The centerline of the simulator **49** must remain along the centerline of the course and the anchor point on the transom of the boat also remains at a constant distance from the centerline of the course, since the two anchor pins on the transom are maintained at a fixed location relative to the centerline of the boat and thus the course. One of these latter points, that is the anchor points on the transom of the boat is indicated by the reference numeral **64**. It can be seen from the drawing of FIG. 9 that the angle of the tow line with the centerline of the device changes with each length of line and that the length of the rope between the anchor **64** on the transom of the boat and the plate **49** increases as the length of the tow line increases. Further, also the point at which the extension of the tow lines crosses the base line **59** of the member **49** becomes closer to the centerline of the plate **49** as the length of the tow line increases.

The actual length of rope between the transom anchor **64** and the pintle pivot **52** may be calculated as follows: if the distance between anchor points **64** and **64'** on the transom of the boat (see FIG. 10) is taken as a length B and Z represents the length of line between one of the points **64** and **64'** and the pivot point **52** of the plate **49**, then:

$$Z=\frac{B/2}{\sin \phi}$$

B is a fixed distance for any particular tow boat and thus Z can be determined by substituting the values of sin ϕ in the equation from Table I, these values being indicated in Table II below.

TABLE II

Rope length	ϕ	Sin ϕ=X	Z
70----------	32.4	.535	1.87·B/2
63----------	36.5	.595	1.67·B/2
57----------	41.1	.658	1.52·B/2
51----------	47.2	.735	1.36·B/2
45----------	56.5	.834	1.20·B/2

Referring now specifically to FIGS. 6 and 11, since the angle that the pintle **51** makes with the centerline of the apparatus for a specific deviation of the skier; that is, the deviation required to clear a buoy (buoy angle), changes with the length of the tow line, the mechanism for sensing deflection of the pintle, or more particularly, the angle of rotation of the pintle relative to the centerline of the device, must also take into account this difference. In FIG. 6, a second set of groups of four holes **67**, **68**, **69**, and **71** and **72** is provided, the inner two holes of each group, each lying along a line drawn from the center of one of the holes **50** to the pivot point **52** of the pintle **51**. For instance, a line **73** drawn from the center of the hole **50** for the seventy foot tow line and the center of the pivot **52** for the pintle intersects the center of one of the holes **67**. A line drawn from the hole on the opposite side of the centerline for the seventy foot tow line to the center of the pivot **52** intersects the center of the second one of the holes **67**. These holes and the two further holes of the group designated **67**; also dispose symmetrically on opposite sides of the centerline of the plate **49** are adapted to receive pins from a switch sensing mechanism illustrated in elevation in FIG. 11.

The switch apparatus of FIG. 11 comprises a pair of spaced, flat, parallel plates **74** and **82**, secured to the member **49** by a plurality of pins, generally designated by the reference numeral **77**, when seated in appropriate sets of holes **67**, **68**, **69**, **71** and **72** and their primes. Secured to the top of the number **74** is a flexible reed or member **78**. Bolts **79** having their heads seated in the plate **74** extend upward through reed **78**, a rigid insulating and spacing block **81** and contact plate **82**. Nuts or similar securing devices **83** are applied to the end of the bolts **79** to rigidly secure the assembly to the plate **74** and thus to the plate **49**. The reed **78** carries two members **84** and **86** which extend downwardly through apertures in the plates **49** and **74** and into the region between the plates **49** and **76**. A tongue **87** extends from the pintle **51** of FIG. 6 toward the base lines **59** of plates **49** and **76**. The height of tongue **87** is less than the height of the region between the plates **49** and **76**.

The member **87** is beveled and upon rotation through a predetermined distance with rotation of the pintle **51** one of the sloping surfaces on member **87** engages a corresponding sloping surface on the bottom of one of the members **84** and **86**. Continued rotation of pintle **51** about the pivot point **52** causes, for instance, the member **86** or the member **84** to raise and deflect one end of the flexible member **78**. When the pintle **51** has been deflected through an appropriate angle, one of two contacts **88** and **88'**, carried near the opposite ends of reed **78**, is raised sufficiently to engage a contact **89** or **89'** respectively disposed immediately thereabove and secured to the underside of the plate **82**.

By locating the mechanism of FIG. 11 at the appropriate holes **67** through **72**, engagement between the contacts **88** and **89** or **88'** and **89'** is produced whenever the skier has moved outwardly from the centerline of the course through the buoy angle. Appropriate electrical wiring may be provided, as generally indicated in FIG. 4, to

produce an audible, visual or tactile alarm whenever engagement is produced between contacts of the mechanism of FIG. 11.

Another form of slack-type simulator can be configured as shown in FIG. 12. This device is substituted for the hook or fitting which attaches the transom ropes to the hull or structure of the boat.

Referring to FIG. 12, it is seen that a loop of the transom rope **12** is passed around the hook **91** and rests against pressure plate **92**. When rope **12** is in tension, pressure plate **92** is forced to the right as viewed in FIG. 12 against hook **91**. This pressure, transferred through rod **94** and washer **93** secured thereto compresses spring **95**. At the same time, rod **94** separates contact bar **96** carried near the end of rod **94** from stationary contact **97**, opening the circuit connected thereto.

Wires **98** and **99** are connected to contacts **97** and are connected in parallel with wires from the corresponding apparatus at the other connection point to operate the signal in a manner similar to that shown for the tension switch in FIG. 4.

When either of the transom ropes becomes slack, the spring **95** presses against washer **93** and moves rod **94** to the left, bringing contact bar **96** in contact with contacts **97**. The circuit between wires **98** and **99** is closed, indicating that the tow rope has assumed the angle at which the skier would pass around the buoy on an official course.

Similar slack-type simulator switches may be configured for various means of attaching the transom ropes to the hull.

A pylon-type simulator may be configured by rigidly affixing a plate-type simulator such as shown in FIG. 6 to the pylon so that the centerline of the plate CL—CL corresponds to the centerline of the tow boat.

The tow rope can then be attachedd to the pintle of the simulator and excursions of the skier simulating buoy roundings on each side of the boat will then be indicated by circuit closings as described for the plate-type simulator. This configuration is called the series-type pylon simulator. However, attaching the tow rope to the pintle pylon be able to resist strong twisting forces. To eliminate these twisting forces, the tow rope may be attached directly to the pylon with the plate simulator mounted rigidly on the pylon so that its pivot is directly above the pylon. The pintle is then attached to the tow rope by means of a light line and spring. This scheme, named the parallel pylon simultaor, greatly reduces the twisting forces which must be resisted by the connection between the pylon and the plate is illustrated in FIGS. 13 and 14 of the accompanying drawings.

Referring specifically to FIG. 13 which illustrates a conventional pylon arrangement with the simulator of the invention attached, a tow rope **101** is normally connected to an attachment eye which pivots about the vertical axis of a pylon **103**. The pylon-type slalom simulator **104** includes a cam **106** attached to the tow rope **101** by means of a string **107** and a light spring **108**. As the skier moves from side to side of the boat track, the tow rope attachment eye **102** pivots about a spacer **109** and bolt **111** and the string **103**, spring **104** assembly causes the cam **106** to pivot about the bolt **111**. The cam is therefore rotated about the boat axis in synchronism with the movements of the tow rope.

A switch positioning plate **112** is held rigidly to the pylon **103** by the bolt **111** so that the centerline of the switch positioning plate **112** remains aligned with the fore and aft axis of the boat.

The cam **106** has an axisymmetric gull-wing shaped cam surface **113** generated such that when the cam **106** is rotated by an angle equal to the buoy angle for a particular tow line length, a point on the cam operating surface **113** is coincident with the center of that one of a plurality of threaded switch location holes **114** formed in plate **112** which corresponds to a prescribed length of tow line.

A sealed, cam-operated switch **116** is screwed into a threaded switch location hole **114** in plate **112** corresponding to the length of the tow line used. The switch **116** has a downwardly depending conical rod actuator **117** which is engaged and pushed upward by the cam operating surface **113** of cam **106** when the cam has rotated to the buoy angle, closing the switch and thus a circuit between wires **118** and **119** and operating indicators as described previously.

A support plate **121** is for structural rigidity and plays no active part in the operation of the device.

Under certain circumstances, an audible or visual signal to the skier might prove unsatisfactory or difficult to use. Another embodiment of the invention is a tactile signal to the skier that he has reached the buoy angle.

A two conductor wire is woven in the center of the tow rope and carried to the handle. The handle used is fitted with a hollow cylindrical center. Into this hollow handle center is fitted an electrical device, which when energized through the conductors in the tow rope, produces a distinctive vibration in the handle. Either a solenoid with a reciprocating core or a small motor with an eccentric flywheel will produce this vibration in the handle which is easily sensed by the skier.

The nature of the slalom course, consisting of two gate passages and six buoy roundings, lends itself to automatically timing of the run.

While I have described and illustrated several embodiments of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

I claim:

1. A slalom simulator for determining when a water skier, being pulled through the water by a tow line attached to a boat, has deviated from the path of the boat by a distance at least equal to the standard displacement of the slalom buoy from the centerline of a slalom course, and of notifying the skier and/or an observer of this deviation by audible, visible or tactile means said simulator comprising an electric switch, a movable element for varying conductivity through said electric switch upon movement of said movable element, means for coupling said movable element to the tow line pulling the skier so as to position said element to establish a predetermined condition of conductivity through said switch when the angular deviation of the rope from the path of the boat is less than a prescribed angle, and to alter the position of said movable element to change the condition of conductivity through said switch when the angular deviation of the tow rope from the path of the boat is at least as great as said prescribed angle.

2. The combination according to claim **1** wherein said means for coupling comprises a plate having a pintle pivotally secured thereto, said tow rope adapted to be secured to said pintle, means for securing the end of said plate opposite said pintle to said boat, said movable element being secured to said pintle for rotation therewith.

3. The combination according to claim **2** wherein means for securing comprises a pair of lengths of material extending from said plate to said boat, an extension of the longitudinal axis of each of said lengths of material passing through the pivot point of said pintle and forming with the path of said boat said prescribed angle, said lengths of material forming angles of opposite sense with the path of said boat.

4. The combination according to claim **2** further comprising a pair of stationary electrical contacts secured to said plate, a further electrical contact secured to said movable element, said stationary contacts being aligned on opposite sides of said movable contacts in the path of movement thereof.

5. The combination according to claim **3** wherein said plate is provided with a plurality of pairs of holes for attaching said lengths of material to said plate, the holes of

each pair being disposed on opposite sides of and equal distances from the centerline of said plate which passes through the pivot point of said pintle, means cooperating with said holes for securing said lengths of material to said plate, each pair of holes being located such that lengths of material, when secured to said plate via said holes, make an angle with the centerline of the slalom course equal to the prescribed angle for a predetermined length of tow rope.

6. The combination according to claim 5 further comprising means for establishing different positions of said electric switch relative to said movable element so that said condition of conductivity is altered upon said tow rope obtaining different predetermined angles as a function of the length of said tow rope.

7. The combination according to claim 6 wherein said means for establishing establishes positions of said switch such that said switch conductivity is altered when said movable element has been deflected through an angle the sine of which is X/Y where X is the standard distance of a slalom buoy from the centerline of a slalom course and Y is the length of the tow rope.

8. The combination according to claim 1 wherein said means for coupling comprises a plate having a pintle pivotally secured thereto for receiving said tow rope, a pair of lengths of material extending from said plate to said boat, an extension of the longitudinal axis of each said length of material passing through the pivot point of said pintle and forming with the path of said boat said prescribed angle, said lengths of material forming angles of opposite senses with the path of the boat, a second switch having a movable element, said means for coupling further comprising means for securing each said switch to a different one of said lengths of material such that each said movable member alters conductivity of its associated switch upon a change of its associated length of material between taut and slack conditions.

9. The combination according to claim 1 further comprising a pair of lengths of material extending from said boat at equal transverse distances from the centerline of said boat, said means for coupling securing said lengths of material to one end of the tow rope, the angle between each said length of material and the path of the boat being equal to said predetermined angle, means securing said electric switch to one of said lengths of material such that said movable member is moved as a function of tension in said length of material to alter the conductivity of said switch.

10. The combination according to claim 1 further comprising a support member, a plate pivotally secured to said member, said plate having a cam surface, means for coupling said plate to said tow rope, means for mounting said support member so that the pivot for said plate and the pivot point for the tow rope are coaxial, and means for securing said electric switch to said support member such that said movable member is operated by said cam surface.

11. The combination according to claim 3 wherein said plate is provided with a plurality of pairs of attachment means for attaching said lengths of material to said plate, the attachment means of each pair being disposed on opposite sides of and equal distances from the centerline of said plate which passes through the pivot point of said pintle, means cooperating with said attachment means for securing said lengths of material to said plate, each pair of attachment means being located such that lengths of material, when secured to said plate via said attachment means, makes an angle with the centerline of the slalom course equal to the prescribed angle for a predetermined length of tow rope.

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