An apparatus and a method for cutting vegetation and simultaneously treating the remaining stems of the cut vegetation with a treatment fluid. The apparatus includes a mower (42), a cutting blade drive means (60) rotatably mounted on the mower (42), a blade carrier (92) secured to the rotatable drive means (60), and at least one cutting blade assembly (100) rotatably mounted on the blade carrier (92). The apparatus further includes fluid container means (130) for containing the treatment fluid in a plurality of interconnected, stackable and removable fluid-containing cells (32), pumping means (150) for pumping the treatment fluid to the at least one cutting blade assembly (100), flow control means (160) for metering the amount of treatment fluid that is pumped to the at least one cutting blade assembly (100), and fluid conduit means (190) for delivering the treatment fluid from the fluid container means (130) to the cutting and treating means (190). The method includes the steps of cutting vegetation with at least one cutting blade, and delivering a treatment fluid to the underside of the at least one cutting blade in a continuous stream so that the treatment fluid is continuously available to the remaining stems of the cut vegetation.
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APPARATUS AND METHOD FOR
CUTTING AND TREATING VEGETATION

FIELD OF THE INVENTION

The present invention relates to an apparatus and method for
cutting and treating vegetation, and more particularly to an
apparatus and method for cutting vegetation while simultaneously
applying a treatment fluid to the remaining stems of the cut
vegetation.

1. BACKGROUND OF THE INVENTION

Power companies periodically cut the vegetation that grows
along powerline right-of-ways to maintain access to the powerlines
and to minimize line losses. Access is required to facilitate
service and repair of damaged powerlines. Excessive line losses may
occur when high, dense vegetation beneath the powerline causes the
electricity flowing through the powerline to bleed into the ground.
The higher and more dense the vegetation, the greater the spurious
radiation loss from the powerline. Similarly, highway departments
periodically cut the vegetation that grows in medians and along
roadsides to enhance the safety of motorists and pedestrians.
Cutting the vegetation improves visibility and provides a shoulder
along the road for emergency stops. As the demand for electrical
power and highways increases, the number of right-of-way and
roadside miles multiplies exponentially. Accordingly, power
companies and highway departments continually seek more efficient
and cost effective methods for cutting vegetation along right-of-
ways and roadsides.

Power companies and highway departments have discovered that
it is advantageous to treat the vegetation at the time it is cut
with a treatment to control the growth of unwanted vegetation, or
to reduce the rate of growth of desirable vegetation. The
vegetation is typically treated with a granular or fluid treatment
such as a growth regulator, herbicide, pesticide, fungicide,
fertilizer or biological agent, depending on the desired result.
The application of a treatment fluid to vegetation is most often
accomplished by broadcasting the fluid through the air so that the
treatment comes in contact with the vegetation, and is held in place
by adhesion of the fluid to the individual plants. The most common methods of broadcasting treatment fluids include spraying the treatment in the area containing the vegetation from an aerial vehicle, from a ground vehicle fitted with a series of spray nozzles, from a hand-held sprayer or from a mower equipped with a treatment applicator. As yet, however, there has not been a mower equipped with a treatment applicator which is capable of cutting vegetation and treating the cut vegetation in a non-horizontal orientation, such as on a hillside using a mower head attached to the end of a hinged boom arm.

Unfortunately, these broadcasting methods do not permit accuracy or control in applying the treatment fluid to the plants. Broadcasting methods, and spraying in particular, allow the treatment to come into contact with desirable plants, and to be applied in areas other than the area to be treated. Once the treatment is broadcast into the air, the spray pattern becomes random and some plants may not be treated at all. Further, when the concentration of the treatment is high, the operator usually applies more treatment than is necessary, and thus substantial amounts of the treatment are wasted. Treatment fluids are typically applied until the foliage of the plant is visibly wet. Thus, there is no way of predicting how much of the treatment will fall onto the ground around the plant where it may contaminate the surrounding soil and the underground water system, and how much, if any, of the treatment will be absorbed into the vascular system, or transpiration stream, of the plant where it will produce the desired result.

DowBlanco, a manufacturer of herbicides, instructs users that its fluid chemistry is effective only if the treatment penetrates the foliage and is absorbed into the transpiration stream of the plant. As a result, chemical companies produce chemicals known as "adjuvants" that enable treatment fluids that are broadcast by spraying to penetrate through dense foliage. Many treatment fluids also include a surfactant to promote absorption of the agent into the transpiration stream of the plant. Nevertheless, usually only a small percentage of the volume of treatment fluid that is broadcast by spraying actually reaches the transpiration stream of the plant. The remainder of the treatment fluid falls onto the ground where it may mix with precipitation and run onto surrounding
land, or may vaporize into the atmosphere and be blown by the wind onto surrounding land.

Naturally, farmers and people living in close proximity to powerline right-of-ways and highways object to the application of treatment fluids which results in run-off or wind drift. Consequently, power companies and highway departments are often restricted by governmental regulations and local ordinances from broadcasting treatment fluids by spraying. Even though the power companies and highway departments regularly heed these regulations and ordinances, environmentalists complain that anytime a treatment fluid is applied by a broadcasting method there is necessarily some contamination of the ground and underground water system, as well as some risk of run-off and wind-drift. Further, in the event that a chemical contamination of the ground or water in the vicinity of the treatment area occurs, the power companies and the highway departments cannot conclusively prove that the cutting and treating operation was not the source of the contamination.

2. DESCRIPTION OF THE PRIOR ART

Various apparatus exist for cutting and treating vegetation with a treatment fluid. For example, US Patent Nos. 2,908,444 and 2,939,636 issued October 13, 1959, and June 7, 1960, respectively to Mullin; US Patent No. 2,973,615 issued March 7, 1961, to Yaremchuk; and US Patent No. 3,332,221 issued July 25, 1967, to McCain each disclose a rotary lawnmower equipped with a fluid chemical sprayer. US Patent No. 5,237,803 issued August 24, 1993, to Domingue, Jr. discloses a "bushhog" or "batwing" cutting apparatus equipped with a fluid chemical sprayer. The sprayers are located above the blade and within the housing of the mower so that the spray of treatment fluid is confined to the area immediately beneath the housing as the mower moves over the ground. The treatment fluid is dispersed by the centrifugal force generated by the rotating blade, or is released above the blade of the mower, so that a portion of the fluid vaporizes as it impinges the housing and/or the rotating blade of the mower. Nevertheless, the treatment fluid may fall onto the ground around the plant, and the vaporized treatment may be carried by the wind onto surrounding land. In
addition, none of these apparatus are capable of cutting vegetation and treating the cut vegetation in a non-horizontal orientation, such as from the end of a hinged boom arm.

US Patent No. 2,878,633 issued March 24, 1959, to Mullin and US Patent No. 3,090,187 issued May 21, 1963, to Livingston each disclose a rotary lawnmower equipped with means for distributing a treatment fluid to the rotating blade of the mower. The Mullin patent further discloses conduit means for delivering the treatment fluid to an axial bore formed in the rotating shaft of the mower which terminates at an orifice formed in the underside of the blade. The centrifugal force of the rotating blade, however, throws the treatment fluid out from the orifice in droplet form. The Livingston patent further discloses a longitudinal groove formed in the leading edge of the blade for delivering the treatment fluid to the underside of the tip of the blade. Accordingly, the treatment fluid is applied directly to the freshly cut stem of the plant. The distributing means of the Livingston mower, however, is open to the atmosphere. Thus, the treatment fluid may be spilled onto the surrounding ground, or vaporized and carried by the wind onto the surrounding land.

US Patent No. 4,926,622 issued May 22, 1990, to McKee discloses a rotary brush cutter and herbicide applicator. The cutter includes a plurality of cutting blades and the applicator includes means for delivering the herbicide adjacent the cutting blades so that the herbicide is applied to the brush as it is being cut by the rotating cutting blades. In one embodiment, the applicator further includes a closed conduit for transporting the treatment fluid from a container mounted on the housing of the rotary cutter to an outlet port adjacent the cutter blade. The conduit includes an elongate tube fixed to the external surface of the rotating blade so that the outlet port is in fluid communication with the axial shaft of the rotary cutter. The tube, however, may break or kink as the blade bends longitudinally, and is subject to being punctured or torn away if the blade strikes a relatively immovable rock or stump.

As is apparent from the limitations of the above rotary mowers, an apparatus and method is needed for cutting vegetation and treating the cut vegetation with a treatment fluid which does not broadcast the treatment fluid onto the surrounding ground or into
the atmosphere. Accordingly, it is an object of the invention to provide an apparatus and method for cutting vegetation and simultaneously applying a treatment fluid to the remaining stems of the cut vegetation without broadcasting the treatment fluid onto the surrounding ground or into the atmosphere.

It is another and more particular object of the invention to provide an apparatus and method for cutting and simultaneously treating the remaining stems of the cut vegetation which includes means for delivering a treatment fluid to the underside of a cutting blade so that a stream of treatment fluid is continuously available to the remaining stems of the vegetation.

It is another object of the invention is to provide an apparatus and method for cutting and simultaneously treating the remaining stems of the cut vegetation by introducing a treatment fluid to the transpiration stream of the vegetation.

It is another object of the invention to provide an apparatus and method for cutting vegetation and simultaneously applying a treatment fluid to the remaining stems of the cut vegetation which is capable of being used in any orientation, and in particular in any inclination from horizontal including vertical.

It is another object of the invention to provide an apparatus and method for cutting vegetation which includes a removable, hermetically sealed fluid container means for containing the treatment fluid.

It is another and more particular object of the invention to provide a method and apparatus for cutting and treating vegetation with a treatment fluid which minimizes spillage, waste and spoilage of the treatment fluid.

It is another object of the invention to provide an apparatus and method for cutting vegetation and simultaneously applying an accurate amount of a treatment fluid to the remaining stems of the cut vegetation.

It is another and more particular object of the invention to provide an apparatus and method for cutting and simultaneously
treating vegetation which includes a flow control means for accurately metering the amount of treatment fluid that is delivered to the cutting blade.

It is another and more particular object of the invention to provide an apparatus and method for cutting and simultaneously treating vegetation which includes a ground speed detection means for detecting the ground speed of the mower so that the desired amount of treatment fluid is applied to the remaining stems of the cut vegetation.

It is another object of the invention to provide an apparatus and method for recording the location and the volume of a treatment fluid that is applied to powerline right-of-ways and highway medians and roadsides.

SUMMARY OF THE INVENTION

The invention is an apparatus and method for cutting vegetation and simultaneously treating the remaining stems of the cut vegetation with a treatment fluid such as a growth regulator, herbicide, pesticide, fungicide, fertilizer, adjuvant, surfactant or biological agent, which is preferably water-born. The treatment fluid is applied without broadcasting, such as by spraying, the treatment onto the surrounding ground or into the atmosphere. Instead, the treatment fluid is delivered from a hermetically sealed fluid container through a fluid conduit to the underside of the cutting blade in a continuous fluid stream. Accordingly, the treatment fluid is continuously available to the cut ends of the remaining stems at the time that the vegetation is cut so that at least about 75-95% of the treatment fluid is absorbed directly into the transpiration stream of the plant in near zero time, thereby maximizing the efficacy of the treatment and vastly reducing the required amount of treatment fluid as well as amount of active ingredient.

The apparatus includes a mower, a cutting blade drive means for rotating a cutting and treating means including at least one cutting blade assembly rotatably mounted on a blade carrier, a fluid container means for containing the treatment fluid, a flow control
means for metering the amount of treatment fluid delivered to the cutting and treating means, and fluid conduit means for delivering the treatment fluid from the fluid container means to the cutting and treating means.

The mower may be any maneuverable tool for cutting vegetation which is movable over the ground, or above the ground such as for trimming hedges, trees and orchards. For example, the mower may be a push lawnmower, a conventional power lawnmower, a riding lawnmower, an engine driven tractor, a bushhog mower, a batwing mower, a harvester, a hydraulic feller buncher, a high speed saw head, a high speed shear head, a sickle bar, a multiple disk mower, a reel mower, a flail mower or a mower head attached to the end of a hinged boom arm. For purposes of illustration only, the mower described herein is a conventional bushhog mower which is attached to the rear of an agricultural tractor.

The mower preferably includes a generally planar mower deck having a central opening therethrough for receiving the cutting blade drive means therein, a pair of generally linear, opposed sides, a generally linear front wall and an arcuate rear wall. At least a portion of the rear wall may include a plurality of short lengths of debris chain for preventing debris, such as loose stones, from being expelled from the underside of the mower deck. The mower is provided with at least one wheel secured to the mower deck for facilitating movement over the ground and for supporting the cutting and treating means at the desired height above the ground. A plurality of upright stanchions are fixed to the top surface of the mower deck for retaining the fluid container means therebetween.

The cutting blade drive means is secured to the mower deck and includes an elongate drive shaft received within the central opening of the mower deck. The cutting blade drive means is preferably powered by the power takeoff from the tractor which pulls the mower. However, the cutting blade drive means may be powered by a gasoline engine, or a hydraulic motor mounted to the topside of the mower deck. In a preferred embodiment, a bevel gear is provided adjacent one end of the drive shaft for engaging the rotating shaft of the power take-off of the tractor. The cutting and treating means is secured to the other end of the drive shaft. Regardless, the cutting blade drive means rotates the drive shaft of the cutting
blade drive means which in turn rotates the blade carrier and at least one cutting blade assembly of the cutting and treating means. The drive shaft of the cutting blade drive means has a fluid conduit formed therein defining a continuous fluid passageway so that the drive shaft of the cutting blade drive means is in fluid communication with the pumping means and the cutting and treating means.

The cutting and treating means is secured to the drive shaft of the cutting blade drive means adjacent the underside of the mower deck, and includes at least one cutting blade assembly rotatably mounted on a blade carrier. The blade carrier may be any shape for mounting the at least one cutting blade assembly thereon. In a preferred embodiment, the blade carrier is an elongate bar having a central opening for receiving the cutting blade drive means therein, and at least one opening adjacent an end of the bar for receiving a cutting blade assembly therein. A lengthwise fluid conduit is provided between the central opening and the opening adjacent the end of the bar. The fluid conduit defines a continuous fluid passageway so that the drive shaft of the cutting blade drive means is in fluid communication with the cutting blade assembly. In another preferred embodiment, the blade carrier is a generally planar disk having a plurality, and preferably four orthogonally spaced, cutting blade assemblies mounted thereon.

At least one cutting blade assembly is rotatably mounted adjacent an end of the blade carrier. Preferably, a cutting blade assembly is mounted adjacent each of the opposed ends of the blade carrier. The cutting blade assembly includes a cutting blade shaft and a cutting blade hub secured on the cutting blade shaft. The cutting blade hub includes a cutting blade disposed outwardly therefrom. Preferably, the underside of the hub is saucer-shaped so that if the hub strikes an obstacle on the ground in the path of the cutting blade, the hub will travel over the obstacle without transferring a shock to the cutting blade. The leading edge of the cutting blade is beveled to provide a sharp cutting edge. The cutting blade assembly has a fluid conduit formed therein defining a continuous fluid passageway so that the fluid conduit provided in the blade carrier is in fluid communication with the underside of the cutting blade.
The fluid container means is secured between the upright stanchions provided on the topside of the mower deck. The fluid container means includes at least one substantially hollow, hermetically sealed fluid container cell containing the fluid treatment. In a preferred embodiment, the fluid container means includes a plurality of stacked, interlocking, removable, interconnected fluid container cells. Each of the cells is made of a material which is substantially resistant to ultraviolet light, such as polyurethane, polyethylene or polyvinylchloride (PVC) plastic.

An inlet port and an outlet port is provided on each cell and fitted with the female portion of a double end shutoff fitting. The male portion of the fitting engages the female portion of the fitting to permit treatment fluid to flow from an upper cell to a lower cell, and from the lowermost cell to a bulkhead fitting adjacent the pumping means. A flexible fluid conduit connects the outlet port of each upper cell to the inlet port of the next lowest cell. The flexible fluid conduit from the outlet port of the bottommost cell passes through the pumping means and is connected to a fitting provided on the housing of the cutting blade drive means. Accordingly, the fluid container means is in fluid communication with the cutting blade drive means. The male portion of the fitting which engages the female portion of the fitting in the inlet port of the uppermost cell is connected to an in-line filter and breather cap for venting the fluid container cells to the ambient atmosphere. The filter prevents debris, insects, etc. from entering the system without restricting the entry of ambient air.

The cells are stacked so that the bottommost cell is automatically filled with the treatment fluid from the upper cells as the treatment fluid is applied to the vegetation. Any number of cells may be filled at a remote location so that the treatment fluid is not spilled at the worksite where it may contact workers, contaminate the surrounding soil or the underground water supply. The cells are hermetically sealed so that the treatment fluid will not spoil or lose potency. A predetermined number of pre-filled cells may be stacked so that the user need not interrupt the cutting and treating operation to refill cells or to replace empty cells. The emptied cells are returned to a formulator for refilling without
the need for rinsing at the treatment site and are never disposed of in public land fills or dumpsters.

The flow control means meters the amount of the treatment fluid which is delivered by the pumping means to the underside of the cutting blade. The flow control means includes a control unit which is electrically coupled to a ground speed detection means. The ground speed detection means includes a sensor for detecting the angular velocity of the rear wheel of the tractor, and thus the estimated ground speed of the mower. In a preferred embodiment, a ground speed detection means is provided adjacent each of the rear wheels of the tractor and the angular velocity of the rear wheels is averaged and multiplied by a correction factor to more accurately estimate the ground speed of the tractor. The control unit is also electrically coupled to a DC stepper drive motor which drives the pumping means so that the desired amount of treatment fluid is applied to the vegetation in the area being treated.

The fluid conduit means defines a continuous fluid passageway so that the fluid container means is in fluid communication with the cutting blade assembly of the cutting and treating means. The fluid conduit means includes the flexible conduit extending between the outlet port of the bottommost fluid container cell and the fluid fitting provided on the housing of the cutting blade drive means, the continuous fluid passageway defined by the fluid conduit of the cutting blade drive means, the continuous fluid passageway defined by the blade carrier, and the continuous fluid passageway defined by the cutting blade assembly. Accordingly, the fluid conduit means forms a continuous fluid passageway for delivering the treatment fluid to the underside of the cutting blade so that a stream of treatment fluid is continuously available to the remaining stems of the vegetation at the time that the vegetation is cut.

BRIEF DESCRIPTION OF THE DRAWINGS

While some of the objects and advantages of the invention have been stated, others will become apparent as preferred embodiments of the invention are described in connection with the accompanying drawings in which:
FIG. 1a illustrates a preferred embodiment of a power lawn mower according to the invention;

FIG. 1b illustrates a preferred embodiment of a bush hog mower according to the invention;

FIG. 2 is a schematic flow diagram illustrating the preferred components of an apparatus for cutting and treating vegetation according to the invention;

FIG. 3 is an enlarged perspective view of the bush hog mower of FIG. 1b;

FIG. 4a is a sectional view of the cutting blade drive means of the bush hog mower of FIG. 1b;

FIG. 4b is an enlarged view of the cutting blade drive means of FIG. 4a;

FIG. 5a is an elevation view and partial sectional view of the cutting and treating means of the bush hog mower of FIG. 1b;

FIG. 5b is a top view of the cutting and treating means of the bush hog mower of FIG. 1b;

FIG. 5c is an enlarged view of the partial sectional view of FIG. 5a;

FIG. 5d is top view of the cutting blade hub taken along line 5d-5d of FIG. 5a;

FIG. 6a is an elevation view and partial sectional view of an alternative embodiment of the cutting and treating means of the bush hog mower of FIG. 1b;

FIG. 6b is a top view of an alternative embodiment of the cutting and treating means of the bush hog mower of FIG. 1b;

FIG. 6c is an elevation view and partial sectional view of an alternative embodiment of the cutting and treating means of the bush hog mower of FIG. 1b;
FIG. 7 is a perspective view of the fluid container means of the bushog mower of FIG. 1b;

FIG. 8 is a perspective view of a FLO-THRU CELL® of the fluid container means of the bushog mower of FIG. 1b;

FIG. 9 is a side view of the FLO-THRU CELL™ of FIG. 8;

FIG. 10 is an end view of the FLO-THRU CELL™ of FIG. 8;

FIG. 10a is a sectional view of the FLO-THRU CELL™ of FIG. 10 taken along line 10a-10a;

FIG. 11 is a perspective view showing the preferred components of the flow control means of the bushog mower of FIG. 1b;

FIG. 12 is an end view of the flange carrier of the flow control means of FIG. 11;

FIG. 13 is a sectional view of the flange carrier of the flow control means of FIG. 12 taken along line 13-13;

FIG. 14 is a front view of the controller of the flow control means of FIG. 12;

FIG. 15 is a schematic flow diagram illustrating the connection of the preferred components of the flow control means of FIG. 12;

FIG. 16 is a schematic diagram illustrating the preferred components of the power lawnmower of FIG. 1a;

FIG. 17a is a perspective view of the blade carrier of FIG. 16;

FIG. 17b is a perspective view of an alternative embodiment of the blade carrier of FIG. 16;

FIG. 18 is a top view of the center portion of the blade carrier of FIG. 17a;
FIG. 19 is a sectional view of an alternative embodiment of a portion of the cutting blade drive means and a portion of the cutting and treating means of a mower according to the invention;

FIG. 20 is a sectional view of an alternative embodiment of a portion of the cutting blade drive means and a portion of the cutting and treating means of a mower according to the invention;

FIG. 21 is a perspective view of a hydraulic feller buncher according to the invention attached to the forward boom arm of a tractor;

FIG. 22 is a perspective view of a high speed saw head according to the invention and adapted for use on the hydraulic feller buncher of FIG. 21;

FIG. 23 is a perspective view of a high speed shear head according to the invention and adapted for use on the hydraulic feller buncher of FIG. 21;

FIG. 24 is a partial sectional view of a portion of the fluid conduit means of the apparatus for cutting and treating vegetation according to the invention illustrated in FIGS. 25-32.

FIG. 25 is a top view of a sickle bar according to the invention;

FIG. 26 is an end view of the sickle bar of FIG. 25;

FIG. 27 is a top view of a multiple disk mower according to the invention;

FIG. 28 is a side view of one of the disk of the multiple disk mower of FIG. 27;

FIG. 29 is a side view of a reel mower according to the invention;

FIG. 30 is an enlarged view of the stationary blade of the reel mower of FIG. 29 showing an alternative embodiment of the treatment fluid exit ports;
FIG. 31 is a side view of a flail mower according to the invention;

FIG. 32 is a top view of the flail mower of FIG. 31; and

FIG. 33 is a partial sectional view of an alternative embodiment of a portion of the fluid conduit means of the apparatus for cutting and treating vegetation according to the invention illustrated in FIGS. 25-32.
DETAIL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the accompanying drawings in which preferred embodiments of the invention are shown, FIGS. 1a and 1b illustrate apparatus, indicated generally at 40, for cutting vegetation and simultaneously treating the remaining stems of the cut vegetation with a treatment fluid. The treatment fluid may be any treatment fluid which is applied to vegetation such as a growth regulator, herbicide, pesticide, fungicide, fertilizer or biological agent, depending on the desired result. Preferably, the treatment fluid is water-born. However, the treatment fluid may be born by any substance which combines with the treatment fluid to produce a non-viscous, flowable fluid. The apparatus 40 delivers the treatment fluid to the underside of the cutting blade so that a stream of treatment fluid is continuously available to the remaining stems of the cut vegetation at the time that the vegetation is cut. It has been discovered that a physical phenomenon occurs at the time that vegetation is cut. Fluid in the vicinity of the cut end of the remaining stem of the plant is drawn into the transpiration stream in zero time, and migrates through the transpiration stream to the root system of the plant. This phenomenon has been termed, and is referred to herein as, the "Burch effect".

The Burch effect has led to the development of an apparatus and method, referred to herein as the "BURCH WET BLADE™ system", which takes advantage of the Burch effect to minimize the amount of treatment fluid required to treat the vegetation, and to maximize the efficacy of the treatment. Specifically, the BURCH WET BLADE™ system does not broadcast the treatment fluid, such as by spraying or by treating and spreading treated cuttings, onto the surrounding ground or into the atmosphere. At least about 75-95% of the treatment fluid which is continuously available at the time that the vegetation is cut is absorbed into the transpiration stream of the remaining stems of the cut vegetation. Accordingly, practically none of the treatment fluid is wasted, is inadvertently applied to desirable vegetation, or contaminates the surrounding soil and the underground water system.

The BURCH WET BLADE™ system may be configured for use with any apparatus 40 having at least one cutting blade and a means for delivering a continuous stream of treatment fluid to the underside
of the cutting blade. For example, the apparatus 40 may be a push lawnmower, a conventional power lawnmower, a riding lawnmower, an engine driven tractor, a bushhog mower, a batwing mower, a harvester, a hydraulic feller buncher, a high speed saw head, a high speed shear head, a sickle bar, a multiple disk mower, a reel mower, a flail mower or a mower head attached to the end of a hinged boom arm, as long as the mower is equipped with suitable means for delivering the continuous stream of treatment fluid to the cut vegetation. In addition to cutting and treating vegetation along right-of-ways and highway medians and roadsides, there are numerous other applications in vegetation management, such as agricultural, turf, ornamental, forestry, and aquatics, wherein the utilization of a non-broadcasting apparatus and method for cutting and treating vegetation is useful, beneficial and practical, including the application of biological agents to the internal transpiration streams of plants due to the reduced risk of exposure and the increased efficacy.

For purposes of illustration only, FIG. 1a is a perspective view of a power lawnmower 41 equipped with the BURCH WET BLADE™ system. FIG. 1b is a perspective view of a bushhog mower 42 equipped with the BURCH WET BLADE™ system and attached to the rear of a tractor 43. The bushhog mower 42 is utilized herein only to illustrate preferred embodiments of the BURCH WET BLADE™ system. As previously stated, the BURCH WET BLADE™ system may be utilized with any apparatus 40 for cutting vegetation and simultaneously treating the cut vegetation with a treatment fluid, and for numerous other vegetation management applications.

FIG. 2 is a schematic flow diagram of the preferred components of the BURCH WET BLADE™ system. Preferably, bushhog mower 42 is powered by a conventional power take-off 44 from the tractor 43. The power take-off 43 cooperates with cutting blade drive means 60 for driving cutting and treating means 90. Fluid container means 130 is provided for containing the treatment fluid in a plurality of sealed cells, as will be described hereinafter. Pumping means 150 pumps the treatment fluid from the fluid container means 130 through the cutting blade drive means 60 to the cutting and treating means 90. Flow control means 160 may be provided for metering the amount of the treatment fluid which is delivered by pumping means 150 to cutting and treating means 90. Fluid conduit means 190
defines a continuous fluid passageway for delivering the treatment fluid from fluid container means 130 to cutting and treating means 90 which is small enough in diameter so that the passageway is continuously filled with treatment fluid regardless of the ground speed of the mower under normal mowing conditions. Thus, the fluid conduit means 90 delivers a continuous stream of treatment fluid at a variable fluid column rate of flow which results in a constant volume of treatment fluid, usually measured in gallons per acre, being applied to the area being treated, while the fluid passageway remains completely filled.

FIG. 3 is an enlarged perspective view of the bushog mower 42. Bushog mower 42 may be any conventional bushog mower. As shown, the bushog mower 42 is a model A-72 manufactured by Alamo Industrial of Seguin, Texas, which is modified to be equipped with the BURCH WET BLADE™ system. The cutting blade drive means 60 of bushog mower 42 is powered by the power take-off 44 from tractor 43. Power take-off 44 may comprise a rotating drive shaft (not shown) which cooperates with cutting blade drive means 60 as will be described to rotate cutting and treating means 90 at speeds between about 12,000 feet per minute (fpm) and 19,000 fpm at the tip of the cutting blade. Accordingly, each cutting blade of the bushog mower 42 may approach a speed of about two hundred (200) miles per hour.

Bushog mower 42 comprises a mower deck 50 for mounting cutting blade drive means 60 thereto and for housing cutting and treating means 90. Fluid container means 130 and pumping means 150 are preferably mounted to mower deck 50, but may be mounted to tractor 43. Flow control means 160 and fluid conduit means 190 are mounted to mower deck 50 and to tractor 43 as required. One end of attachment means 45 is mounted to mower deck 50, and the other end is secured to tractor 43 so that mower 42 may be pulled behind the tractor.

Mower deck 50 may be any size and shape necessary to mount cutting blade drive means 60 thereon, and to house cutting and treating means 90. As shown, mower deck 50 comprises a generally planar, horizontal topside 51, a generally planar, horizontal underside 52 opposite topside 51, a pair of opposed, generally planar sides 53 depending vertically downward from topside 51, a generally planar front edge 54 depending vertically downward from
topside 51, and an arcuate rear edge 55 depending vertically downward from topside 51. Horizontal bottomside 52 and vertically depending sides 53, front edge 54 and rear edge 55 form an integral housing for enclosing cutting and treating means 90. Rear edge 55 preferably comprises a plurality of debris chains 56 for preventing large objects, such as stones, from being ejected rearwardly from underneath the mower. A second plurality of debris chains 56 depending downwardly from bottomside 52 may be provided for preventing large objects from being ejected frontwardly from underneath the mower.

Mower deck 50 has a central opening 57 therethrough for receiving cutting blade drive means 60 therein as will be described. At least one, and preferably two, wheels 58 are secured to the topside 51 of mower deck 50 for supporting the cutting blades of the mower 42 at a suitable height above the ground. The wheels 58 are preferably adjustable so that the elevation of the mower deck 50, and thus the distance of the cutting blades from the ground, may be positioned at any height. The mower deck 50, as described thus far, is a conventional mower deck of a bush hog mower and may be replaced with any mower deck adapted for mounting cutting blade drive means 60 thereon and housing cutting and treating means 90.

The cutting blade drive means 60 is mounted to the topside 51 of the mower deck 50 adjacent the central opening 57. A power means, such as a gasoline engine or a hydraulic motor, for powering cutting blade drive means 60 may be secured to the topside 51 of the mower deck 50. As previously described, however, cutting blade drive means 60 is preferably powered by power take-off 44 from tractor 43. FIG. 4 is a sectional view of the cutting blade drive means 60 of the bush hog mower 42. The cutting blade drive means 60 comprises a bevel gear 61 for cooperating with a driving gear (not shown) provided on the end of the rotating drive shaft of the power take-off 44. Bevel gear 61 in turn transfers the torque from the rotating drive shaft of the power take-off 44 to a drive shaft 62 which is rotatably received in central opening 57 of mower deck 50. The drive shaft 62 is rotated at a rate determined by the revolutions per minute of the rotating drive shaft of the power take-off 44 (or hydraulic motor) and the ratio of the teeth of the driving gear to the teeth of the bevel gear 61 (or the ratio of the hydraulic pump to the hydraulic motor).
Cutting blade drive means housing 63 is secured by capscrews 64 to an I-beam stiffener 65 which is fixed to the topside 51 of mower deck 50. Annular, lower spherical bearing 66 and annular, upper spherical bearing 67 are positioned within a central opening provided in housing 63 to permit drive shaft 62 to rotate freely. The upper end 68 of drive shaft 62 is externally threaded to receive a hex nut 69 for securing bevel gear 61 thereon. The lower end 70 of drive shaft 62 is likewise externally threaded to receive a hex nut 71 for securing cutting and treating means 90 thereon as will be described. The cutting blade drive means 60, as described thus far, is a conventional cutting blade drive means of a bushhog mower and may be replaced by any conventional cutting blade drive means adapted to transfer torque to rotating drive shaft 62 for driving cutting and treating means 90.

Most importantly, an opening 72 provided in the base 73 of cutting blade drive means housing 63 is tapped and threaded to receive a fluid-tight fitting 74. Fitting 74 is adapted to be in fluid communication with fluid container means 130 as will be described. An annular flange 75 is secured to the underside of the base 73 of housing 63 by capscrews 64. Flange 75 comprises a medial wall 76 having a circumferential pocket 77 formed therein. A well 78 is formed in the upper surface of the flange 75 opposite opening 72 in housing 63. The well 78 terminates in a radial bore 79 formed in flange 75. Bore 79 is closed by a fluid-tight setscrew 80 at one end and extends inwardly to pocket 77.

A first radial bore 81 is formed in drive shaft 62 adjacent the pocket 77 of flange 75. Annular upper and lower seals 82, such as Federal Mogul Part No. 62-85-8, form a fluid-tight seal between the pocket 77 and the external surface of drive shaft 62 so that bore 79 of flange 75 is in continuous fluid communication with bore 81 of drive shaft 62. Bore 81 extends inwardly and terminates in a longitudinally extending axial bore 83 formed in drive shaft 62 and closed by a fluid-tight setscrew 84. A second radial bore 85 formed in drive shaft 62 extends outwardly from axial bore 83 for communicating with cutting and treating means 90 as will be described. The setscrew 84 is guarded, such as by countersinking as shown, from striking immovable objects and is removable to permit clean-out of axial bore 83.
FIG. 5a is an elevation view and partial sectional view, and FIG. 5b is a top view, of the cutting and treating means 90 of the bush hog mower 42. Cutting and treating means 90 comprises blade carrier 92 and at least one cutting blade assembly 100. Preferably, as shown, cutting and treating means 90 comprises a pair of radially opposed cutting blade assemblies 100. Blade carrier 92 preferably comprises an upper half 91 and a reverse, or mirror, lower half 93 secured to the upper half in fluid-tight arrangement. Lower half 93 has a plurality of internally threaded holes for receiving a plurality of countersunk hex head bolts therein to secure upper half 91 to lower half 93. A suitable gasket (not shown) may be utilized to provide a fluid-tight seal between upper half 91 and lower half 93. A central opening 94 is provided at the center of blade carrier 92 for receiving drive shaft 62 of cutting blade drive means 60 therethrough. An opening 95 is also provided in carrier blade 92 for receiving each at least one cutting blade assembly 100 therethrough adjacent a radially outer end of the blade carrier.

As best shown in FIG. 4, the lower end 86 of drive shaft 62 received in central opening 94 of blade carrier 92 is externally threaded with male threads. The central opening 94 of blade carrier 92 is internally threaded, preferably with female threads to engage the male threads of lower end 86 of drive shaft 62 so that the blade carrier remains tightly secured to the cutting blade drive means 60. An annular spacer 87 is received on drive shaft 62 between a shoulder 88 provided on the shaft and the upper half 91 of blade carrier 92 for spacing the blade carrier from the bottomside 52 of mower deck 50. Spacer 87 is made of a hard, rigid metal such as 5160 steel, while blade carrier 92 is made of a softer, somewhat flexible metal for a purpose to be described. A lock washer and a hex head jam nut 89 are threaded onto the lower end 86 of drive shaft 62 to secure spacer 87 and blade carrier 92 tightly against shoulder 88.

A fluid channel 96 (FIG. 4) is formed in upper half 91 and lower half 93 of blade carrier 92 and extends outwardly from central opening 94 in the direction of opening 95. A first circumferential pocket 97 is formed in a medial portion of central opening 94 adjacent second radial bore 85 of drive shaft 62 so that channel 96 is in continuous fluid communication with radial bore 85 as the shaft rotates the cutting and treating means 90. Channel 96
terminates in a second circumferential pocket 98 (FIG. 5c) formed in a medial portion of opening 95 so that blade carrier 92 is in fluid communication with each at least one cutting blade assembly 100.

As shown in FIG. 5c, cutting blade assembly 100 comprises a shaft 102 which is rotatably received in opening 95 so that the cutting blade assembly can rotate relative to the blade carrier 92 if the cutting blade 105 strikes an immovable object, such as the top of a buried rock. The upper end 101 of shaft 102 has a hex head jam nut formed thereon for removing and replacing a cutter blade hub 104 on blade carrier 92 as will be described. The lower end 103 of shaft 102 is externally threaded with male threads for receiving the cutting blade hub 104 thereon. Cutting blade hub 104 is internally threaded, preferably with female threads to engage the male threads of lower end 103 of shaft 102 so that the cutting blade hub remains tightly secured to the shaft of the cutting blade assembly.

An annular lower spherical bearing 106 and an annular upper spherical bearing 107 are press fit into opening 95 of blade carrier 92 to permit shaft 102, and thus cutting blade assembly 100, to rotate as required. An upper boss 108 is welded to the upper half 91 of the blade carrier 92, and a lower boss 109 is welded to the lower half 93 of the blade carrier 92 to secure the upper and lower bearings in opening 95. The cutting blade assembly 100, as described thus far, is a conventional cutting blade assembly for a bushhog mower and may be replaced with any cutting blade assembly adapted for mounting at least one cutting blade 105 on blade carrier 92 for cutting vegetation and treating the cut vegetation with a treatment fluid.

A radial bore 110 is formed in shaft 102 adjacent the circumferential pocket 98 of blade carrier 92. Annular upper and lower seals 82, such as Federal Mogul Part No. 62-85-8, form a fluid-tight seal between the pocket 98 and the external surface of shaft 102 so that the radial bore 110 of the shaft is in continuous fluid communication with the channel 96 of carrier blade 92. Radial bore 110 extends inwardly and terminates in a longitudinally extending axial bore 111 formed in shaft 102 and closed by a fluid-tight plug 112 which is welded to the underside of cutting blade hub 104. The plug 112 is stepped to define a fluid reservoir between
one-half of the lower surface of the lower end 103 of shaft 102 and one-half of the upper surface of the plug.

A bore 113 is formed in cutting blade hub 104 and closed by a fluid-tight set screw 114 on the side opposite the cutting blade 105. The bore 113 extends outwardly from the fluid reservoir in the direction of cutting blade 105 and terminates adjacent a small gap 115 between the cutting blade hub 104 and the underside 116 of the cutting blade. The gap 115 is preferably between about .25 and 1.0 inches wide, and more preferably is about .5 inches wide. It has been discovered that the width of gap 115 is essential to the operation of the BURCH WET BLADE™ system. If the gap 115 is too wide (i.e., greater than about 1.0 inch wide), there is insufficient capillary attraction of the treatment fluid to the underside 116 of the cutting blade 105 to maintain a continuous stream of treatment fluid. If the gap 115 is too small (i.e., less than about .25 inches wide), the droplets of treatment fluid exiting the bore 113 are not thinned and the capillary attraction may not be sufficient to maintain the continuous stream of treatment fluid on the underside 116 of the cutting blade 105. Accordingly, the treatment fluid may be broadcast and contaminate the surrounding soil and the underground water system. Bore 113 may also be rifled to impart a slight vortex to the column of treatment fluid exiting the bore. It is believed that the vortex motion of the column improves the capillary attraction of the continuous stream of treatment fluid to the underside of the cutting blade by preventing the droplets from expanding radially in the gap 115.

Fig. 6a is an elevation view and partial sectional view, and Fig. 6b is a top view, of an alternative embodiment of the cutting and treating means 90 of the bush hog mower 42. The cutting and treating means 90 comprises a disk-shaped blade carrier 122 and four orthogonally spaced cutting blade assemblies 100. The disk blade carrier 120 preferably comprises an upper half 121 secured to a lower half 123 as previously described and as illustrated in the partial sectional view of Fig. 6a. However, second radial bore 85 formed in drive shaft 62 may be located above the top surface of the disk blade carrier 122 for communicating with a conduit 124 extending between the second radial bore and axial bore 111 of shaft 102 in the manner previously described as illustrated in Fig. 6c. When conduit 124, or any other fluid treatment conduit is located
above the disk blade carrier 122 and below the mower deck 50, an annular ring guard 125 depending vertically downward from the bottomside 52 of the mower deck is preferably utilized to prevent large objects, such as stones, from striking and damaging the conduit 124.

FIG. 7 is a perspective view of the fluid container means 130 of the bushog mower 42. Fluid container means 130 comprises at least one fluid container cell 132, referred to herein as a Burch FLO-THRU CELL™, made of a material which is substantially resistant to ultraviolet light, such as polyurethane, polyethylene or polyvinylchloride (PVC) plastic. Preferably, as shown, fluid container means 130 comprises a plurality of FLO-THRU CELLS™ 132 removably stacked and supported on the topside 51 of mower deck 50 between stanchions 59. Cells 132 are restrained against horizontal movement by stanchions 59, and a strap (not shown) may be utilized to restrain the cells 132 against vertical movement. The FLO-THRU CELLS™ 132 may be filled with the treatment fluid at a remote location and then transported to the worksite to prevent the possibility of a spill that may contaminate the surrounding soil and the underground water supply at the worksite. The cells 132 may also be filled under vacuum and hermetically sealed to preserve the potency of the formulation. Thus, the Burch FLO-THRU CELLS™ provide an environmentally safe and effective means for supplying the treatment fluid to the mower 42. It should be noted that fluid container means 130 may be utilized with a variety of rotary mowers and is not limited to use with the bushog mower 42 described herein.

FIG. 8 is a perspective view, FIG. 9 is a side view and FIG. 10 is an end view of a FLO-THRU CELL™ 132 of the fluid container means 130 of the bushog mower 42. Each cell 132 comprises a topwall 133, sidewalls 134, a front endwall 135, a rear endwall 136 and a bottomwall 137. Each cell 132 further has an inlet port 138 and an outlet port 139 formed therein. As illustrated in FIG. 10a, each inlet port 138 is configured with the female end 140 of a double end shutoff fitting 141, such as a Parker POLY-TITE® Fitting Part No. 398PD, manufactured by Parker Hannifin Corporation of Otsego, Michigan, to receive the male end 142 of the coupler fitting. The male end 142 of the fitting comprises a spring-loaded release arm so that the fitting 141 may be readily disconnected to replace an
empty FLO-THRU CELL™ 132. A first segment of flexible tubing extends outwardly from the lowermost cell 132 and is connected to a second segment of flexible tubing with a Parker POLY-TITE® bulkhead fitting through the wall of the housing of the pumping means 150. The second segment of flexible tubing passes through the pumping means 150 and terminates at the fitting provided on the housing 63 of the cutting blade cutting blade drive means 60.

As seen in FIG. 10, an in-line filter and breather cap 145 allows ambient air to enter the fluid container cell 132 so that a partial vacuum does not develop and inhibit the flow of the treatment fluid as pumping means 150 extracts the treatment fluid from the cell. Each FLO-THRU CELL™ 132 further has a handhold 142 disposed on front endwall 135 and rear endwall 136 for assisting an operator to transport a filled cell. As seen in FIGS. 7 and 9, bottomwall 137 of cell 132 comprises a guide 152 and feet 154. Guide 152 slidably engages a groove 153 on the topwall 133 of a lower cell 132 and thereby substantially prevents lateral movement of the stacked FLO-THRU CELLS™ 132. In addition, feet 154 are also in contact with notches 124 on topside 133 to minimize relative motion between adjacent stacked cells 132.

A single FLO-THRU CELL™ 132 may be utilized if only a small area is to be cut, and thus a relatively small amount of treatment fluid is to be applied to the cut vegetation. A single cell 132 may also be utilized if it is desired to apply a predetermined number of FLO-THRU CELLS™ containing the same treatment fluid to an area, or if it is desired to apply different treatment fluids to the same area. For example, a first FLO-THRU CELL™ pre-filled with a fluid crabgrass herbicide treatment may be used to simultaneously apply crabgrass herbicide to the remaining stems of the vegetation at the same that the vegetation is cut. Thereafter, the FLO-THRU CELL™ containing the crabgrass herbicide may be removed and replaced with a second FLO-THRU CELL™ containing a cleansing solution to flush the fluid conduit means 190. The FLO-THRU CELL™ containing the cleansing solution may then be removed and replaced with a third FLO-THRU CELL™ containing a fluid fungicide. The height of the cutting blade above the surface of the ground is reduced to expose the remaining stems to the cutting blade, and the fungicide is applied as the vegetation is cut again.
However, it is preferred that at least two FLO-THRU CELLS™ 132 be used so that the level of the treatment fluid does not fall below the level of the outlet port 139 of the lowermost cell regardless of the orientation of the cutting blades of the mower relative to the FLO-THRU CELLS™ 132. The use of a plurality of FLO-THRU CELLS™ 132 permits an area to be treated at one time which would otherwise be too large to be safely treated with a single fluid container cell. Further, the use of a plurality of FLO-THRU CELLS™ 132 permits a large area to be treated at one time without the need to repeatedly discontinue the cutting and treating operation to refill a single large fluid treatment container. Instead, the upper FLO-THRU CELLS™ 132 may be readily removed and replaced with additional pre-filled cells.

Pumping means 150 (FIG. 3) pumps the treatment fluid from the fluid container means 130 to the cutting blade drive means 60 so that a stream of treatment fluid is continuously available to the transpiration streams of the remaining stems of the cut vegetation at the time that the vegetation is cut. Pumping means 150 comprises any type of variable capacity pump for pumping widely varying amounts of the treatment fluid depending on the speed of the mower over the surface of the ground, as will be described. Preferably, however, pumping means 150 is a peristaltic pump of the type available from TAT Engineering of Branford, Connecticut, which pumps the treatment fluid through fluid conduit means 190 via waves of contraction at a pressure of about 5 psi produced mechanically by a series of rollers compressing the flexible tubing containing the treatment fluid.

FIG. 11 is a perspective view of the preferred components of the flow control means 160, and FIG. 15 is a schematic flow diagram illustrating the connection of the preferred components of the flow control means. Flow control means 160 comprises a control unit 162 which is preferably powered by a power source from the tractor 43, such as 12 volt battery 161. Control unit 162 is electrically coupled to a ground speed detection means 164 preferably located on the rear axle 163 of tractor 43 adjacent each wheel 165. As shown in FIGS. 12 and 13, the detection means 164 comprises a cup-shaped flange carrier 166 having a hole pattern comprising holes 167 for receiving the lugs of the axle 163. The flange carrier 166 is positioned over the outer end of the axle 163 and extends inwardly.
so that the radially outwardly extending flange 168 of flange carrier 166 is adjacent an adjustable sensing means 170 secured to axle 163. Sensing means 170 is typically positioned within a removable housing (not shown) which protects the sensor 171 from the elements and debris which may come into contact with the axle 163.

Flange 168 is preferably made of a ferrous metal and comprises a predetermined plurality of radial teeth 172 spaced apart on the periphery of the flange. Sensor 171 is preferably a proximity sensor that detects the passing teeth 172 as the flange carrier 166 rotates with the shaft of axle 163. Sensor 171 may be any electronic sensor such as an inductance, magnetic or optical sensor, which produces an electrical signal proportional to the angular velocity of the flange carrier 166, and thus the speed of the wheel 165 of the tractor 43. A sensor which can detect through a viscous fluid, such as oil, may also be utilized so that the sensor may be located in the gear box of the rear axle, or in a speedometer cable attached to the rear axle of the tractor. Preferably, a separate ground speed detection means 164 is secured to each wheel 165 of the tractor 43 and the electrical signal from each detection means is provided to control unit 162. Thus, the electrical signal having the greatest velocity value may be selected, or the electrical signals from both detection means 164 may be combined and averaged, or may be combined, averaged and multiplied by a correction factor, so that the most accurate estimate of the ground speed of the bush hog mower 42 is determined.

FIG. 14 is a front view of the control unit 162, manufactured by ESSCO, Inc., of Greensboro, North Carolina, of the flow control means 160. The control unit 162 comprises an on-off switch 173 for providing power to the control unit from the 12 volt battery 161 of tractor 43. Switch 173 is preferably a combination 12 volt to 24 volt DC voltage converter and a 24 volt DC voltage regulator. Control unit 162 further comprises a programmable operator interface, such as a Mitsubishi MTA-10 processor 174 for processing predetermined data provided by the operator, such as the width of the cut made by the cutting and treating means 90 and the volume of treatment fluid to be applied to the area treated, and the electrical signals from the ground speed detection means 164. Processor 174 preferably comprises a data screen and keypad 175 for scrolling the command line displayed on data screen and for editing
the predetermined data utilized by the processor 174 to determine the ground speed of the mower 42.

Control unit 162 further comprises an on-off toggle switch 176 for powering pumping means 150, and a by-pass toggle switch 177 for by-passing the pumping means, for example when the operator desires to move the tractor 43 without applying treatment fluid to vegetation. Control unit 162 further comprises a green light-emitting-diode (LED) 178 for indicating that the pumping means 150 is powered and operating (i.e., for example when the tractor 43 is moving, or the by-pass is engaged for flushing treatment fluid from the conduit means 190), and a red LED 179 for indicating that the pumping means 150 is powered, but is not operating (i.e., for example when the tractor 43 is not moving).

Preferably, control unit 162 is also electrically coupled to a DC stepper drive motor 180 for driving the peristaltic pump of pumping means 150. Processor 174 provides an electrical signal to stepper drive motor 180 that is proportional to the estimated ground speed of the mower 42, and the stepper drive motor 180 drives the peristaltic pump in fine increments so that a controlled amount of treatment fluid is applied by the cutting and treating means 90 to the vegetation. Stepper drive motor 180 is preferably a 250 step linear drive motor of the type manufactured by Intelligent Motions Systems Inc., of Branford, Connecticut. The output shaft of stepper drive motor 180 is fixed to a first pulley 181 which drives a second pulley 182 fixed to the output shaft of the peristaltic pump of pumping means 150. The ratio of the first pulley 181 to the second pulley 182 may be any ratio, but is preferably 1.0/1.5 so that the maximum speed of the peristaltic pump is not exceeded.

Control Unit 162 may further comprise a global positioning satellite (GPS) transceiver 184 for communicating with a remote base station via a satellite. The transceiver 184 receives and transmits position data relating to the location of the tractor 43 and the mower 42 as the vegetation is being treated with the treatment fluid. Accordingly, a permanent record of the area that was treated can be maintained for purposes of, for example, disputing the tort claims of farmers and owners of land adjoining the right-of-way or roadside that a toxic treatment fluid was broadcast onto land adjacent the intended treatment area.
In an alternative embodiment, the ground speed detection means 164 may be mechanically coupled to the pumping means 150. For example, flange carrier 166 may comprise a sprocket in place of flange 168, and sensor 171 may mechanically engage the radial teeth 172 of the sprocket to drive the peristaltic pump of pumping means 150. Pumping means 150 may be directly driven by the sensor 171, or may be driven by any type of gear box for converting the output of the sensor so that the maximum speed of the peristaltic pump is not exceeded.

Fluid conduit means 190 defines a fluid passageway extending between fluid container means 130 and cutting and treating means 90. Fluid conduit means 190 delivers the treatment fluid to the underside of the cutting blade so that a stream of treatment fluid is continuously available to the vegetation at the time that the vegetation is cut. Fluid conduit means 190 preferably comprises a flexible tube 191 for example made of soft polyvinylchloride (PVC), which extends from the bottommost FLO-THRU CELL™ 132 through the rollers of the peristaltic pump of pumping means 150 to the fluid-tight fitting 74 provided on the exterior of the housing 63 of the cutting blade drive means 60. Fluid conduit means 190 further comprises well 78; radial bore 79 and circumferential pocket 77 formed in flange 75; radial bore 81, axial bore 83 and radial bore 85 formed in drive shaft 62; first circumferential pocket 97, fluid channel 96, and second circumferential pocket 98 formed in blade carrier 92; radial bore 110 and axial bore 111 formed in shaft 102 of cutting blade assembly 100; and radial bore 113 formed in cutting blade hub 104. Fluid conduit means 190 terminates adjacent gap 115 opposite the underside 116 of the cutting blade.

It is believed that the constant availability of the stream of treatment fluid at the time that the vegetation is cut is critical to the efficacy of the treatment. The combination of the capillary attraction of the underside of the cutting blade and the vortex of the treatment fluid ensures that the treatment fluid will always be available to the transpiration streams of the remaining stems of the vegetation at the time that the vegetation is cut regardless of the speed of rotation of the cutting blade, the ground speed of the mower or the orientation of the cutting blade relative to the FLO-THRU CELLS™. Accordingly, all of the treatment fluid is absorbed
into the transpiration streams of the plants when vegetation is available to the cutting blade.

FIG. 16 is a schematic diagram illustrating the preferred components of the power lawnmower 41 shown in FIG. 1a. Preferably the power lawnmower 41 comprises a fluid container means 230, a flow control means 260 and a pumping means 250 which are conceptually the same as fluid container means 130, flow control means 160 and pumping 150, respectively, as previously described. The primary variation being that the components of the power lawnmower 41 are scaled to the dimensions and capabilities of the lawnmower. A filter 200, such as an in-line gasoline filter, may also be inserted before the pumping means 150 to filter particulate matter from the treatment fluid before it is introduced to the cutting blade drive means 210. Cutting blade drive means 210 is conceptually the same as cutting blade drive means 60 previously described, but comprises a manifold 220, referred to herein as the Burch WET BAR™.

A typical blade 211 for a power lawnmower is made of soft metal, and is relatively thin and measures between about 18 and 30 inches in length. Thus, as indicated by the broken lines in FIG. 16, the blade 211 is flexible about the cutting blade drive means 210 so that the tip 212 of the blade 211 will deflect upwards if the blade strikes an immovable object. Accordingly, if the blade 211 were provided with a solid fluid conduit extending outwardly from the drive shaft of the cutting blade drive means 210, the conduit would buckle as the blade flexes. The Burch WET BAR™ permits the BURCH WET BLADE® system to be utilized on a power lawnmower having a flexible cutting blade.

FIG. 17a is a perspective view of the Burch WET BAR™ 220 secured to the cutting blade drive means 210 of the power lawnmower 41, and FIG. 18 is a top view of the center portion of the Burch WET BAR™ shown in FIG. 17a. The WET BAR™ 220 comprises a fluid conduit 221 which is in fluid communication with fluid container means 230 in the manner previously described. Accordingly, a continuous stream of treatment fluid is delivered to the underside of the blade 211 and is continuously available to the cut vegetation at the time that the vegetation is cut. FIG. 17b is a perspective view of an alternative embodiment of the Burch WET BAR™ 220. In this
embodiment, a solid fluid conduit 221 is positioned in a longitudinal channel 222 formed in the top surface of the WET BAR™ 220, and is welded to the WET BAR™ in a conventional manner. In still another embodiment, the thicker WET BAR™ 220 may be inverted and may replace the thinner blade 211 for appropriate applications.

ALTERNATIVE EMBODIMENTS

FIGS. 19 and 20 are sectional views of alternative embodiments of a portion of the cutting blade drive means 360 and a portion of the cutting and treating means 390 of a mower according to the invention. The treatment fluid passes through a cap 310 covering one end of the drive shaft 320 of the cutting blade drive means 360. The cap 310 may be any stationary cap which permits the treatment fluid to be transferred to the axial bore formed in the rotating drive shaft 320. But preferably, cap 310 is a two-piece swivel, or universal ball, joint. In the embodiment illustrated in FIG. 19, the treatment fluid is transferred to the blade carrier 340 in the manner previously described in conjunction with FIG. 6. In the embodiment illustrated in FIG. 20, the treatment fluid is transferred to the blade cutting assembly 350 in the manner previously described in conjunction with FIG. 6a.

FIG. 21 is a perspective view of a hydraulic feller buncher according to the invention attached to the forward boom arm of a tractor. Feller bunchers are used in forest management and rights of way. The feller buncher 400, Figure 21, is a large piece of equipment capable of taking down trees.

FIG. 22 is a perspective view of a high speed saw head according to the invention and adapted for use on the hydraulic feller buncher of FIG. 21. When equipped with the saw head 402, Figure 22, the feller buncher operates similar to a chain saw, however in this application, fluid is delivered to the bottom of the cutting edge, of the saw head, before the cut to facilitate delivery of fluids directly into the vascular system of the treated plant or tree.

FIG. 23 is a perspective view of a high speed shear head according to the invention and adapted for use on the hydraulic
feller buncher of FIG. 21. When equipped a high speed shear head 404, Figure 23, the feller buncher delivers a treatment fluid to the bottom of the cutting edge, of the high speed shear, before the cut facilitating delivery of fluids directly into the vascular system of the treated tree or plant.

FIG. 24 is a partial sectional view of a portion of the fluid conduit means of the apparatus for cutting and treating vegetation according to the invention illustrated in FIGS. 25-32. Cutting mechanism other than rotary mowers, such as reel, flail bar, disk and sickle bar cutting apparatus, require controlled fluid delivery to the appropriate cutting edge at the appropriate time. The pulsing sealed hollow shaft fluid delivery apparatus 406, Figure 24, has a ball bearing assembly and allows for timed controlled delivery of fluids. The pulsing sealed hollow shaft fluid delivery apparatus 406, has a hollow stationary shaft 408 which is press fitted at the center. About shaft 408 is fitted an inside race 410 which are in contact with ball bearings 412 packed in a seal 414 within the outside race 416. A hollow rotating shaft 418 is in sliding contact with the outside race 416. The rotating shaft 418 is fitted with hollow spokes 420, which are in communication with a fitting 422 having a nipple 424 for engagement with piping or tubing 426. At least one port or slot 428 is tapped into the stationary shaft 408 and allows fluid to flow from the stationary shaft 408 to the hollow spoke 420. During most of the rotation cycle the fluid in the system is static, from the hollow spoke 420 to just before the outlet port spaced from the blade. When slot 428 comes into alignment with hollow spoke 420 additional fluid is pulsed through the system resulting in fluid on the lower cutting edge of the blade. In this embodiment the outside fittings rotate for use with the flail bar and reel mowers.

An alternative pulsing sealed hollow shaft fluid delivery apparatus 429, Figure 33, can also be configured with a hollow rotating shaft 430 which at the center. About shaft 430 is an inside race 431 which are in contact with ball bearings 412 packed in a seal 414 within the press fitted outside race 432. A stationary shaft 433 is in fixed contact with the outside race 432. The stationary shaft 433 is fitted with hollow spokes 420, which are in communication with a fitting 422 having a nipple 424 for engagement with piping or tubing 426. At least one port or slot 428
is tapped into the rotating shaft 430 and allows fluid to flow from the rotating shaft 430 to the hollow spoke 420. During most of the rotation cycle the fluid in the system is static, from the hollow spoke 420 to just before the outlet port spaced from the blade. When slot 428 comes into alignment with hollow spoke 420 additional fluid is pulsed through the system resulting in fluid on the lower cutting edge of the blade. In this embodiment the outside fittings are stationary and this device can be used as a timed distributor for sickle bar cutting systems.

FIG. 25 is a top view of a sickle bar according to the invention. The sickle bar type mowing apparatus 440, Figure 25, having guards 442 and a reciprocating bar 444. A series of blades 446 are mounted to the bar 444.

FIG. 26 is an end view of the sickle bar of FIG. 25. The guards 442 being mounted to guard mount bar 448, Figure 26. Seated in the guards 442 is a sickle bar manifold 450 having a delivery tube 452, which may be welded, which provides fluid delivery through exit ports 454 in tube 452. Fluid from the timed distributor is of a pulsing sealed hollow shaft fluid delivery apparatus 429 is connected for communication through tube 452.

FIG. 27 is a top view of a multiple disk mower according to the invention. A disk type mowing apparatus 460, Figure 27, uses a series of cutting decks 462. Here, the blades 464 from the disks protrude from the apparatus in the front 466.

FIG. 28 is a side view of one of the disk of the multiple disk mower of FIG. 27. The fluid delivery apparatus can be nearly identical to that of the rotary cutter using an elongated fluid delivery member 468, Figure 28, to wet out the blades 464 of the disk type mower. Alternatively the disk mower could use the pulsing sealed hollow shaft fluid delivery system 406 to deliver timed pulse of treatment fluid to the blades of disk.

FIG. 29 is a side view of a reel mower according to the invention. A reel type mowing apparatus 480, Figure 29, which utilizes the sealed hollow shaft fluid delivery apparatus 406, described above, to deliver fluid to the bottom cutting edge 482 of the rotating blades 484. This device uses a central axle 486.
configured as fluid delivery apparatus 406. Attached to the axle 486 are blade support spokes 488 as well as tubing 426 which facilitate fluid flow from the axle to the blade. The interactions between the rotating blades 484 and a stationary blade or anvil 490 effect both the cut of the vegetation 492 and the delivery of the treatment fluid directly into the plants vascular stream. A roller 494 facilitates movement over the ground 496 and fresh cut vegetation 498. In this system the pulse of treatment fluid is timed to be released just before the blade comes into cutting contact with the vegetation. As with the rotary mower it can be connected to ground speed regulator which controls the amount of fluid being carried through the system over time.

FIG. 30 is an alternative enlarged view of the anvil 490 of the reel mower of FIG. 29. This alternative reel type mowing apparatus, which, instead of utilizing the sealed hollow shaft fluid delivery apparatus 406, uses a standard, "non-wetable" reel, with a wetable stationary blade or anvil 500. The stationary blade or anvil 500 has a machined groove 502 in which a fluid delivery tube 504 is welded into place. The fluid delivery tube has a continuous slot exit port 506 or porous metal or plastic tubing. This system is connected to a ground speed regulator for controlled release based on ground speed of the device.

FIG. 31 is a side view of a flail mower according to the invention. The flail type mowing apparatus 520, Figure 31, which is comprised of a drive shaft 522, Figure 32, configured as pulsing sealed hollow shaft fluid delivery apparatus 406, fitted with multiple blades 524 and multiple fluid delivery bars 526. Fluids are delivered to each individual fluid delivery bar 526 by the pulsing sealed hollow shaft fluid delivery apparatus 406, Figure 24, which allows for timed controlled delivery of fluids. In operation fluid is delivered to the cutting edge 528 just prior to the cut to facilitate delivery of fluids directly into the plants vascular system. Note that the blades are staggered to ensure an even cut across the width of the drive shaft 230. This system can be connected to a ground speed regulator for controlled release based on ground speed of the device.
FIG. 32 is a top view of the flail mower of FIG. 31 and which helps depict the spacial relationship of the blades 524, fluid delivery bars 526 with the drive shaft 522.

FIG. 33 is a partial sectional view of an alternative embodiment of a portion of the fluid conduit means of the apparatus for cutting and treating vegetation according to the invention illustrated in FIGS. 25-32. In this embodiment the hollow center shaft 430 rotates while the outer stationary shaft 433, hollow spokes 420, fittings 422 and nipple 424 all remain stationary.

It is to be understood that the foregoing description and specific embodiments are merely illustrative of the best mode of the invention and the principles thereof, and that various modifications may be made to the apparatus by those skilled in the art without departing from the spirit and scope of the invention, which is therefore understood to be limited only by the scope of the appended claims.
THAT WHICH IS CLAIMED IS:

1. An apparatus for cutting vegetation and treating the cut vegetation with a treatment fluid, said apparatus comprising at least one cutting blade;
   fluid container means for containing the treatment fluid, said fluid container means in fluid communication with said at least one cutting blade;
   fluid conduit means defining a fluid passageway for delivering the treatment fluid in a continuous stream from said fluid container means to said at least one cutting blade so that the treatment fluid is continuously available to the cut vegetation at the time that the vegetation is cut.

2. An apparatus according to Claim 1 further comprising pumping means for pumping the treatment fluid from said fluid container means to said at least one cutting blade; and flow control means coupled to said pumping means for metering the amount of the treatment fluid delivered to said at least one cutting blade through said fluid conduit means.

3. An apparatus according to Claim 1 further comprising a mower comprising a generally planar mower deck;
   cutting blade drive means rotatably mounted to said mower deck; and
   a blade carrier secured to said cutting blade drive means; and
   wherein said at least one cutting blade is rotatably mounted to said blade carrier.

4. An apparatus according to Claim 3 further comprising pumping means for pumping the treatment fluid from said fluid container means to said at least one cutting blade; and flow control means coupled to said pumping means for metering the amount of the treatment fluid delivered to said at least one cutting blade through said fluid conduit means.

5. An apparatus according to Claim 4 wherein said flow control means further comprises ground speed detection means for detecting the ground speed of said mower.
6. An apparatus according to Claim 5 wherein said ground speed detection means comprises
   a cup-shaped sprocket carrier comprising a sprocket having a plurality of radial teeth thereon; and
   mechanical sensor means for engaging the teeth of said sprocket, said sensor means mechanically coupled to said pumping means.

7. An apparatus according to Claim 5 wherein said ground speed detection means comprises
   a cup-shaped flange carrier comprising a flange having a plurality of radial teeth thereon; and
   electrical sensor means for sensing the angular velocity of the teeth of said flange, said sensor means electrically coupled to said pumping means.

8. An apparatus according to Claim 7 wherein said flange of said flange carrier is made of a ferrous material and said electrical sensing means comprises an inductance sensor that senses the rate of fluctuation in the inductance measured by said sensor.

9. An apparatus according to Claim 6 or Claim 7 wherein at least one axle of the mower comprises a rotating shaft and a non-rotating shaft and wherein said flange carrier is mounted to the rotating shaft of the at least one axle of the mower and said sensor is secured to the non-rotating shaft of the at least one axle of the mower.

10. An apparatus according to Claim 5 wherein said mower comprises at least one wheel and said ground speed detection means is provided adjacent said at least one wheel of said mower.

11. An apparatus according to Claim 5 wherein said mower comprises a plurality of wheels and a separate one of said ground speed detection means is provided adjacent each of said wheels of said mower.

12. An apparatus according to Claim 5 wherein said flow control means further comprises a control unit electrically coupled to said ground speed detection means for processing predetermined input data and an electrical signal produced by said ground speed
detection to determine the amount of treatment fluid to be delivered
to said at least one cutting blade from said fluid container means.

13. An apparatus according to Claim 12 wherein said control
unit is electrically coupled to said pumping means and said control
unit produces an electrical signal for controlling the operation of
said pumping means.

14. An apparatus according to Claim 12 wherein said flow
control means further comprises a stepper drive motor and wherein
said control unit is electrically coupled to said stepper drive
motor and produces an electrical signal for controlling the
operation of said stepper drive motor.

15. An apparatus according to Claim 14 wherein said stepper
drive motor is mechanically coupled to said pumping means for
driving said pumping means.

16. An apparatus according to Claim 12 wherein said control
unit comprises a Global Positioning Satellite (GPS) transceiver for
transmitting the location of said mower when the treatment fluid is
delivered to said at least one cutting blade from said fluid
container means.

17. An apparatus according to Claim 12 wherein said control
unit further comprises a DC voltage converter and a DC voltage
regulator.

18. An apparatus according to Claim 12 wherein said control
unit further comprises an on-off toggle switch for powering said
pumping means and a by-pass toggle switch for by-passing said
pumping means.

19. An apparatus according to Claim 3 wherein said cutting
blade drive means is powered by the power take-off from a tractor.

20. An apparatus according to Claim 19 wherein said cutting
blade drive means comprises a bevel gear for cooperating with a
rotating drive shaft provided on the power take-off from the
tractor.
21. An apparatus according to Claim 3 wherein said mower deck has a central opening and wherein said cutting blade drive means comprises a drive shaft which is rotatably received in the central opening of said mower deck.

22. An apparatus according to Claim 21 wherein said cutting blade drive means further comprises a housing secured to said mower deck and having a central opening therein, an annular lower spherical bearing and an annular upper spherical bearing and wherein said lower spherical bearing and said upper spherical bearing are positioned within the central opening provided in said housing.

23. An apparatus according to Claim 22 wherein said drive shaft of said cutting blade drive means is rotatably positioned within said lower spherical bearing and said upper spherical bearing so that said drive shaft rotates freely relative to said housing and said mower deck.

24. An apparatus according to Claim 23 wherein said drive shaft of said cutting blade drive means comprises an upper end and a lower end wherein said upper end of said drive shaft is externally threaded to receive a hex nut thereon for securing said lower spherical bearing and said upper spherical bearing to said drive shaft.

25. An apparatus according to Claim 24 wherein said lower end of said drive shaft is externally threaded to receive a hex nut thereon for securing said blade carrier to said cutting blade drive means.

26. An apparatus according to Claim 22 wherein said housing of said cutting blade drive means has an opening provided therein which is tapped and threaded to receive a fluid-tight fitting which is in fluid communication with said fluid container means.

27. An apparatus according to Claim 26 wherein said cutting blade drive means further comprises an annular flange secured to the underside of said housing, said flange comprising a medial wall having a circumferential pocket formed therein.
28. An apparatus according to Claim 27 wherein said flange further comprises an upper surface having a well formed therein opposite the opening formed in said housing and wherein the well formed in said upper surface of said flange terminates in a radial bore formed in said flange, one end of said bore closed by a fluid-tight setscrew, said flange further having a circumferential pocket formed therein adjacent the open end of said bore.

29. An apparatus according to Claim 28 wherein said drive shaft of said cutting blade drive means has a first radial bore formed therein adjacent said pocket formed in said flange.

30. An apparatus according to Claim 29 wherein said cutting blade drive means further comprises an annular upper seal and an annular lower seal, said upper seal and said lower seal positioned adjacent said pocket formed in said flange to form a fluid-tight seal between said pocket and the external surface of said drive shaft so that said bore formed in said flange is in continuous fluid communication with said first bore of said drive shaft.

31. An apparatus according to Claim 30 wherein said first bore of said drive shaft terminates in a longitudinally extending axial bore formed in said drive shaft and having one end closed by a fluid-tight setscrew and wherein said drive shaft has a second radial bore formed therein and extending outwardly from said axial bore adjacent said blade carrier.

31. An apparatus according to Claim 3 wherein said blade carrier has a central opening for receiving said cutting blade drive means and at least one opening spaced outwardly from the central opening, said blade carrier further having a channel formed therein extending between the central opening and the at least one opening spaced outwardly from the central opening.

32. An apparatus according to Claim 31 wherein said blade carrier comprises an elongate bar comprising an upper half secured to a lower half and wherein said at least one opening spaced outwardly from the central opening is located adjacent an opposed end of said bar and receives said at least one cutting blade therein.
33. An apparatus according to Claim 31 wherein said blade carrier comprises a disk and wherein the at least one opening spaced outwardly from the central opening is located adjacent the outer edge of said disk and receives said at least one cutting blade therein.

34. An apparatus according to Claim 33 wherein said disk has a plurality of openings spaced outwardly from the central opening and located adjacent the outer edge of said disk, each opening receiving said at least one cutting blade therein.

35. An apparatus according to Claim 31 wherein said blade carrier comprises a circumferential pocket formed on the central opening adjacent said channel so that said channel is in fluid communication with said cutting blade drive means.

36. An apparatus according to Claim 31 wherein said channel of said blade carrier terminates in a second circumferential pocket formed on the at least one opening spaced outwardly from the central opening so that said blade carrier is in fluid communication with said at least one cutting blade.

37. An apparatus according to Claim 36 wherein said at least one cutting blade comprises a shaft rotatably received in the at least one opening spaced outwardly from the central opening so that said at least one cutting blade can rotate relative to said blade carrier.

38. An apparatus according to Claim 37 wherein said at least one cutting blade further comprises a cutter blade hub and said shaft comprises an upper end and a lower end, said upper end of said shaft having a hex head jam nut formed thereon for removing and replacing said cutter blade hub on said shaft, said lower end of said shaft externally threaded with male threads and said cutter blade hub internally threaded with female threads, the male and female threads cooperating to secure said cutting blade hub tightly on said shaft.

39. An apparatus according to Claim 37 wherein said at least one cutting blade further comprises an annular lower spherical bearing and an annular upper spherical bearing press fit into the
at least one opening spaced outwardly from the central opening of
said blade carrier to permit said shaft of said at least one cutting
blade to rotate.

40. An apparatus according to Claim 37 wherein said shaft of
said at least one cutting blade has a radial bore formed therein
adjacent said circumferential pocket of said blade carrier, said
radial bore extending inwardly from said pocket and terminating in
a longitudinally extending axial bore formed in said shaft and
closed by a fluid-tight plug secured to the underside of said
cutting blade hub.

41. An apparatus according to Claim 40 wherein said at least
one cutting blade further comprises an annular upper seal and an
annular lower seal positioned on said shaft adjacent said pocket of
said blade carrier and adjacent said radial bore of said shaft to
form a fluid-tight seal between said pocket and the external surface
of said shaft so that said radial bore of said shaft is in fluid
communication with said channel of said carrier blade.

42. An apparatus according to Claim 40 wherein said cutting
blade hub has a bore formed closed at one end by a fluid-tight
set screw, said bore extending outwardly from said axial bore of said
shaft and terminating at an opening adjacent a gap between said
cutting blade hub and the underside of said at least one cutting
blade.

43. An apparatus according to Claim 42 wherein the gap
between said cutting blade hub and the underside of said at least
one cutting blade is between about .25 and 1.0 inches wide.

44. An apparatus according to Claim 42 wherein the gap
between said cutting blade hub and the underside of said at least
one cutting blade is about .5 inches wide.

45. An apparatus according to Claim 42 wherein said bore of
said cutting blade hub is rifled to impart a slight vortex to the
treatment fluid exiting the bore.

46. An apparatus according to Claim 4 wherein said pumping
means comprises a variable capacity pump for pumping variable
amounts of the treatment fluid through said fluid conduit means depending on the speed of said mower over the ground.

47. An apparatus according to Claim 46 wherein said pumping means comprises a peristaltic pump which pumps the treatment fluid through said fluid conduit means via waves of contraction produced by a series of rollers which compress the fluid conduit means containing the treatment fluid.

48. An apparatus according to Claim 4 wherein said fluid conduit means comprises a flexible tube which extends outwardly from said fluid container means and passes through said pumping means to said cutting blade drive means.

49. An apparatus according to Claim 48 wherein said cutting blade drive means comprises a housing and a drive shaft;

said at least one cutting blade comprises a shaft and a cutting blade hub; and

said fluid conduit means further comprises

a well, a radial bore and a circumferential pocket formed in said housing of said cutting blade drive means;

a first radial bore, an axial bore and a second radial bore formed in said drive shaft of said cutting blade drive means;

a first circumferential pocket, a fluid channel and a second circumferential pocket formed in said blade carrier;

a radial bore and an axial bore formed in said shaft of said at least one cutting blade; and

a bore formed in said cutting blade hub of said at least one cutting blade.

50. An apparatus according to Claim 49 wherein said fluid conduit means terminates adjacent a gap opposite the underside of said at least one cutting blade.

51. An apparatus according to Claim 3 wherein said mower is selected from the group consisting of a push lawnmower, a conventional power lawnmower, a riding lawnmower, an engine driven tractor, a bushog mower, a batwing mower, a harvester, a hydraulic feller buncher, a high speed saw head, a high speed shear head, a
sickle bar, a multiple disk mower, a reel mower, a flail mower and a mower head attached to the end of a hinged boom arm.

52. An apparatus according to Claim 4 wherein said mower is a bushhog mower attached to and pulled behind a tractor and said flow control means is coupled to the rear axle of the tractor.

53. A liquid container cell for containing and dispensing a liquid treatment, comprising:
   a top wall, a bottom wall, a pair of opposed sidewalls, a front endwall and a rear endwall;
   said front endwall being provided with an inlet port and an outlet port; and
   means connectable to said inlet port and to said outlet port for hermetically sealing said cell;
   said cell being removably securable to a base.

54. The liquid container cell according to Claim 53 wherein said bottom wall includes feet near at least two edges thereof.

55. The liquid container cell according to Claim 54 wherein said top wall includes mating recesses adapted to receive feet of another cell.

56. The liquid container cell according to Claim 53 wherein said bottom wall includes an inclined protruding fluid guide disposed thereon, which communicates with said outlet port.

57. The liquid container cell according to Claim 56 wherein said top wall includes a mating recess adjacent the front endwall, said recess being adapted to receive an inclined protruding fluid guide of another cell.

58. The liquid container cell according to Claim 53 wherein said front wall and said rear wall each include a recessed handhold disposed therein.

59. The liquid container cell according to Claim 53 wherein said cell is made of a material which is substantially resistant to ultraviolet light.
60. The liquid container cell according to Claim 59 wherein said ultraviolet-resistant material is selected from the group consisting of polyurethane, polyethylene and polyvinylchloride (PVC) plastic.

61. The liquid container cell according to Claim 53 further comprising flexible tubing connected to said outlet port for dispensing the contents of the cell.

62. The liquid container cell according to Claim 53 further comprising means connected to said cell whereby ambient air may enter the fluid container cell to prevent the development of a partial vacuum in the cell.

63. A liquid container means for containing a liquid treatment agent for treating vegetation comprising:
   a base;
   a plurality of stackable liquid container cells in stacked relation, each of said plurality of liquid container cells having a top wall, a bottom wall, a pair of opposed sidewalls, a front endwall, a rear endwall, one endwall being provided with an inlet port and an outlet port; and
   at least two of said liquid container cells being connected in fluid communication by a fluid passageway.

64. A liquid container means for containing a liquid treatment agent for treating vegetation according to Claim 63, further comprising:
   means for holding said stackable liquid container cells in stacked relation.

65. A liquid container means for containing a liquid treatment agent for treating vegetation according to Claim 64, wherein said holding means comprises a plurality of spaced upright stanchions adapted to receive a plurality of cells, and means for urging all cells in the container means in the same direction.

66. A liquid container means for containing a liquid treatment agent for treating vegetation according to Claim 65, wherein said urging means is a resilient strap passing over said stacked cells and connected to said base.
67. A method for dispensing treatment fluid from a liquid container cell, comprising:
  filling the cell with treatment fluid at a remote location
  from the location of use;
  hermetically sealing the cell;
  transporting the cell to the treatment location;
  connecting the cell to a dispensing mechanism;
  providing means for ambient air access to the interior of the
cell to prevent a vacuum from developing therein; and
  dispensing the treatment liquid from the cell.

68. An apparatus according to Claim 2 wherein said fluid conduit means further comprises:
a pulsing sealed hollow shaft fluid delivery apparatus having a
  center with a hollow stationary shaft at said center;
  said hollow shaft having an outlet port in communication with
  said fluid container means;
  an inner race having an outlet port, said inner race in
  contact with and surrounding said hollow shaft;
  a seal surrounding and in slidable contact with said inner
  race;
  ball bearings packed in said seal;
  an outer race surrounding the ball bearings;
  a hollow rotating shaft in sliding contact with said outer
  race;
  at least one hollow spoke in fluid communication with fluid
  within said hollow rotating shaft; and
  a fitting in communication with said hollow spoke having a
  nipple for engagement with piping;
  wherein said hollow spoke rotates about said hollow stationary
  shaft and upon alignment with said outlet port additional liquid is
  pulsed through the system resulting in placement of fluid on the
  lower cutting edge of the blade.

69. An apparatus according to Claim 68 further comprising a
  reel mower comprising:
  a central axle configured as said pulsing sealed hollow shaft
  fluid delivery apparatus;
  at least one blade support spoke fixed to said central axle;
  at least one rotating blade fixed to said blade support spoke;
at least one tube communicating with said nipple and terminating and in communication with said rotating blade;  
a stationary anvil spaced slightly from said rotating blade;  
and  
a roller spaced from said anvil;  
wherein interaction of said rotating blade and said anvil facilitates the cut of vegetation and said tubing supplies treatment fluid to said rotating blade.

70. An apparatus according to Claim 68 further comprising a  
flail mower comprising:  
a central axle configured as said pulsing sealed hollow shaft fluid delivery apparatus;  
at least one rotating blade fixed to said central axle;  
at least one fluid delivery bars communicating with said  
fitting and in communication with said rotating blade; and  
a roller spaced from said rotating blade;  
wherein said rotating blade facilitates the cut of vegetation and said fluid delivery bar supplies treatment fluid to said rotating blade.

71. An apparatus according to Claim 2 further wherein said  
fluid conduit means further comprises:  
a pulsing hollow shaft fluid delivery system having a center  
with a hollow rotating shaft at said center;  
said hollow shaft having an outlet port;  
an inner race having a port, said inner race in contact with  
and surrounding said hollow shaft;  
a seal surrounding and in slidable contact with said inner  
race;  
ball bearings packed in said seal;  
an outer race surrounding the ball bearings;  
a hollow stationary shaft in sliding contact with said outer  
race;  
at least one hollow spoke in fluid communication with fluid  
within said hollow stationary shaft; and  
a fitting in communication with said hollow spoke having a  
nipple for engagement with piping;  
wherein said hollow shaft rotates within said hollow stationary shaft and when the hollow spoke aligns with the outlet port from said hollow rotating shaft additional liquid is pulsed.
through the system resulting in placement of fluid on the lower cutting edge of the blade.

72. An apparatus according to Claim 71 further comprising a sickle bar mower comprising:
a reciprocating bar;
a series of blades mounted to said reciprocating bar;
a series of guards spaced from and surrounding said series of blades;
a manifold having a fluid delivery tube seated in said series of guards;
said fluid delivery tube having exit ports; and
said fluid delivery tube communicating with said pulsing hollow shaft fluid delivery system
wherein fluid from said fluid delivery tube delivers treatment fluid to a lower edge of said series of blades.

73. An apparatus according to Claim 2 further comprising a reel mower comprising:
a central axle;
at least one blade support spoke fixed to said central axle;
at least one rotating blade fixed to said blade support spoke;
a stationary anvil spaced slightly from said rotating blade having a machined groove journaling a fluid delivery tube;
said fluid delivery tube having continuous slot exit ports; and
a roller spaced from said anvil;
wherein interaction of said rotating blade and said anvil facilitates the cut of vegetation and said tubing supplies treatment fluid to said rotating blade.

74. A method of cutting vegetation and treating the cut vegetation with a treatment fluid at the time that the vegetation is cut, said method comprising the steps of providing at least one cutting blade, a fluid container and a fluid conduit extending between the fluid container and the at least one cutting blade;
cutting the vegetation using the at least one cutting blade; and
delivering a continuous stream of the treatment fluid to the at least one cutting blade so that the treatment fluid is
continuously available to the cut vegetation at the time that the vegetation is cut.

75. The method of Claim 74 further comprising the steps of pumping the treatment fluid from the fluid container through the fluid conduit to the at least one cutting blade; and controlling the amount of treatment fluid which is continuously available to the cut vegetation cut vegetation at the time that the vegetation is cut.

76. The method of Claim 74 further comprising the steps of securing the at least one cutting blade to a rotatable cutting blade drive means; and rotating the at least one cutting blade using the cutting blade drive means.

77. The method of Claim 74 wherein the at least one cutting blade is rotatably mounted on a bushhog mower attached to and pulled behind a tractor.

78. The method of Claim 74 wherein the at least one cutting blade is rotatably mounted on a mower head attached to a hinged boom arm.

79. The method of Claim 74 wherein the treatment fluid may be delivered to the at least one cutting blade with the at least one cutting blade in any horizontal or non-horizontal orientation relative to the fluid container.

80. The method of Claim 74 wherein the stream of treatment fluid that is continuously available to the cut vegetation at the time that the vegetation is cut is absorbed directly into the transpiration stream of the cut vegetation.

81. The method of Claim 80 wherein between about 75 percent and about 95 percent of the treatment fluid that is continuously available to the cut vegetation at the time that the vegetation is cut is absorbed directly into the transpiration stream of the cut vegetation.
82. The method of Claim 81 wherein the treatment fluid that is absorbed directly into the transpiration stream of the cut vegetation migrates to the root system of the vegetation.

83. The method of Claim 74 wherein the treatment fluid that is delivered to the at least one cutting blade is not broadcast and does not contaminate the soil surrounding the vegetation and the underground water supply.

84. The method of Claim 74 wherein the treatment fluid is delivered to the underside of the at least one cutting blade and is applied directly to the remaining stems of the cut vegetation.

85. The method of Claim 74 wherein the treatment fluid is delivered to the underside of the at least one cutting blade and is not applied to the cuttings of the cut vegetation.
AXLE

DOUBLE POLE / DOUBLE THROW SWITCH

SENSOR MEANS

DC DRIVE CONTROL UNIT

TRACTOR POWER SOURCE

ON / OFF SWITCH

DC STEPPER MOTOR

PUMP

Fig.15

11/21
SUBSTITUTE SHEET (RULE 26)
Fig. 29

Fig. 30
INTERNATIONAL SEARCH REPORT
International application No.
PCT/US96/13362

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : A01D 34/64 ; B65D 21/02
US CL. : 56/16.8, 16.4R, DIG. 2 : 222/143
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 56/16.8, 16.4R, DIG. 2, 16.9, DIG. 9 ; 222/143
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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</table>
| X Y       | US 2,973,615 A (YAREMCHUK ET AL.) 07 MARCH 1961 (07.03.61), SEE FIGURES 1-3 AND COLUMN 2, LINES 44-63. | 1-4, 51
|           |                                                                                   | 19-26,46-48,52,73-85 |
| X Y       | US 5,329,752 A (MILBOURN) 19 JULY 1994 (19.07.94), SEE FIGURES 4-7 AND 10         | 1-4, 51
|           |                                                                                   | 19-26,46-48,52,73-85 |

Further documents are listed in the continuation of Box C. [ ] See patent family annex.

<table>
<thead>
<tr>
<th>*</th>
<th>Special categories of cited documents:</th>
<th>&quot;T&quot;</th>
<th>&quot;E&quot;</th>
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<tbody>
<tr>
<td></td>
<td>document defining the general state of the art which is not considered to be of particular relevance</td>
<td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td>
<td></td>
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<tr>
<td>&quot;A&quot;</td>
<td>earlier document published on or after the international filing date</td>
<td>&quot;X&quot;</td>
<td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td>
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<tr>
<td>&quot;L&quot;</td>
<td>earlier document published on or after the international filing date</td>
<td>&quot;Y&quot;</td>
<td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td>
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<tr>
<td>&quot;O&quot;</td>
<td>document referring to an oral disclosure, use, exhibition or other means</td>
<td>&quot;&amp;&quot;</td>
<td>document member of the same patent family</td>
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<tr>
<td>&quot;P&quot;</td>
<td>document published prior to the international filing date but later than the priority date claimed</td>
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</table>

Date of the actual completion of the international search
20 NOVEMBER 1996

Date of mailing of the international search report
08 JAN 1997

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
TERRY LEE MEIELD

Telephone No. (703) 308-2168

Form PCT/ISA/210 (second sheet)(July 1992)*
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 2,740,248 A (PICKENS) 03 APRIL 1956 (03.04.56), SEE FIGURES 2-6 AND COLUMN 2, LINE 69 THROUGH COLUMN 7, LINE 74.</td>
<td>73</td>
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<tr>
<td>X</td>
<td>US 5,105,858 A (LEVINSON) 21 APRIL 1992 (21.04.92), SEE FIGURES 2-6 AND COLUMN 5, LINE 14 THROUGH COLUMN 6, LINE 49.</td>
<td>53-67</td>
</tr>
<tr>
<td>A</td>
<td>US 4,926,622 A (MCKEE) 22 MAY 1990 (22.05.90), SEE FIGURES 1-2.</td>
<td>1,51 AND 74</td>
</tr>
<tr>
<td>A</td>
<td>US 5,237,803 A (DOMINGUE,JR.) 24 AUGUST 1993 (24.08.93), SEE FIGURES 1, 2 AND 5-7.</td>
<td>1,51 AND 74</td>
</tr>
<tr>
<td>A</td>
<td>US 3,334,475 A (DANISCH) 08 AUGUST 1967 (08.08.67), SEE FIGURES 1-4.</td>
<td>1,51, 53, 63, 67 AND 74</td>
</tr>
</tbody>
</table>
INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

   Please See Extra Sheet.

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [x] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet(1))(July 1992)
BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

Group I, claim(s) 1-52 and 68-85, drawn to an apparatus and method for cutting vegetation and treating the cut vegetation.

Group II, claim(s) 53-67, drawn to a liquid container cell and dispensing a fluid therefrom.

The inventions listed as Groups I and II do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the liquid container cell may be used in conjunction with other devices (not just a mower).