All Terrain Cedar Saw

RANGESCAPING

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All Terrain Cedar Saw

Abstract

Ron Cole is owner of All Terrain Cedar Saw, LLC. His company manufactures and sells All Terrain Cedar Saws. The All Terrain Cedar Saw is an attachment for an ATV used to clear rangeland and pastureland of small eastern red cedar trees. The objective of project was to improve the current design of the All Terrain Cedar Saw. RangeScaping is a design team composed of three senior design students in the Biosystems and Agricultural Engineering Department at Oklahoma State University. RangeScaping was to improve the current design of the All Terrain Cedar Saw to certain criteria given by All Terrain Cedar Saw, LLC. These criteria included the following: an All Terrain Cedar Saw capable of use on a 300-cc ATV, a quicker blade stopping time, guards for the exposed blade, and limited horizontal motion of the All Terrain Cedar Saw attachment. Through the production of a prototype and extensive testing, these criteria have been measured. The results of this project reflect the extent to which RangeScaping was able to meet the requirements of All Terrain Cedar Saw, LLC.

Acknowledgements

- Ron Cole – Owner of All Terrain Cedar Saw, LLC
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- Dr. John Solie – Oklahoma State University Biosystems and Agricultural Engineering Professor
- Dr. Paul Weckler – Oklahoma State University Biosystems and Agricultural Engineering Senior Design Advisor

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Introduction

All Terrain Cedar Saw LLC is a small business owned by Ron Cole. The undercarriage, or portion that mounts under the all terrain vehicle, is built by Cole in his shop located near Vici, OK. The main frame for the cedar saw is built by a company in Oklahoma City. The cedar saws are packaged for shipping in his shop, to be assembled on site. They are shipped in two pieces: the large sub frame and another large box containing the remaining components and parts, with the exception of the cable winch.

Figure 1: All Terrain Cedar Saw

The All Terrain Cedar Saw is currently designed to cut cedar trees at ground level no larger than 5 inches in diameter. It attaches at the front and rear of a 500 cc or larger ATV. A winch at the front and a 2 inch receiver hitch welded to the rear of the ATV are used to carry the cedar saw. A 9 horsepower Briggs & Stratton engine is used to power the 14 inch diameter 60 tooth saw blade via a v-belt. The blade is engaged by an electric clutch via a footswitch.

Problem Definition

A significant problem associated with the current design of the All Terrain Cedar Saw is the design's failure to evenly distribute the weight of the sawing apparatus. Most of the weight of the All Terrain Cedar Saw is carried by the front of the ATV since all the major components are suspended from the front. Safety is a major concern as well. When the footswitch is disengaged the blade does not stop turning immediately, but rather takes a few seconds.

Besides the problems of weight and safety, several other issues arise with the current design of the cedar saw. One is the freedom of motion at the front end of the apparatus. The blade is allowed approximately 20 degrees of swing in the horizontal plane, which may add to problems in safety. Another operational issue is the need to slow down and lean forward on the ATV to bring the saw blade close enough to the ground to cut the cedar tree below the lowest limb. Also, welding a receiver hitch to the rear of the ATV may void some warranties. Thus, the goals of the project are to:

- investigate weight reduction concepts
- improve the stopping time of the blade
- control the horizontal swing of the frame
- investigate safety concepts concerning blade exposure
- address the operational technique
- investigate actual power requirements

Statement of Work

Ron Cole has identified several limitations of the All Terrain Cedar Saw. The cedar tree must not exceed 7 feet in height and a trunk larger than 5 inches in diameter.

The cedar saw is only designed for use with small soft wood trees in pasture lands. Continuous use of the winch to adjust the height of the blade is not recommended. Adjusting the blade height is necessary when operating in rock-covered areas, rough terrain, or loading and unloading the ATV. When the footswitch is frequently pressed and released, the clutch will overheat. Due to the weight of the cedar saw, the handling characteristics of the ATV will change. Thus, the ATV must be operated at reasonable speeds.

Figure 2: Maximum Trunk Size

RangeScaping is a group composed of three Biosystems Engineering students in the senior design class. Ron Cole has sought the knowledge of RangeScaping to help improve the All Terrain Cedar Saw design.

RangeScaping will focus on several goals in making design improvements to the All Terrain Cedar Saw. First, we will explore different options of correcting the weight distribution. Placement of the engine, size of the engine, and using counterbalance weights are possibilities. The second issue addresses safety. Rigidly attaching the cedar saw to the ATV, and using a brake clutch to stop the blade immediately when the footswitch is released will increase the safety features.

Investigation

Patent Search

One of the first tasks RangeScaping undertook in researching the All Terrain Cedar Saw design project was conducting a patent search. Searching was carried out for any patents relevant to a tree saw. It quickly became apparent that no one has ever attached a cedar saw to an ATV. The closest possible matches are patents of saw attachments for tractors. One example is the Rotary Tree Cutter Attachment for Tractor, which uses a circular blade on a pivot arm mounted perpendicular to the tractor's frame outside the wheel path of the tractor. Several patents, like the Cutting Machine and the Tree and Stump Removal device, exist for attachments to earthmoving equipment in place of a conventional bucket for a tractor mounted backhoe or a front-end loader. Patents are listed in Appendix A. Finally, it was observed that these saws were typically for cutting larger trees than what the All Terrain Cedar Saw is designed to handle.

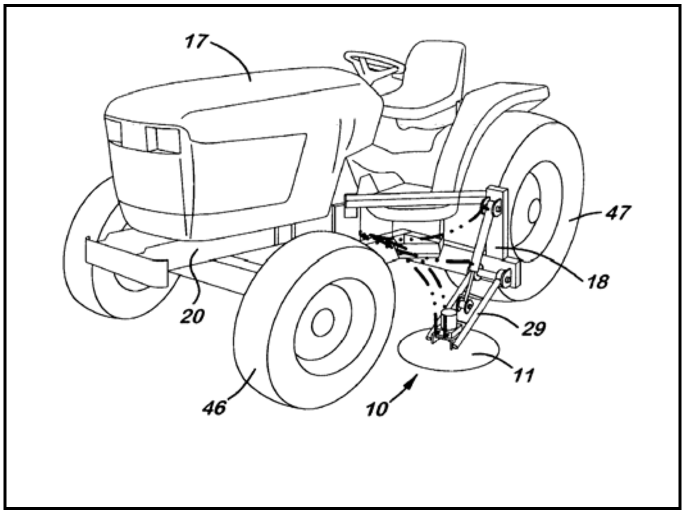

Figure 3: Rotary Tree Cutter Attachment

Operation of Current Equipment

Operating the current All Terrain Cedar Saw was another high priority on the tasks list of RangeScaping. The team exhausted a day traveling to Vici, Oklahoma and operating the cedar saw. Each team member was able to operate the cedar saw, cutting down small cedar trees in one of Cole's fields. Actually having the opportunity to maneuver the All Terrain Cedar Saw in the field was very beneficial for new concept development.

Figure 4: Colby Operating the All Terrain Cedar Saw

Requirements and Specifications

The new ATV cedar saw design that RangeScaping will develop should adhere to several safety criteria. It is to be designed for use on cedar trees with trunk diameter no larger than 5 inches or height no greater than 7 feet. This restriction is due to the safety of the operator when the tree is falling after it has been cut. Any kind of exposed blade on the cedar saw should have some sort of guard for the protection of the operator and any possible bystanders. A controlling device, such as a switch, will be used to allow for the immediate disengagement of the cutting apparatus. The saw should be capable for use with at least a 300 cc ATV. The ATV should be reasonably maneuverable in the field when the cedar saw is attached. Maneuverability also applies to fields with rougher terrain. Due to the sales of All Terrain Cedar Saws to older persons, if possible the new cedar saw ought not to require much physical exertion to operate. Finally, the overall design should be affordable for ranchers, the target customers.

Concept Development

After attaining an understanding of the project, RangeScaping began to investigate different design concepts. Due to the uniqueness of the All Terrain Cedar Saw, the team is limited only by their imaginations. Several different ideas were discussed among the team members, from mere improvements in the current design to a completely new design. These concepts were then compiled into plausible designs through evaluating their feasibility. Further refinement has come through dialogue with our sponsors and professors. Cost evaluations and efficiency calculations were performed before a final design was chosen.

Designs Concepts

Flywheel System

The inspiration behind implementing a flywheel on the current cedar saw design is the ability to use a smaller horsepower engine. This system will be set up very similar to the current All Terrain Cedar Saw with a V-belt drive. A break clutch will be employed for the immediate stopping of the saw blade. A safety shield will be fabricated to cover the circular blade for protection. Stabilizer bars will also be fabricated to rigidly mount the frame to the ATV.

Overall weight of the system decreases due to a smaller engine, e.g. a 6.5 hp engine weighs approximately 40 lb less than a 9 hp engine. A smaller engine would also decrease the cost of the cedar saw. Another advantage would be few necessary design changes to the current cedar saw frame.

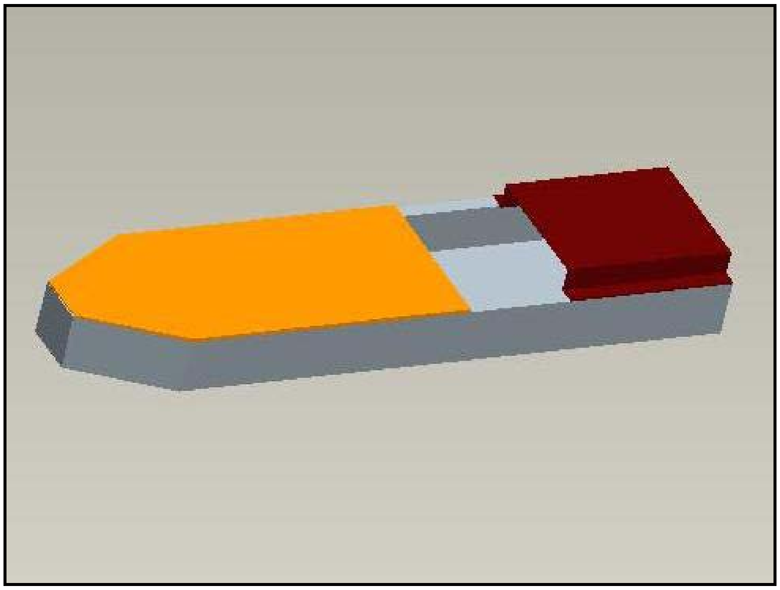

Figure 5: Flywheel System Frame

Hydraulic System

For the hydraulic system, the engine is mounted at the rear of the ATV with a hydraulic pump coupled to the engine. Hydraulic hoses will run to the front of the cedar saw and connect to a hydraulic motor. This motor, in turn, will drive the circular blade. A fluid reservoir and appropriate valves is included as well. A heat exchanger my also be needed to keep the overall efficiency of the system as high as possible by cooling the oil beyond the capacity of the reservoir. A safety shield will still need to be incorporated around the circular saw for safety concerns. Stabilizer bars will be incorporated to rigidly mount the frame to the ATV. Finally, this system would provide for quickly stopping the blade.

Several advantages to the hydraulic system include the weight distribution. Placing the engine at the back of the ATV would correct the front heaviness of the current design. Also, with the use of hydraulic hoses the entire system becomes more flexible. However, the overall weight of the system may increase due to the additional components, such as a hydraulic pump, motor, oil reservoir, hydraulic oil, and valves. Finally, the overall cost of the cedar saw would increase close to $1000 due to these necessary hydraulic components.

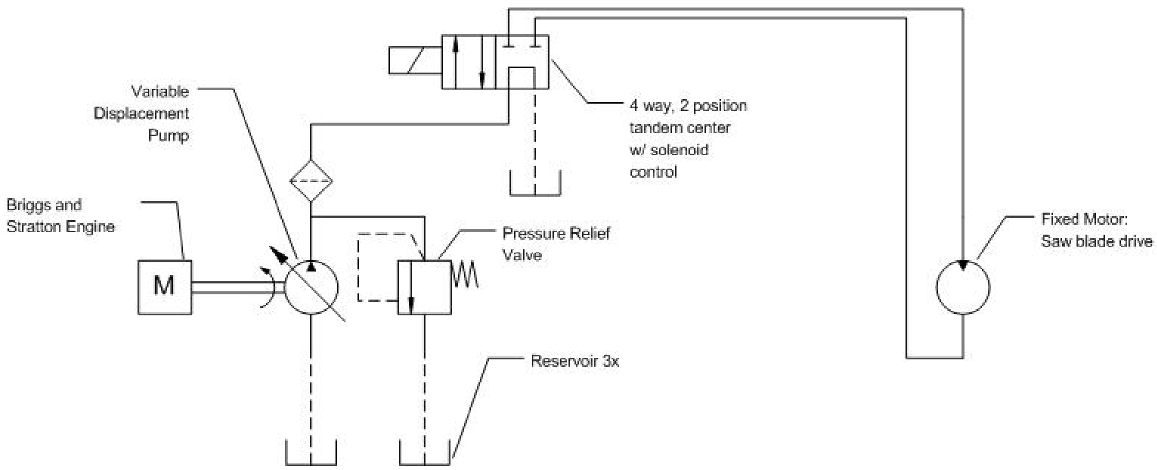

Figure 6: Hydraulic System Schematic

Flexible Cable Drive System

The engine is mounted on the rear of the ATV for this system. The saw blade will be driven by a drive shaft. Due to the considerable costs of using a conventional telescoping drive shaft, bearing carriers and universal joints, it was determined better to implement a flexible cable drive. A brake clutch would immediately stop the saw blade. The drive shaft is coupled to the engine and run the length of the ATV to the saw blade. The other end of the drive shaft is coupled to a gear box. A safety shield will also be fabricated to cover the circular saw blade. In addition, this system will implement stabilizer bars to rigidly mount the frame to the ATV.

The advantages to the flexible cable drive include the transfer of most of the cedar saw weight to the rear of the ATV. Flexibility is another advantage to this system. Though the cost would be lower than that of a hydraulic system, the individual cost of the flexible cable drive is significantly high, approximately $45 per foot.

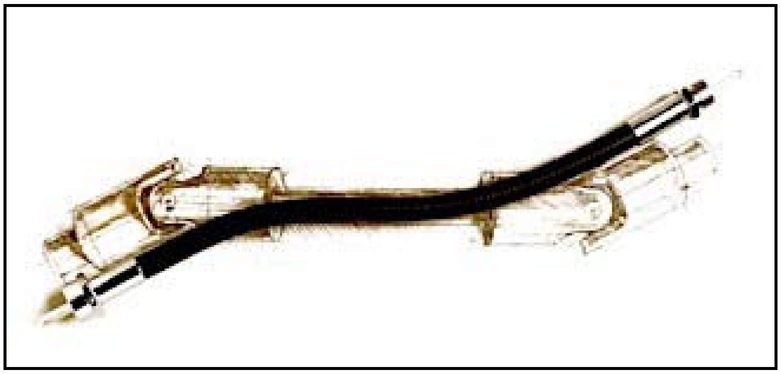

Figure 7: Flexible Cable Drive

Testing and Analysis

In order to determine the most suitable design concept, testing was conducted on the current All Terrain Cedar Saw configuration. Once this preliminary testing was completed, it became clear the best design concept was the flywheel system for reasons of financial feasibility, ability to meet design criteria and ease of integration into the current product line of All Terrain Cedar Saw, L.L.C. Next, testing was performed with the smaller engine configuration to determine an adequate flywheel size. Final design testing was performed last of all in the field to determine effectiveness of drive train and safety components.

Figure 8: Colby Feeding Tree into Blade

Preliminary Testing

Initial testing was executed using the current All Terrain Cedar Saw configuration. Several cedar trees, with 4 inch trunk diameters, were cut down with a chainsaw and stripped of there branches for this test. A Hall Effect Sensor was used in conjunction with a Data Acquisition to determine the speed of the saw blade during cutting. The cedar trunks were fed into the blade over and over, resulting in the cutting of many cylinders about 2 inches tall and corresponding in diameter with that of the tree. This information was logged on a computer as speed vs. time data shown graphically in Figure 9. Each “spike” in the graph indicates the blade speed slowing down and speeding back up due to cutting a tree.

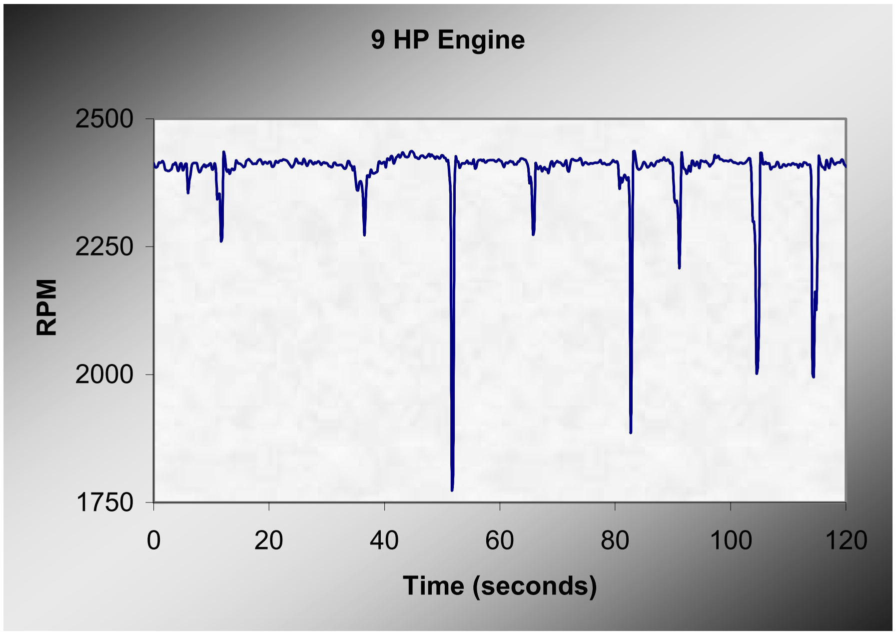

Figure 9: Revolutions per Minute vs. Time for 9 HP Engine

The graph indicated that the 9 hp engine cut through the cedar trees with relative ease. These results led RangeScaping to conclude downgrading the engine to a 6.5 hp engine would not significantly decrease the cutting potential of the saw. Any loss in energy could be supplied by a flywheel. Thus, RangeScaping pursued the flywheel system design concept. A 6.5 hp Briggs & Stratton engine was obtained for further testing.

Design Concept Testing

For the next stage of testing the 9-hp engine was replaced with the 6.5-hp engine. Due to dissimilar shaft diameters, a sheave was used to drive the saw blade in place of the electric clutch on the previous configuration. Using the same setup used to test the 9-hp engine, the speed of the saw blade was determined during the cutting of many different cedar tree trunks of differing sizes. The resulting speed vs. time data is shown graphically in Figure 11.

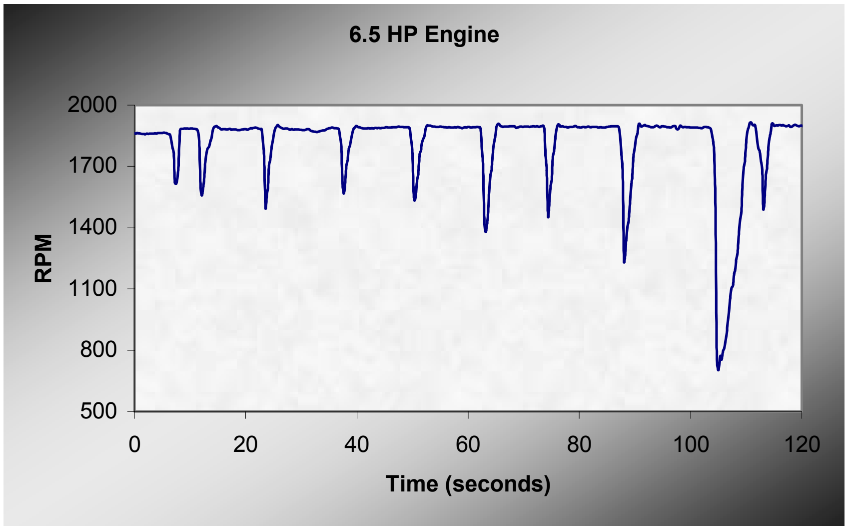

Figure 10: Revolutions per Minute vs. Time for 6.5 HP Engine

The 6.5 hp engine yielded some interesting results upon testing. The engine was easily able to cut through the smaller tree trunks, performing much like the 9 hp engine. However, when trees with diameters close to 3 inches or larger were run through the saw blade, the 6.5 hp engine would slow down, sometimes as much as 1200 RPM. This was expected and could have been resolved by the use of the flywheel. Yet, the engine would not immediately return to its normal operating speed. Rather, it would continue running at the lower speed for quite awhile before returning to the normal operating speed. It was immediately observed by RangeScaping that a flywheel would in no way help this kind of situation. Instead, a flywheel would only increase the difficulty the engine had in returning to normal operating speed. Although a flywheel size was calculated using two different methods, the resulting flywheel size was only about 0.2 lb. A flywheel of this size would most likely move this 3-inch threshold to a somewhat larger tree, it would not move it beyond 5 inches, which is the size of tree the All Terrain Cedar Saw is designed to cut. Thus, it was determined the All Terrain Cedar Saw would continue use with the 9 hp engine as opposed to the proposed 6.5 hp engine and flywheel system.

Final Design Testing

For final testing, the All Terrain Cedar Saw final design was operated in a field full of small eastern red cedar trees. The objective of this testing was to determine how the cedar saw performed on the whole after the many alterations made by RangeScaping. Most importantly, the performance of the blade guards, stabilizer bars, skid plate, and blade stabilizers were observed. The blade guards did not respond favorably. After cutting the first tree, two linkages came unbolted allowing the blade guards to fall onto the saw blade. These were removed before further testing. To the contrary, the stabilizer bars, blade stabilizers, and skid plate performed as intended. There was no horizontal swing allowed in the saw frame, and the blade was not allowed to flex.

Safety Regulations

There are no regulations for a tree saw attachment for an All Terrain Vehicle. However, regulations for walk behind power lawn mowers were deemed adequate to apply to the All Terrain Cedar Saw. The U.S. Consumer Product Safety Commission and Underwriters Laboratories Inc. provide these regulations. Specifically, the U.S. Consumer Product Safety Commission states the following parameters for blade control: (1) the operator must have control of engaging and disengaging the blade, (2) the blade is allowed to turn only when the operator is holding or in contact with the control, and (3) when the blade is running at full speed, the blade must come to a complete stop within three seconds after the operator has disengaged the control. The standard for blade exposure is to have protective shields. These protective shields must prevent body parts from entering the blade path. RangeScaping adopted these standards for the All Terrain Cedar Saw.

Final Design

The All Terrain Cedar Saw final design improvements consist of an electric clutch/brake, blade guard, stabilizer bars, skid plate, and blade stabilizers. Safety was the highest priority in the design of each component, both in function and interaction with the operator. These will be addressed below.

Driveline

The driveline of the All Terrain Cedar Saw final design is very similar to the original design. Power for the cedar saw is provided by a 9 hp Briggs & Stratton vertical shaft engine. Attached to the engine shaft is a Warner electric clutch/brake. This clutch/brake is engaged by the operator using a footswitch. A notched V-belt connects the clutch/brake to another pulley at the end of the cedar saw frame. This second pulley is used to drive a 14 inch, 60 tooth circular saw blade.

Figure 11: Warner Electric Clutch/Brake

Blade Guard

The design currently has no blade guard. This is a safety hazard for those standing near the cedar saw. Someone could easily be severely harmed if they are not paying attention to their surroundings. A blade guard is a must, especially if operating close to observers. The guard not only needs to cover the top of the blade, but also the side or the teeth. This will prevent someone from walking into the blade. Also, if any teeth break off they don't go flying in any direction they want.

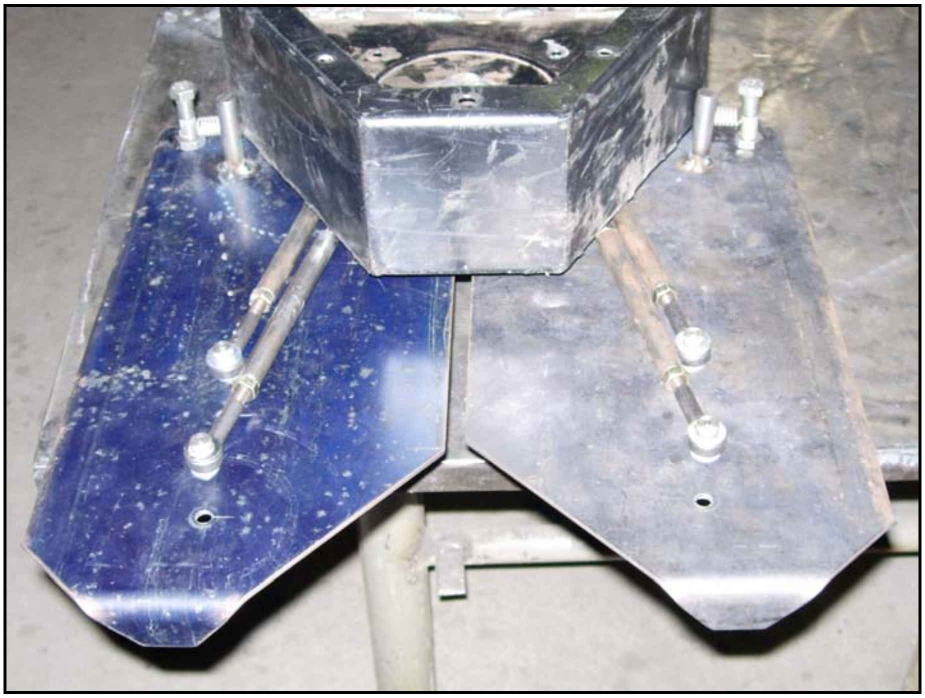

Figure 12: Blade Guards

The guard is made out of 1/8" steel. The flat piece is 9" wide and 19" long. It is cut such that it follows the design of the snout and V-ed in the middle to guide and angled at the edge to not snag on anything. There are two linkages that connect each piece to the snout, and two springs that hold them closed. When a tree is cut off, the blade opens, cuts the tree off, and the spring closes the guard to keep the blade hidden.

Stabilizer Bars

The current design is attached to the ATV using only a receiver hitch at the rear and a winch at the front. The current setup allows a lot of freedom as far as swing in the horizontal plane. This is a safety hazard. It was decided to incorporate a stabilizer bar system. The bars would attach to the saw and also to the ATV and reduce, if not eliminate, any swing. Also, the bars had to be adjustable so they could move with the winch. We decided to attach the stabilizer bars to the under carriage portion of the saw so the snout could still be removed without taking off the bars. A1 .5" x 15" piece of 1/8" was welded to the lower portion of the undercarriage and gussets were welded to support the overhang. The lower portion of the stabilizer bars consisted 1"-14 gage square tubing. The upper portion of the stabilizer bars is made out of 1-1/4"-14 gage square tubing. Holes were drilled and bushings were welded in to support the load. The upper mounts are made out of 1/8" steel and attached to the front push guard using U-bolts. The 1" square tubing slides inside of the 1-1/4" square tubing and adjusts easily with the winch height.

Figure 13: Stabilizer Bars

Skid Plate

The current design employs the use of two caster wheels which is suppose to limit the blade from coming in contact with the ground during operation. Through testing we found out that that is not always true. During operation in uneven terrain, if the tree was on a small hill or in front of a ditch, the blade was more than likely going to dig into the ground. This would possible bend the blade and if rocks were present break teeth off of the saw blade. We saw this as something that needed to be remedied. We commenced the design of a skid plate to replace the caster wheels.

Figure 14: Skid Plate

The design of the skid plate would be so that the skid plate itself would come underneath the blade. This would keep the blade from coming into contact with ground. A piece of 4” x 14.5” piece 3/16” sheet metal was used. It was broke 1.5” from one edge at an angle of 152^{o}, from the same edge 8.5” at and angle of 152^{o}, and 9.5” from the same edge at and angle of 155^{o}. Two gussets were made to give support to the skid plate, and two 3/8” holes were drilled into the 1.5” section of the skid plate. The skid plate is attached to the snout using two 3/8" bolts. After the installation of the skid plate, the snout flexed too much which allowed the skid plate to get into the blade. The area where the skid plate attached was reinforced. A piece of 1/8", 6" long and as wide as the snout was welded into the snout. This took away the flex in the snout which allowed the skid plate not to get into the blade.

Blade Stabilizers

During the testing of the 6.5 Hp engine, it was noticed that the blade became unbalanced and produced a wave motion. The first instinct was that the blade was loose. Upon further inspection, the blade was still tight. The assessment became that due to the engine harmonics at 2900 RPM, the blade produced the wave like motion. After consulting with advisors, it was concluded that a set of blade stabilizers needed to be incorporated. The blade stabilizers consist of two metal disks, five inches in diameter and ¼" thick. These blade stabilizers sandwich the blade. The top blade stabilizer replaces the current spacer, while the bottom one is an addition. The edge of the stabilizer is chamfered to keep any trees from hanging up in the blade. After the completion of the blade stabilizers, testing proved that the blade stabilizers reduced, if not eliminated, any wave motion of the blade.

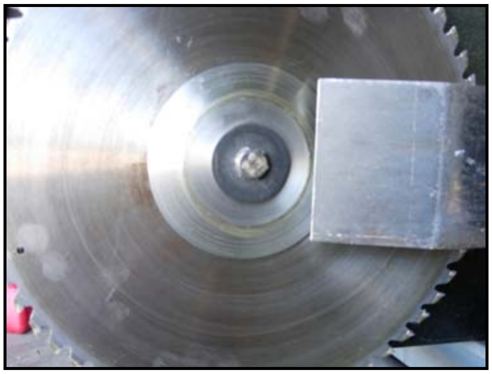

Figure 15: Bottom Blade Stabilizer

Owner's Manual

An owner's manual already existed for the original All Terrain Cedar Saw. It covered safety, operation, maintenance, and installation. After the final prototype was completed, this owner's manual was updated to include the changes made for the new All Terrain Cedar Saw.

Project Schedule

Project scheduling was divided into the major objectives RangeScaping needed to meet. During the fall semester, the main tasks consisted of Project Definition, Research, Concept Design and Documentation. The tasks for the spring semester involved the above with the addition of Testing, Drafting and Final Design. The fall semester tasks were completed as planned. Concept testing was completed during the spring semester, followed by component drafting, prototype fabrication, and final testing of the prototype. A detailed Gantt chart for the entire fall and spring semesters can be found in Appendix C.

Cost Analysis

Proposed Project Budget

As mentioned above, exact cost of the three design concepts could not be determined during the fall semester. However, rough estimates were made considering RangeScaping's past experience with similar systems. The hydraulic components of the Hydraulic System were estimated to cost around $1000. This estimate did not include the cost of the cedar saw frame. Flexible shafts sized for the cedar saw application cost about

$500. Again, this did not include the cost of the brake clutch, gear box and cedar saw frame.

Figure 14 shows an approximate budget for the Flywheel System. Parts that need to be fabricated in the Biosystems and Agricultural Engineering Laboratory include the blade guard, stabilizing bars and sheet metal skid plates. Estimated price of these items does not include the cost of the machinists' labor. The miscellaneous items include the wiring, electronic switch, nuts, washers, bolts, and any other unforeseen assembly parts required.

Item	Price
Frame	350
Undercarriage	125
Engine	277
Brake Clutch	175
Blade Guard	20
Stabilizing Bars	13
Sheet Metal Skid Plates	13
Miscellaneous Items	100
Total	**$1,072**

Figure 16: Estimated Flywheel System Budget

Prototype Cost

The actual cost of manufacturing the prototype included purchased components, material costs for fabricated components, and fabrication costs. After the final prototype was completed, the total costs of these areas were determined. Figure 15 shows the costs of each component, fabrication costs and total cost.

Item	Price
Frame	350
Undercarriage	125
Engine	384
Clutch/Brake	193
Blade Guards	58
Stabilizer Bars	9
Skid Plate	2
Blade Stabilizers	10
Fabrication Costs	150
Total	**$1,280**

Figure 17: Final Prototype Cost

Several factors contribute to the actual prototype cost exceeding the fall semester's proposed budget. One was the need to continue use of the 9-hp engine, which cost approximately $100 more than the 6.5-hp engine. Another factor was the fabrication costs, which were not incorporated into the fall semester's proposed budget. Finally, the blade stabilizers were an unforeseen need which added some additional cost.

Conclusion

Design Criteria

The results of this project reflect the extent to which RangeScaping was able to meet the design criteria set forth by Ron Cole of All Terrain Cedar Saw, LLC and RangeScaping itself. Cole required the cedar saw be capable of cutting cedar trees up to 5 inches in trunk diameter and/or 7 feet high. Design changes should not limit the cedar saw's maneuverability in rougher terrain. Finally, the cedar saw should be capable of being used on at least a 300-cc ATV. RangeScaping required covering the exposed blade with some type of guard or shield or the safety of the operator and bystanders. A braking device should be implemented to permit the blade to stop within 3 seconds of being disengaged. Finally, the cedar saw frame should not be allowed to swing in the horizontal plane.

Figure 18: Final Prototype

RangeScaping's final prototype of the All Terrain Cedar Saw was able to meet some of the above criteria while failing to meet others. The cedar saw was capable of cutting cedar trees with trunk diameters up to 5 inches and tree heights up to the allowable 7 feet. Maneuverability in the field was not a problem with the final design. Also, the cedar saw was not allowed to swing in the horizontal plane. A breaking device was implemented on the new design; however, it was not able to bring the blade to a stop within 3 seconds. Rather, it stopped the blade within 4 seconds of being disengaged. The blade guards that were implemented did protect the operator and bystanders by completely covering the blade. However, final design testing revealed that they did not perform as intended. Finally, with RangeScaping's decision to continue use of the 9-hp engine came an inability of the cedar saw being used on at least a 300-cc ATV. However, final design testing was performed using a 400-cc ATV, which was competent with the All Terrain Cedar Saw.

Recommendations

RangeScaping recommends more time be spent to further improve the All Terrain Cedar Saw. It was discovered the tighter the brake/clutch was adjusted, the quicker the blade could be stopped. However, a tradeoff existed in the difficulty of pull starting the engine. Thus, if the 3 second stopping time is ultimately desired it can be achieved with the added difficulty in pull starting the engine. More time needs to be put into the blade guards to have them working properly, including using stouter linkages. Another recommendation is more testing should be performed on the 6.5-hp engine. With the added inertia of the blade stabilizers, and if a flywheel were incorporated, the engine might not drop below that threshold which keeps it running at a lower RPM for quite awhile. It may also be determined that the problem lies with that particular engine. With more time and thought RangeScaping feels many more improvements could be made to the All Terrain Cedar Saw.

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Appendices

US006662835B1

(12) **United States Patent**
Gengler

(10) **Patent No.:** **US 6,662,835 B1**
(45) **Date of Patent:** **Dec. 16, 2003**

(54) **ROTARY TREE CUTTER ATTACHMENT FOR TRACTOR**

(76) Inventor: **Melvin Gengler**, R.R. 1, Beloit, KS (US) 67420-9801

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(58) **Field of Search** 144/34.1, 4.1, 144/335, 336, 24.12; 56/229, 255, 13.6, 11.9, 6, 10.8; 37/302

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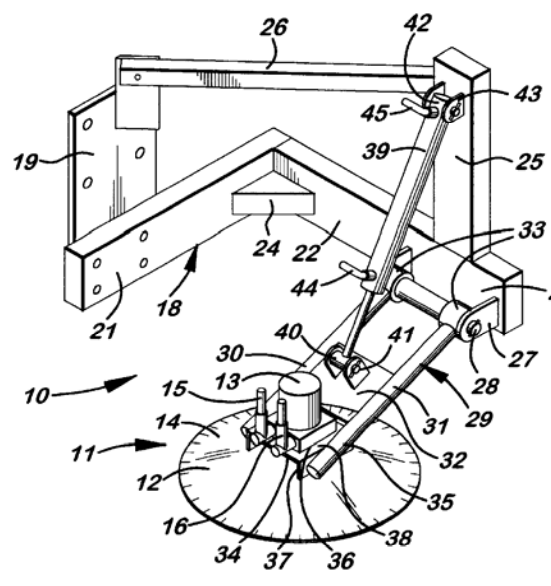
(74) *Attorney, Agent, or Firm*—Jeffrey L. Thompson; Thompson & Thompson, P.A.

(57) **ABSTRACT**

A rotary tree cutter attachment for a tractor includes a cutting assembly having a circular blade with a serrated outer edge, and a motor for rotatably driving the blade. A frame assembly for the tree cutter includes a first portion attached to the tractor frame, and a second portion extending perpendicular to the first portion and providing an offset mounting location outside a wheel path of the tractor. A pivot arm is pivotally connected to the offset mounting location for rotation about an axis transverse to the tractor's direction of travel. The pivot arm supports the cutting assembly and is movable about the transverse axis between a lowered position in which the cutting edge of the circular blade is generally horizontal and at ground level for cutting, and a raised position in which the cutting edge of the circular blade is elevated above ground level for traveling.

8 Claims, 3 Drawing Sheets



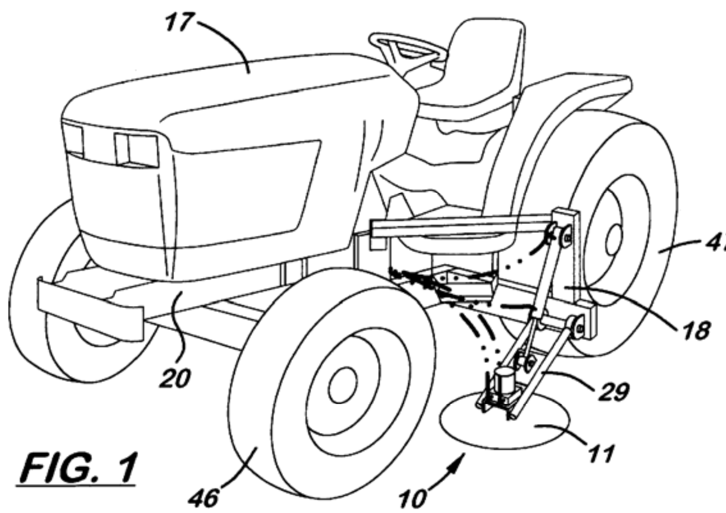

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FIG. 1

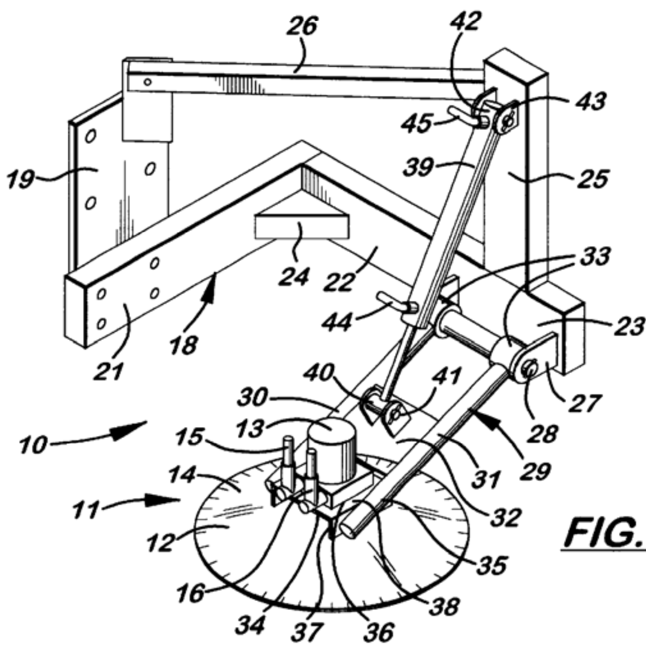
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FIG. 2

US006640528B1

(12) **United States Patent**
Rowland

(10) **Patent No.:** **US 6,640,528 B1**
(45) **Date of Patent:** **Nov. 4, 2003**

(54) **TRACTOR MOUNTED BOOM SYSTEM THAT IS CONVERTIBLE BETWEEN A BACKHOE AND A ROTARY CUTTING SYSTEM**

(76) Inventor: **Scott Rowland**, 6551 Dwight Rowland Rd., Willow Springs, NC (US) 27592

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/041,918**

(22) Filed: **Jan. 8, 2002**

(51) **Int. Cl.**[7] **A01D 34/86**; A01D 34/64
(52) **U.S. Cl.** **56/15.2**
(58) **Field of Search** .... 56/10.9, 11.9, 56/15.2, 15.1, 15.4, 15.6, 15.7, 15.9, DIG. 11, DIG. 14; 37/104, 301, 302

(56) **References Cited**

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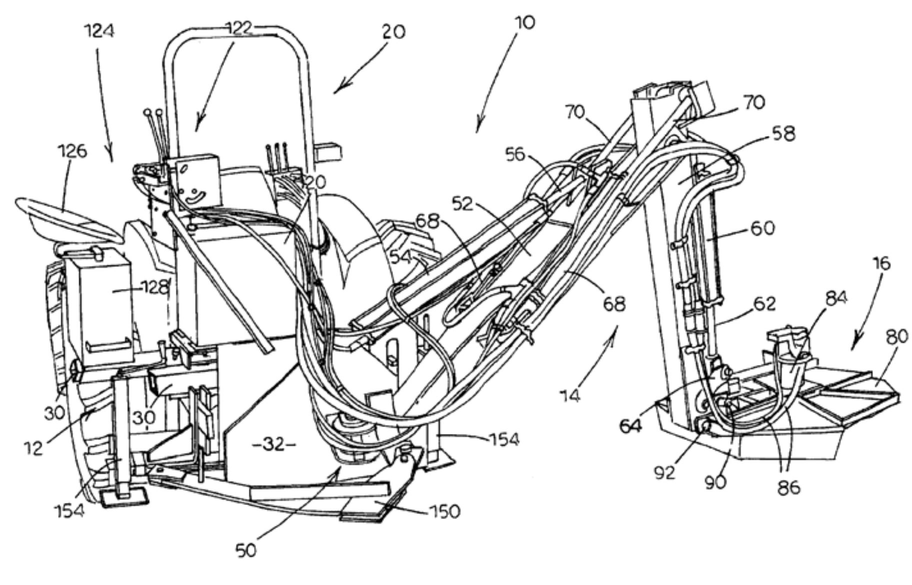
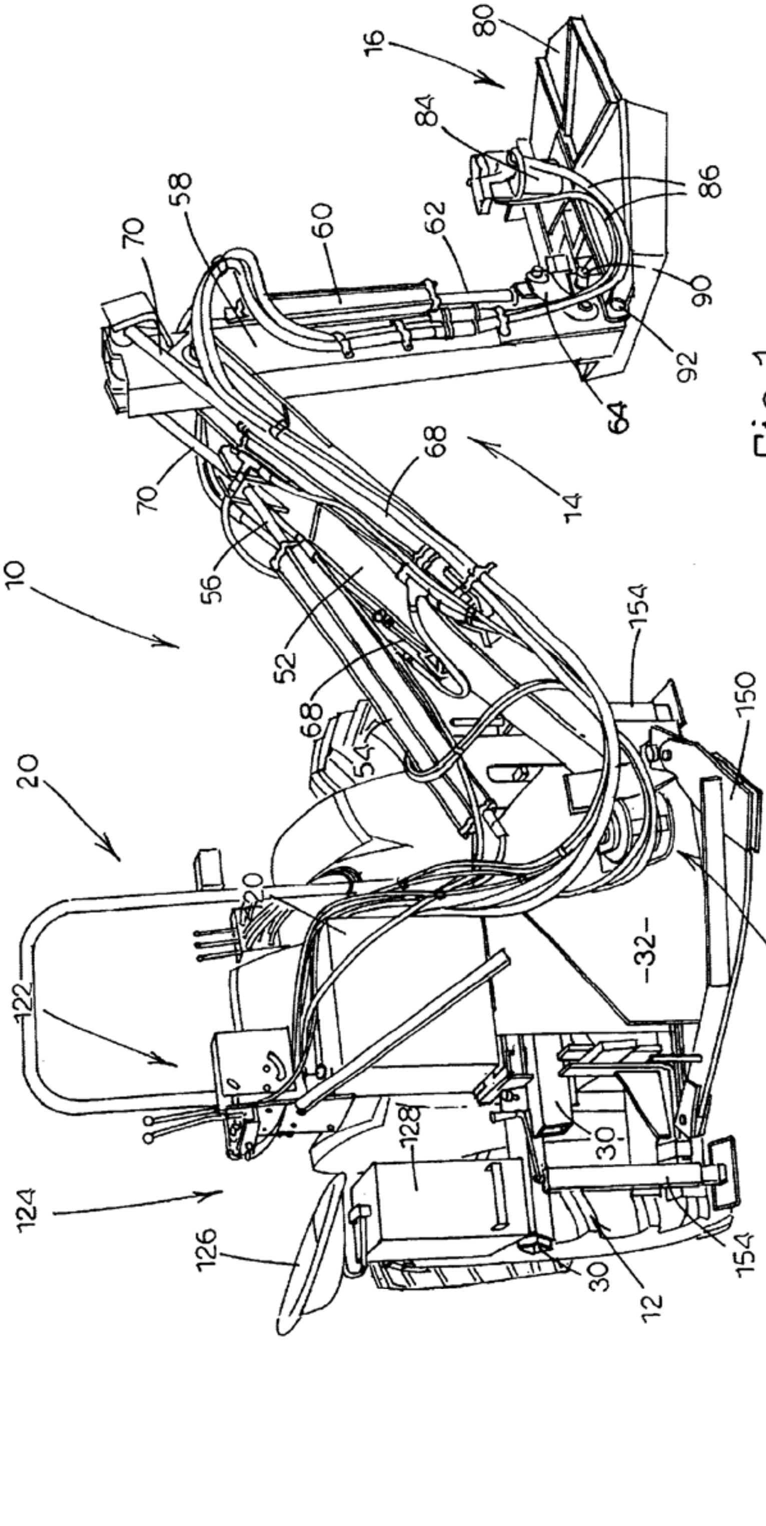
Primary Examiner—Robert E. Pezzuto
(74) *Attorney, Agent, or Firm*—Coats & Bennett, P.L.L.C.

(57) **ABSTRACT**

A tractor mounted boom structure is provided where the boom is adapted, in one mode, to connect a rotary cutter and in a second mode is adapted to connect to a bucket to form a backhoe. The system comprises a mainframe structure adapted to be mounted to a tractor such as by a three-point hitch associated with a tractor. Extending from the frame structure is a first or Primary boom. Connected to the end of the first boom is a second boom. An array of hydraulic cylinders is provided that enables the first boom to articulate with respect to the frame structure and permits the second boom to articulate with respect to the first boom. The second boom is provided with a connector assembly that enables the second boom to be connected to either a rotary cutter or to a bucket. When used to support a rotary cutter, the first boom is generally maintained in a locked position with respect to the mainframe structure of the system. On the other hand, when the system is converted to a backhoe, the first boom is unlocked with respect to the mainframe and in fact is provided with a hydraulic cylinder for articulating the second boom with respect to the frame structure about a generally vertical axis.

18 Claims, 4 Drawing Sheets

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US006439279B1

(12) **United States Patent**
Underwood

(10) **Patent No.: US 6,439,279 B1**
(45) **Date of Patent: Aug. 27, 2002**

(54) **TREE SAW ATTACHMENT WITH TWEEZER ARM**

(75) Inventor: **Mark Underwood**, Burr Oak, KS (US)

(73) Assignee: **Great Plains Manufacturing, Incorporated**, Salina, KS (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/004,150**

(22) Filed: **Oct. 31, 2001**

(51) **Int. Cl.**[7] **A01G 23/08**

(52) **U.S. Cl.** **144/34.6**; 37/301; 56/16.4; 30/379; 83/928; 144/34.1; 144/336

(58) **Field of Search** 56/16.4; 37/301; 30/379, 379.5; 83/846, 852, 928; 144/34.1, 34.5, 34.6, 336; 172/701.1, 701.3

(56) **References Cited**

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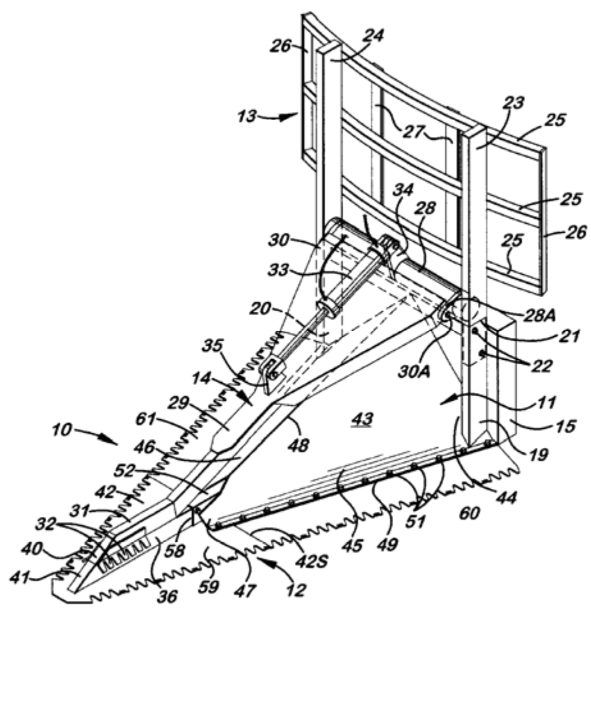
Primary Examiner—W. Donald Bray
(74) *Attorney, Agent, or Firm*—Hovey Williams LLP

(57) **ABSTRACT**

A tree saw attachment (**10**) for use with a loader vehicle includes a base frame (**11**), a generally V-shaped blade assembly (**12**), a brush guard (**13**), and a tweezer arm assembly (**14**). A swingable tweezer arm (**29**) of the tweezer arm assembly is movable using a hydraulic cylinder (**33**) to grasp objects against an upper surface of the base frame or the blade assembly. The brush guard and tweezer arm assembly are removable from the base frame as a single unit to facilitate shipping and assembly. A sprayer assembly (**90**) is positioned within the base frame for applying a herbicide to tree stumps cut by the V-shaped blade assembly. The blade assembly can be a single integral blade (**42**), or can be formed of right and left blades (**70**, **71**) with intermeshing projections (**73**, **74**) secured to a rib member (**36**) along a centerline of the blade assembly.

27 Claims, 5 Drawing Sheets



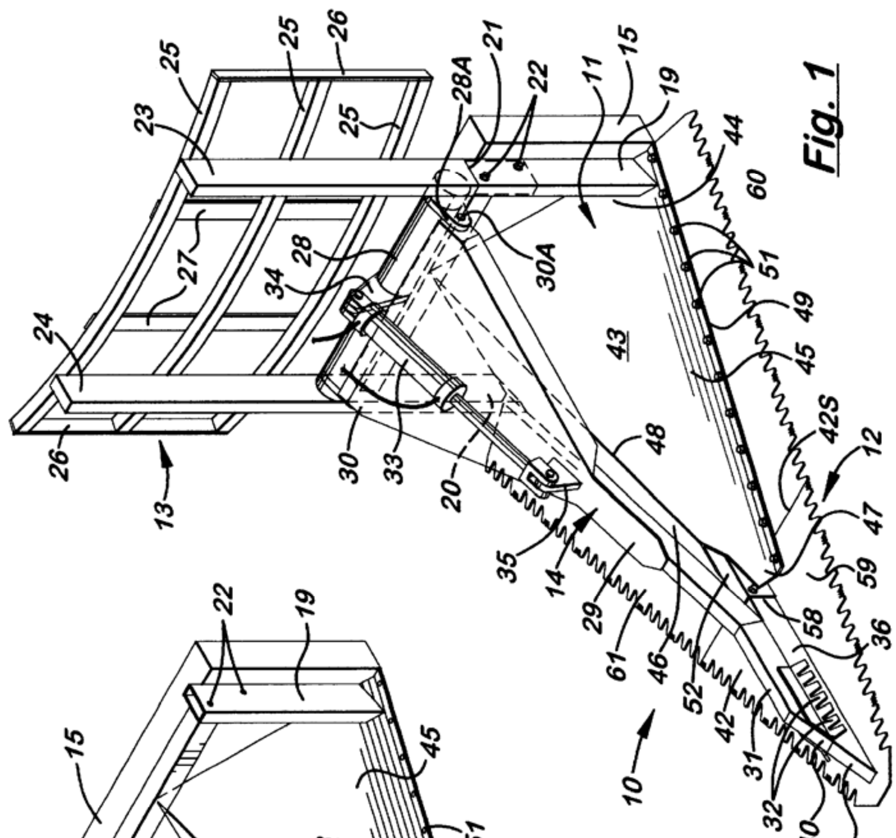

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Fig. 1

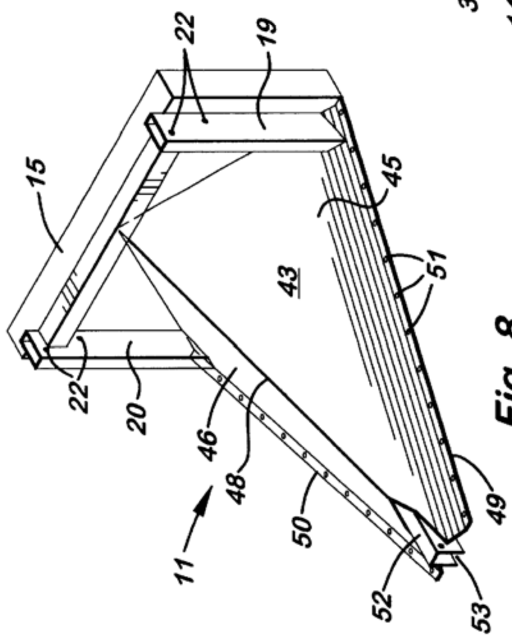
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Fig. 8

US006662479B2

(12) **United States Patent**
Chaney

(10) **Patent No.: US 6,662,479 B2**
(45) **Date of Patent: Dec. 16, 2003**

(54) **TREE AND STUMP REMOVAL**

(76) Inventor: **Sam R. Chaney**, 403 Buffalo La., San Angelo, TX (US) 76901

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/245,807**

(22) Filed: **Sep. 18, 2002**

(65) **Prior Publication Data**

US 2003/0014886 A1 Jan. 23, 2003

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/776,113, filed on Feb. 5, 2001, now abandoned.

(51) **Int. Cl.**[7] **A01B 13/00**; A01G 23/06
(52) **U.S. Cl.** **37/301**; 37/302; 172/699
(58) **Field of Search** 37/302, 301, 303, 37/403, 468; 172/82, 50, 699, 720; 144/334, 336

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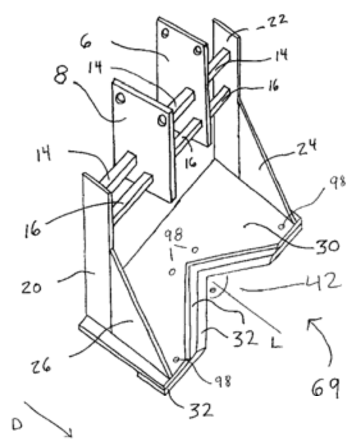
Primary Examiner—Robert F. Pezzuto
Assistant Examiner—Thomas A. Beach
(74) *Attorney, Agent, or Firm*—Christopher J. Whewell

(57) **ABSTRACT**

Provided herein is a device which is useful in removing trees, stumps, and the like from various landscapes. A device according to the invention may be attached to existing earthmoving equipment, preferably in the place of a conventional bucket used on a track driven or tractor mounted backhoe attachment or other functional portion of a hydraulic excavator that is adapted to receive a bucket. A device according to the present invention may be caused to be operated beneath the surface of the ground, as in cases where it is desired to remove root masses and whole trees, such as mesquite and other species. In an alternate embodiment, a device according to the invention is useful above-ground for grasping small cedar trees and the like by grasping sabres affixed to the device. Methods for the use of such devices are provided.

18 Claims, 11 Drawing Sheets



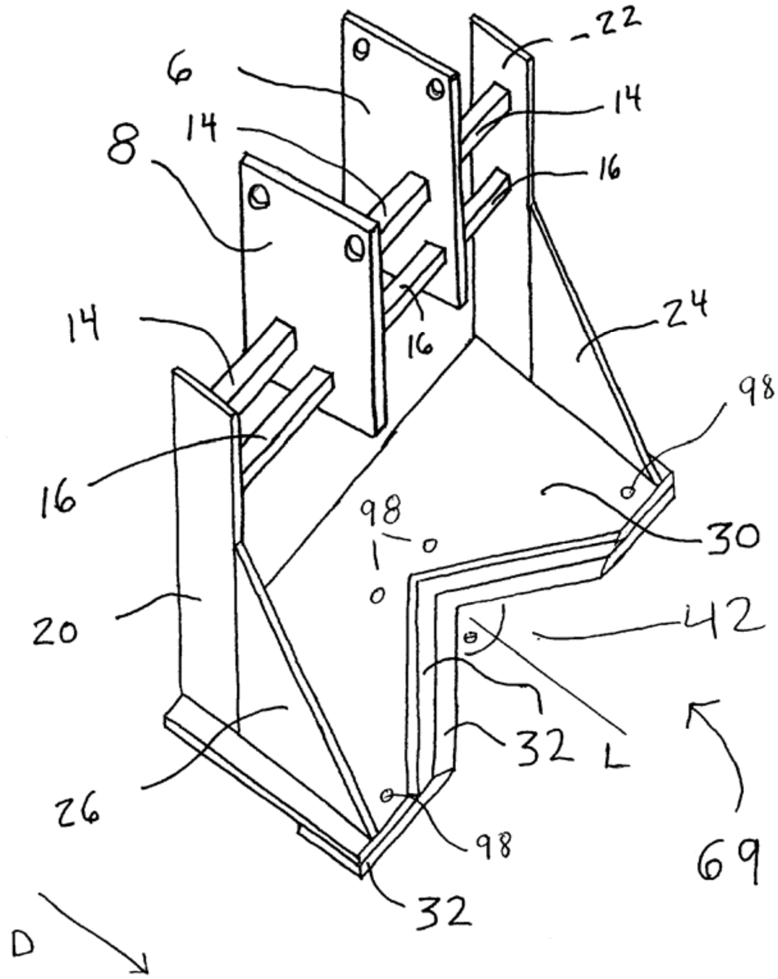


Fig. 1

US005901538A

United States Patent [19]

Vohl

[11] **Patent Number: 5,901,538**

[45] **Date of Patent: May 11, 1999**

[54] **BRUSH FELLING HEAD**

[75] Inventor: **Raynald Vohl**, St-Marc-des-Carrières, Canada

[73] Assignee: **Vohl Inc.**, St-Marc-des-Carrières, Canada

[21] Appl. No.: **08/889,849**

[22] Filed: **Jul. 8, 1997**

[51] **Int. Cl.**[6] **A01D 34/24**; A01G 23/08

[52] **U.S. Cl.** **56/15.2**; 56/295; 56/218; 56/DIG. 14; 144/34.1

[58] **Field of Search** .... 56/13.5, 15.1, 56/15.2, 16.4 R, 255, 295, 229, 218, DIG. 14, DIG. 20, DIG. 24; 144/34.1, 336

[56] **References Cited**

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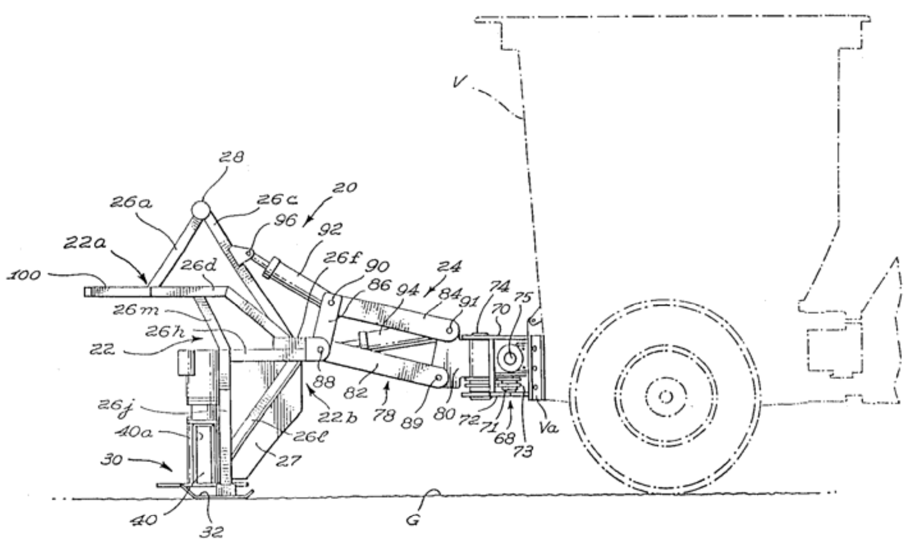
Primary Examiner—Heather Shackelford
Attorney, Agent, or Firm—F. Martineau

[57] **ABSTRACT**

The felling head is operatively installed at the front end of a tractor vehicle, and used for debrushing a brush covered terrain. It comprises a rigid framework, from which downwardly depends a pair of flat, spaced-apart elongated skates that slidingly rest on the ground and support the framework over ground. A pair of discoid saw blades are rotatably supported by the frame, with a ground clearance of a few inches relative to the plane of the skates. The framework is hingedly attached to the tractor vehicle by of a pair of linked parallel parallelograms forced into a common pivotal displacement, each having four rigid bars hingedly attached to one another so as to form a parallelogram configuration. A pair of hydraulic cylinders act on the parallelograms and on the frame, so as to allow vertical linear movement of the frame and a distinct vertical pivotal movement thereof. Thus, when the tractor vehicle pushes the felling head over an uneven ground surface, the elongated skates will be forced under the load of the framework to flatly engage the ground surface, and concurrently the saw blades will be forced to remain parallel to the ground surface with a ground clearance. The felling head further comprises a vertical pivotal axle, to horizontally pivot the saw blades. Outwardly frontwardly divergent arms are provided to convergently bias incoming brush towards the central saw blades.

17 Claims, 6 Drawing Sheets



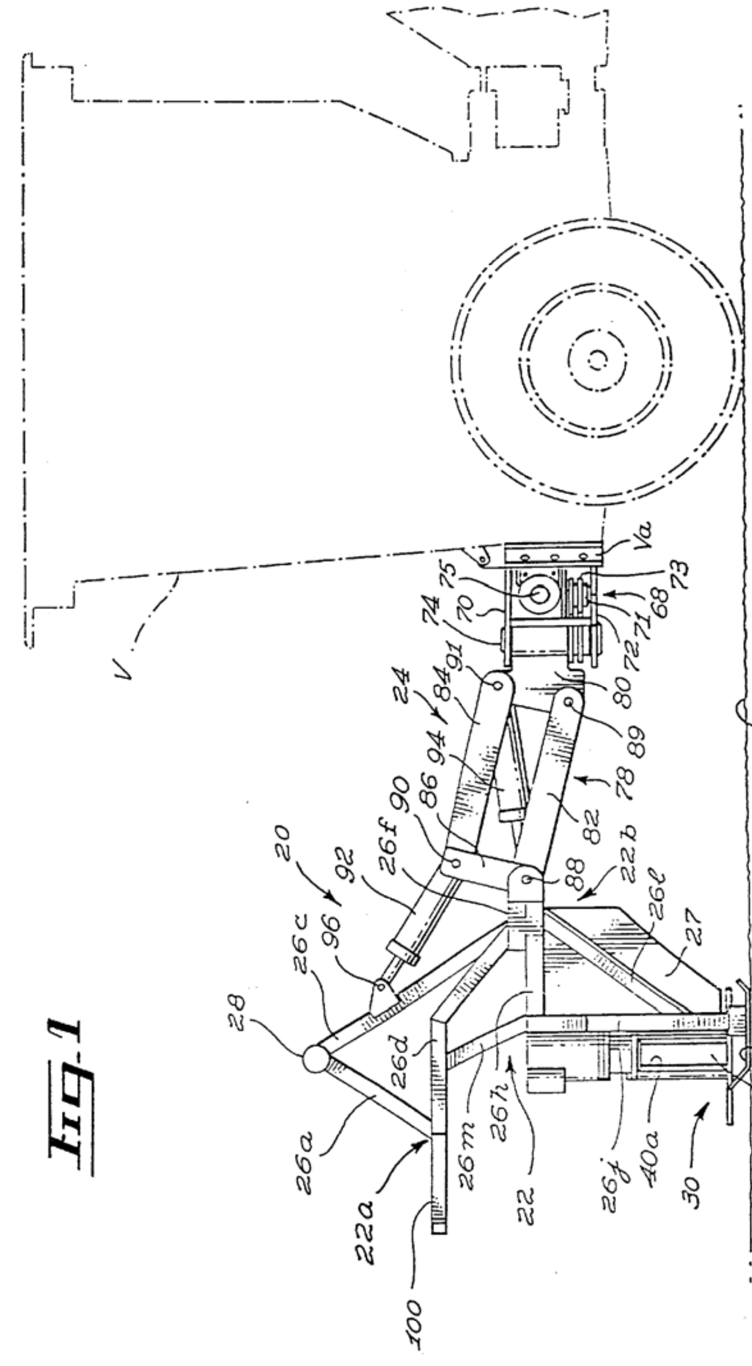

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Fig. 1

United States Patent [19]

Diggs

[11] **4,018,255**

[45] **Apr. 19, 1977**

[54] **TREE SAW**

[76] Inventor: **Richard E. Diggs,** S. 12A Road, P.O. Box 776, Carthage, Mo. 64836

[22] Filed: **Oct. 7, 1975**

[21] Appl. No.: **620,261**

[52] **U.S. Cl.** .... **144/34 R;** 37/2 R; 56/229; 83/836; 83/928; 144/2 N; 172/273; 172/304; 172/618

[51] **Int. Cl.²** **A01G 23/08**

[58] **Field of Search** .... 172/273, 297, 304, 618; 56/229; 144/2 N, 3 R, 34 R, 34 A, 34 F, 309 AC; 83/836, 928; 37/2 R; 30/223, 369

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3,804,138	4/1974	Adcock	144/34 F
3,809,135	5/1974	Dove	144/34 F

Primary Examiner—Othell M. Simpson
Assistant Examiner—W. D. Bray
Attorney, Agent, or Firm—Shoemaker and Mattare

[57] **ABSTRACT**

A tree saw for sawing trees beneath ground level. A saw blade is attached to the front end of a land vehicle which has furrow forming blades on the sides thereof. Movable cutting bits are pivotally attached to the saw blade longitudinal side edges and each bit has two cutting edges. One cutting edge contacts a tree during a forward stroke of the saw blade to cut the tree, and the other cutting edge contacts the tree on the reverse stroke to cut the tree. A hydraulic cylinder connected to the land vehicle moves the blade sideways to cut the tree while the vehicle moves forward and/or rearward.

15 Claims, 9 Drawing Figures

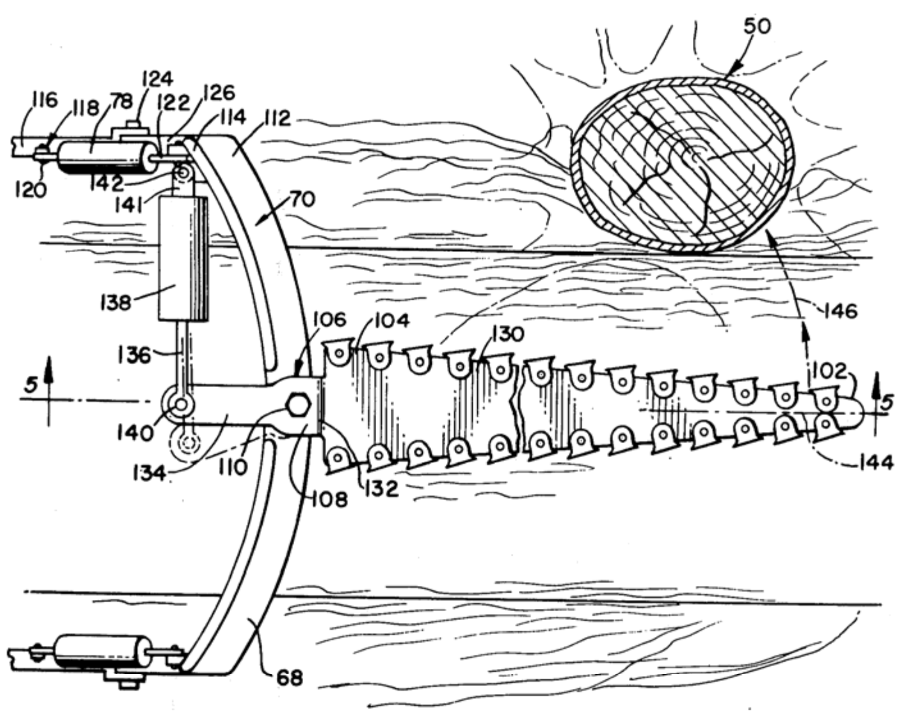

FIG.1.

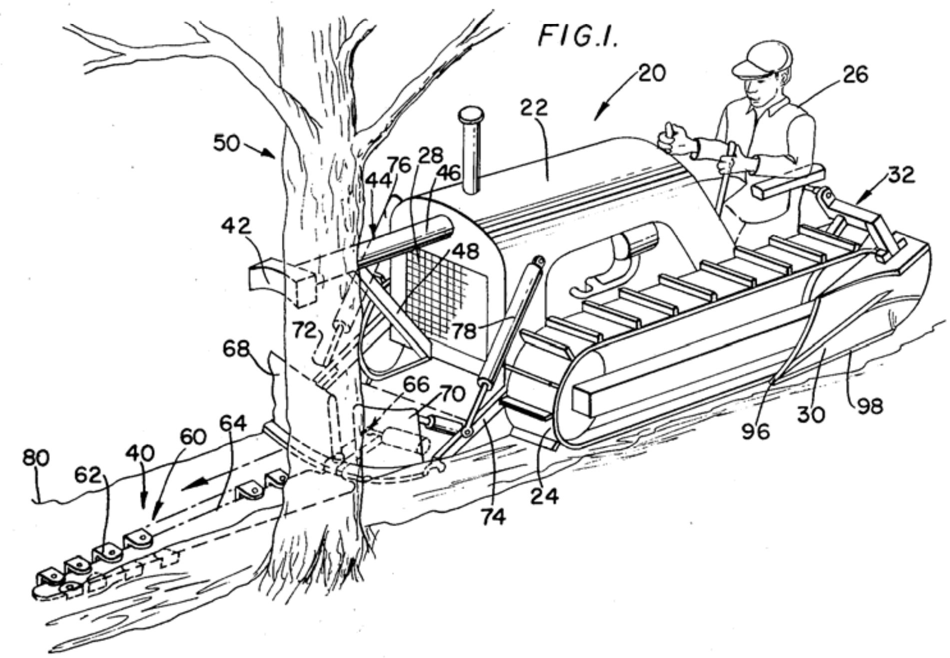
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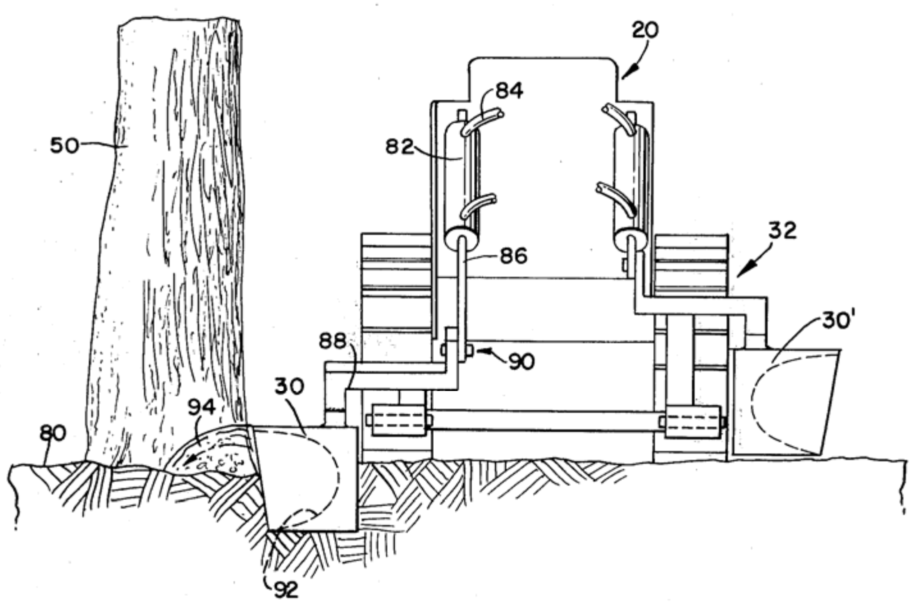
FIG.2.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$$power = \frac{speed \times torque}{5252}$$

$$energy = power \times time$$

$$W = \frac{2gE}{V_m^2 \delta} = \frac{4gE}{V_{1_o}^2 - V_{2_o}^2} = \frac{4gE}{r_o^2(\varpi_1^2 - \varpi_2^2)}$$

9 HP Engine

Time =	0.22	sec			
Speed =	2441	rpm			
Torque =	20.4	ft-lbs			
Power =	9.481417	hp			
Energy =	2.085912	ft-lbs	Energy =	5.487331	ft-lbs

6.5 HP Engine

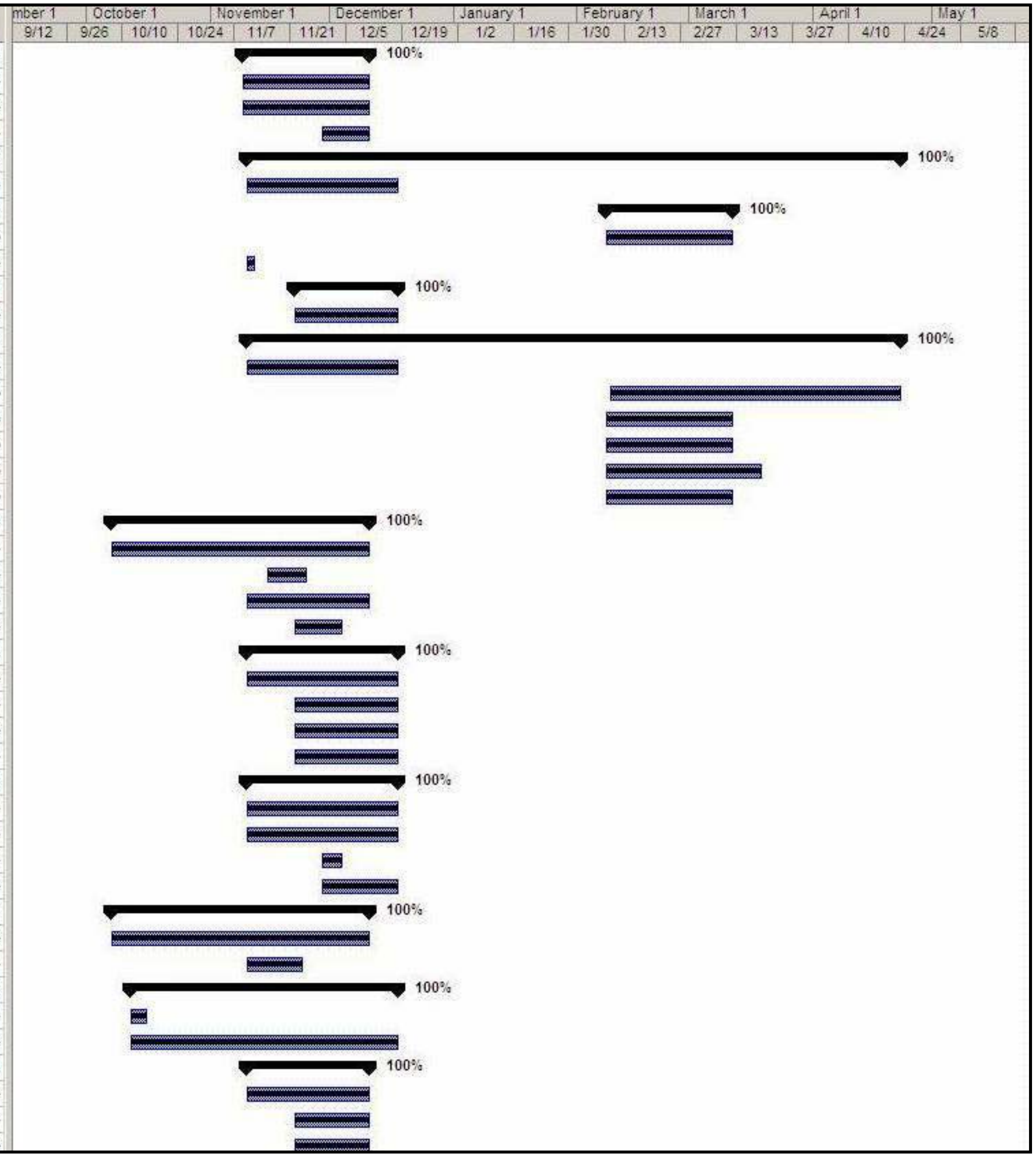
Time =	0.22	sec			
Speed =	1800	rpm			
Torque =	6.4	ft-lbs			
Power =	2.19345	hp			
Energy =	0.482559	ft-lbs	Energy =	3.331511	ft-lbs

Flywheel

Energy =	1.603353	ft-lbs	Energy =	2.15582	ft-lbs
Weight =	0.176316	lb	Weight =	0.237069	lb
g =	32.2	ft/sec^2	g =	32.2	ft/sec^2
r_o =	0.5	ft	r_o =	0.5	ft
RPM max =	1915	rpm	RPM max =	1915	rpm
RPM min =	1800	rpm	RPM min =	1800	rpm
ω_1 =	200.5383	rad/sec	ω_1 =	200.5383	rad/sec
ω_2 =	188.4956	rad/sec	ω_2 =	188.4956	rad/sec

Gantt Chart

	Task Name	Duration	Start	Finish
1	⊟ **Brochure**	**24 days**	**Tue 11/9/04**	**Fri 12/10/04**
2	Team Picture	24 days	Tue 11/9/04	Fri 12/10/04
3	Work Experience	24 days	Tue 11/9/04	Fri 12/10/04
4	Project Experience	10 days	Mon 11/29/04	Fri 12/10/04
5	⊟ **Webpage**	**120 days**	**Wed 11/10/04**	**Fri 4/22/05**
6	Learn Adobe GoLive	28 days	Wed 11/10/04	Fri 12/17/04
7	⊟ **Sponsor Picture**	**25 days**	**Tue 2/8/05**	**Fri 3/11/05**
8	Sponsor information	25 days	Tue 2/8/05	Fri 3/11/05
9	Product Picture	2 days	Wed 11/10/04	Thu 11/11/04
10	⊟ **Team Members**	**20 days**	**Mon 11/22/04**	**Fri 12/17/04**
11	Pictures and Biography	20 days	Mon 11/22/04	Fri 12/17/04
12	⊟ **Video Link**	**120 days**	**Wed 11/10/04**	**Fri 4/22/05**
13	Change video to DVD Format	28 days	Wed 11/10/04	Fri 12/17/04
14	Add complete video from fall semeste	55 days	Wed 2/9/05	Fri 4/22/05
15	Attach last semester's report	25 days	Tue 2/8/05	Fri 3/11/05
16	Attach last semester's presentation	25 days	Tue 2/8/05	Fri 3/11/05
17	Add pictures from this semester's product	30 days	Tue 2/8/05	Fri 3/18/05
18	Make sure all links work properly	25 days	Tue 2/8/05	Fri 3/11/05
19	⊟ **Design Development**	**47 days**	**Thu 10/7/04**	**Fri 12/10/04**
20	Develop different design concepts	47 days	Thu 10/7/04	Fri 12/10/04
21	Consult Wayne and Dr. Weckler about safe	8 days	Mon 11/15/04	Wed 11/24/04
22	Alternatives for driving the Saw Blade	23 days	Wed 11/10/04	Fri 12/10/04
23	Begin calculations for Forces on Saw Blad	10 days	Mon 11/22/04	Fri 12/3/04
24	⊟ **Drafting of Cedar Saw**	**28 days**	**Wed 11/10/04**	**Fri 12/17/04**
25	Frame Dimensions	28 days	Wed 11/10/04	Fri 12/17/04
26	Draft Flywheel	20 days	Mon 11/22/04	Fri 12/17/04
27	Sketch of Hydraulic System	20 days	Mon 11/22/04	Fri 12/17/04
28	Draft of Flexible Cable	20 days	Mon 11/22/04	Fri 12/17/04
29	⊟ **Saw Blade and Power Requirements**	**28 days**	**Wed 11/10/04**	**Fri 12/17/04**
30	Sizing of Flywheel	28 days	Wed 11/10/04	Fri 12/17/04
31	Sizing of Engine	28 days	Wed 11/10/04	Fri 12/17/04
32	Speed Reduction of Saw Blade	5 days	Mon 11/29/04	Fri 12/3/04
33	Cost to fabricate vs. purchase	15 days	Mon 11/29/04	Fri 12/17/04
34	⊟ **Safety Devices**	**47 days**	**Thu 10/7/04**	**Fri 12/10/04**
35	Information on Brake Clutches	47 days	Thu 10/7/04	Fri 12/10/04
36	Blade guard	10 days	Wed 11/10/04	Tue 11/23/04
37	⊟ **Fall Design Proposal Report**	**49 days**	**Tue 10/12/04**	**Fri 12/17/04**
38	Statement of Work (SOW)	4 days	Tue 10/12/04	Fri 10/15/04
39	Patent Research	49 days	Tue 10/12/04	Fri 12/17/04
40	⊟ **Feasibility of Possible Designs**	**23 days**	**Wed 11/10/04**	**Fri 12/10/04**
41	Flywheel	23 days	Wed 11/10/04	Fri 12/10/04
42	Rear Mounted engine with drive shaft	15 days	Mon 11/22/04	Fri 12/10/04
43	Rear Mounted engine with hydraulics	15 days	Mon 11/22/04	Fri 12/10/04



Gantt Chart

	Task Name	Duration	Start	Finish
44	⊟ **Fall Presentation**	**10 days**	**Mon 11/29/04**	**Fri 12/10/04**
45	Gather Research Information	10 days	Mon 11/29/04	Fri 12/10/04
46	Determine Background of slides	10 days	Mon 11/29/04	Fri 12/10/04
47	Put it all together	10 days	Mon 11/29/04	Fri 12/10/04
48	⊟ **Product Testing**	**112 days**	**Wed 11/10/04**	**Tue 4/12/05**
49	Current Product	28 days	Wed 11/10/04	Fri 12/17/04
50	Attach sensor to obtain speed	11 days	Mon 1/10/05	Mon 1/24/05
51	Cut down cedar trees at Dr. Weckler's hou	3 days	Thu 1/20/05	Mon 1/24/05
52	Group trees by trunk size in order to ensur	36 days	Mon 1/24/05	Fri 3/11/05
53	Test 9 hp engine for change in speed vs...	36 days	Mon 1/24/05	Fri 3/11/05
54	Test 6.5 hp engine for change in speed vs	35 days	Mon 1/31/05	Thu 3/17/05
55	Use statistics to determine if the two engin	25 days	Mon 2/14/05	Thu 3/17/05
56	If necessary, calculate flywheel size for th	10 days	Mon 3/7/05	Fri 3/18/05
57	Test completed cedar saw with safety fea	2 days	Mon 4/11/05	Tue 4/12/05
58	⊟ **Design Prototype Features**	**30 days**	**Tue 2/15/05**	**Fri 3/25/05**
59	Design safety guard for circular saw blade	25 days	Tue 2/22/05	Fri 3/25/05
60	Design method of stabilizing front of cedar	7 days	Mon 3/7/05	Tue 3/15/05
61	Design skid plates	16 days	Sat 3/5/05	Fri 3/25/05
62	If necessary, design flywheel	15 days	Mon 3/7/05	Fri 3/25/05
63	Do CAD drawings for all necessary parts	20 days	Tue 2/15/05	Fri 3/11/05
64	⊟ **Build Prototype**	**50 days**	**Tue 2/1/05**	**Thu 4/7/05**
65	Order 6.5 hp engine	10 days	Mon 2/7/05	Fri 2/18/05
66	Order Brake Clutch	5 days	Mon 3/7/05	Fri 3/11/05
67	⊟ **Build Safety Shield**	**20 days**	**Tue 2/22/05**	**Fri 3/18/05**
68	Buy needed material for fabrication of	15 days	Tue 2/22/05	Fri 3/11/05
69	Have Wayne fabricate safety guard	10 days	Mon 3/7/05	Fri 3/18/05
70	⊟ **Build Stabilizer Bars**	**31 days**	**Tue 2/1/05**	**Mon 3/14/05**
71	Buy needed material for fabrication of	26 days	Tue 2/1/05	Mon 3/7/05
72	Have Wayne fabricate mounts	6 days	Mon 3/7/05	Mon 3/14/05
73	⊟ **Build Skid Plate**	**9 days**	**Fri 3/4/05**	**Tue 3/15/05**
74	Buy needed material for skid plates	5 days	Fri 3/4/05	Wed 3/9/05
75	Have Wayne fabricate skid plates	3 days	Fri 3/11/05	Tue 3/15/05
76	⊟ **Flywheel**	**10 days**	**Mon 3/7/05**	**Fri 3/18/05**
77	Flywheel calculations	5 days	Mon 3/7/05	Fri 3/11/05
78	If necessary, have Wayne fabricate a	10 days	Mon 3/7/05	Fri 3/18/05
79	Assemble Cedar Saw	5 days	Fri 4/1/05	Thu 4/7/05
80	⊟ **Test Prototype**	**37 days**	**Mon 3/7/05**	**Mon 4/25/05**
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82	Cut Cedar Trees	2 days	Fri 3/25/05	Sat 3/26/05
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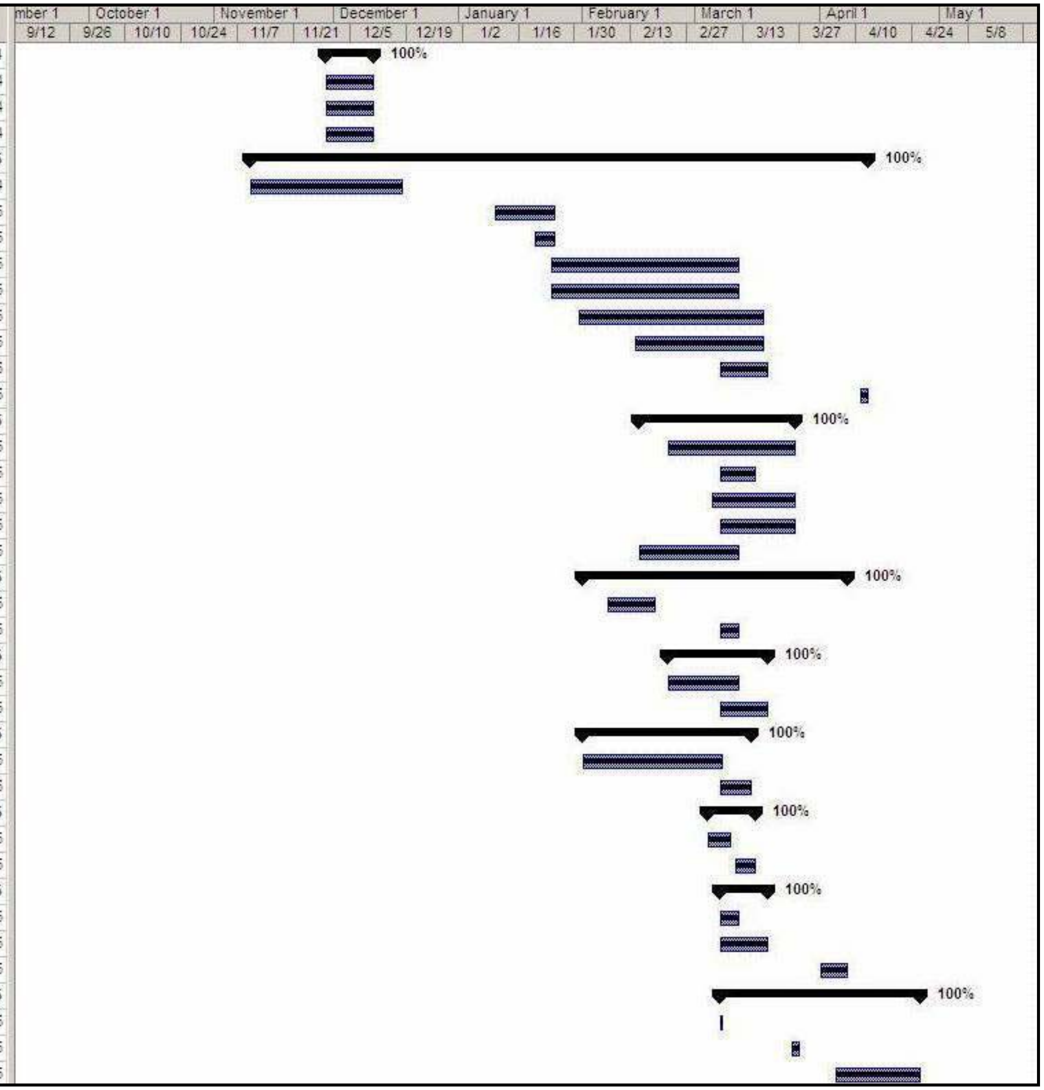
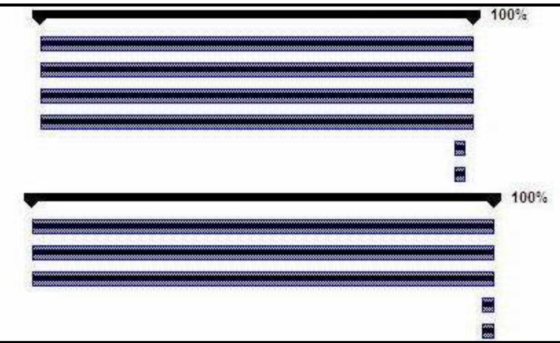


84	**Spring Presentation**	**80 days**	**Wed 1/12/05**	**Fri 4/29/05**
85	New Information	80 days	Wed 1/12/05	Fri 4/29/05
86	Technical information about cedar saw	80 days	Wed 1/12/05	Fri 4/29/05
87	Test Results	80 days	Wed 1/12/05	Fri 4/29/05
88	Put it all together	80 days	Wed 1/12/05	Fri 4/29/05
89	Print copies	3 days	Mon 4/25/05	Wed 4/27/05
90	Bind copies	3 days	Mon 4/25/05	Wed 4/27/05
91	**Final Technical Report**	**85 days**	**Mon 1/10/05**	**Wed 5/4/05**
92	Technical Data from new Cedar Saw Desi	85 days	Mon 1/10/05	Wed 5/4/05
93	Results of Prototype Testing	85 days	Mon 1/10/05	Wed 5/4/05
94	Necessary Features for Final Report	85 days	Mon 1/10/05	Wed 5/4/05
95	Print copies	3 days	Mon 5/2/05	Wed 5/4/05
96	Bind copies	3 days	Mon 5/2/05	Wed 5/4/05



RangeScaping

All Terrain Cedar Saw, LLC

Oklahoma State University

Senior Design

28 April 2005

Colby J. Funk

Wendy S. Sheets

William F. Thomason

ALL TERRAIN CEDAR SAW

PROBLEM DEFINITION

- Factors subject to improvement include the following:
  - At least a 500cc ATV is required due to front-end weight,
  - A dangerous amount of the circular saw blade is exposed,
  - Once the circular saw blade is disengaged, a few seconds of free rotation pass before stopping, and
  - The frame is able to swing horizontally due to front-end attachment via a winch.

PROJECT INVESTIGATION

- United States Patent Office
  - Tree saw attachments for tractors
  - Mount to loader and 3-point hitch
  - No tree saw attachments for ATVs
- All Terrain Cedar Saw
  - Operated by each team member

SAFETY REGULATIONS

- U.S. Consumer Product Safety Commission
- Safety Standard for Walk-Behind Power Lawn Mowers, 16 C.F.R. Part 1205
  - Keep blade from turning unless operator starts control
  - Allow blade to turn only while operator in contact with control
  - Make blade, when running at top speed, come to complete stop within 3 seconds after operator lets go of control

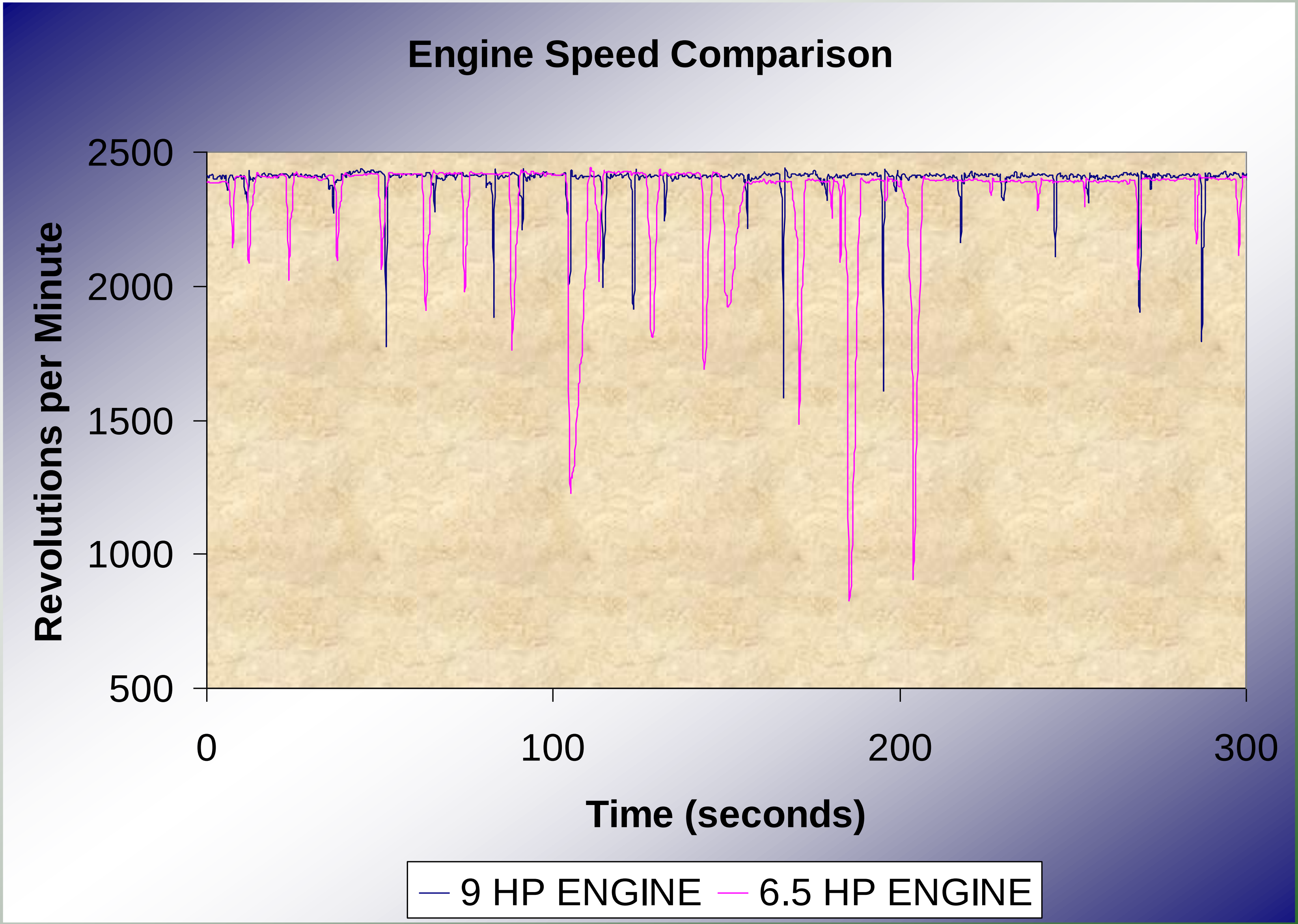
DESIGN CONCEPTS

- Flywheel System
  - Smaller engine weighs considerably less
  - Flywheel makes up for lost power
- Flexible Cable Drive System
  - Engine moved to rear of ATV
  - Flexible cable used to drive blade
- Hydraulic System
  - Engine moved to rear of ATV
  - Hydraulics used to drive blade

PERFORMANCE TESTING

- Purpose to find energy of cutting
- Both engines tested for comparison
- Cedar branches of various diameters
- Blade speed versus time recorded

TESTING RESULTS

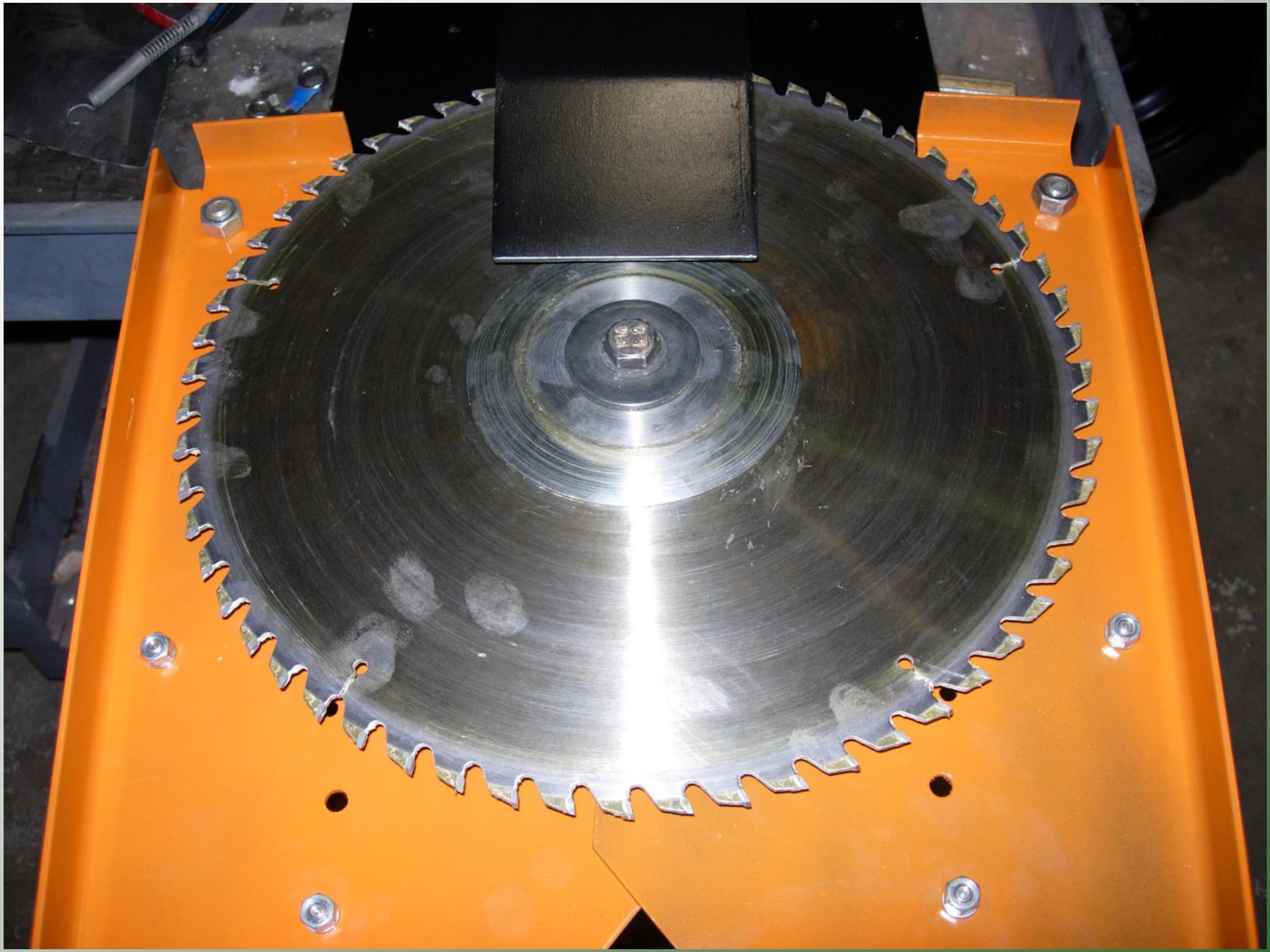


CLUTCH / BRAKE

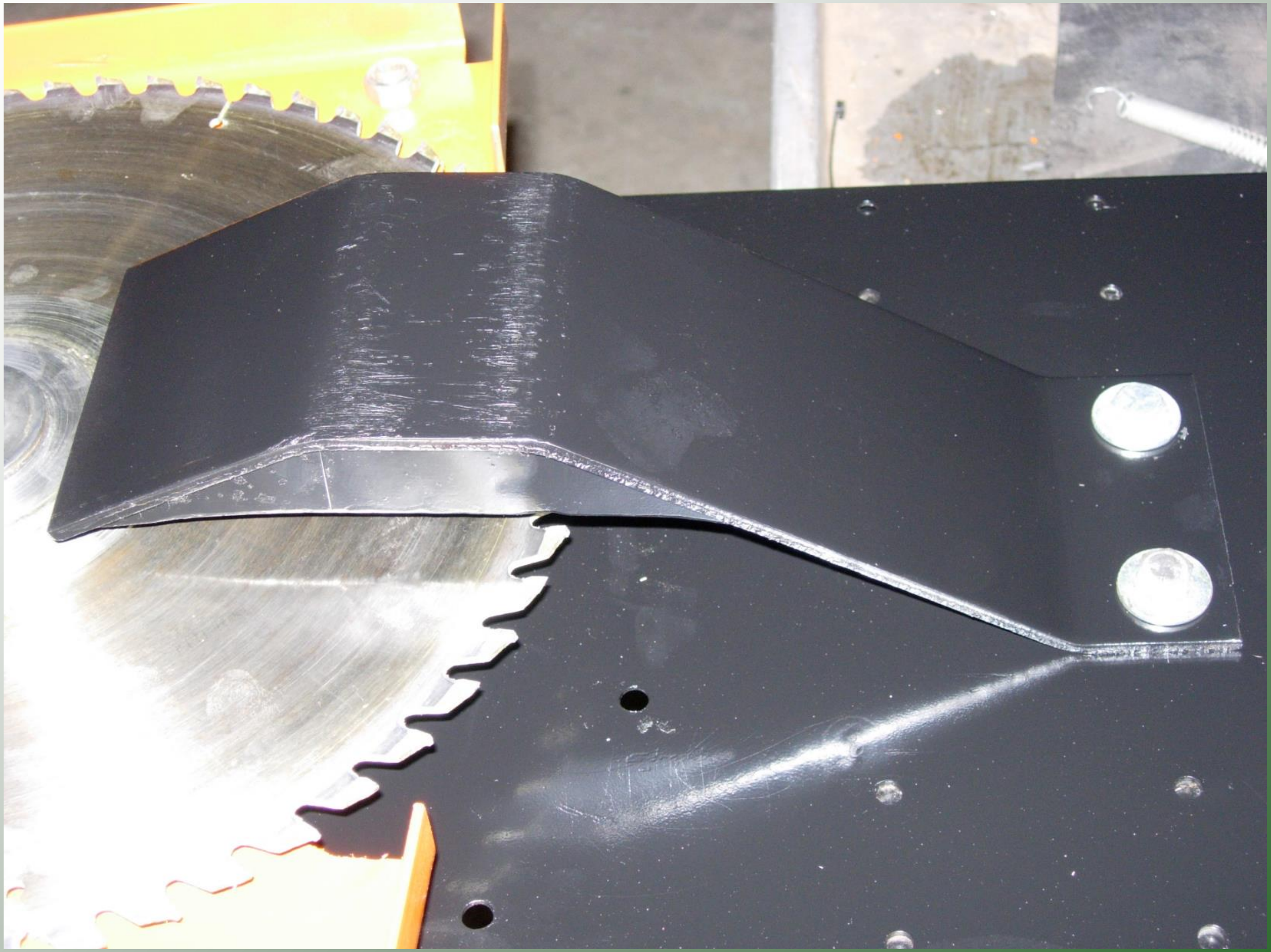
BLADE GUARDS

STABILIZER BARS

BLADE STABILIZERS



SKID PLATE



COST COMPARISON

Proposed Budget	
Item	**Price**
Frame	350
Undercarriage	125
Engine	277
Brake Clutch	175
Blade Guard	20
Stabilizing Bars	13
Sheet Metal Skid Plates	13
Miscellaneous Items	100
Total	**$1,072**

Prototype Cost	
Item	**Price**
Frame	350
Undercarriage	125
Engine	384
Clutch/Brake	193
Blade Guards	58
Stabilizer Bars	9
Skid Plate	2
Blade Stabilizers	10
Fabrication Costs	150
Total	**$1,280**

PROJECT SCHEDULE

Gantt Chart

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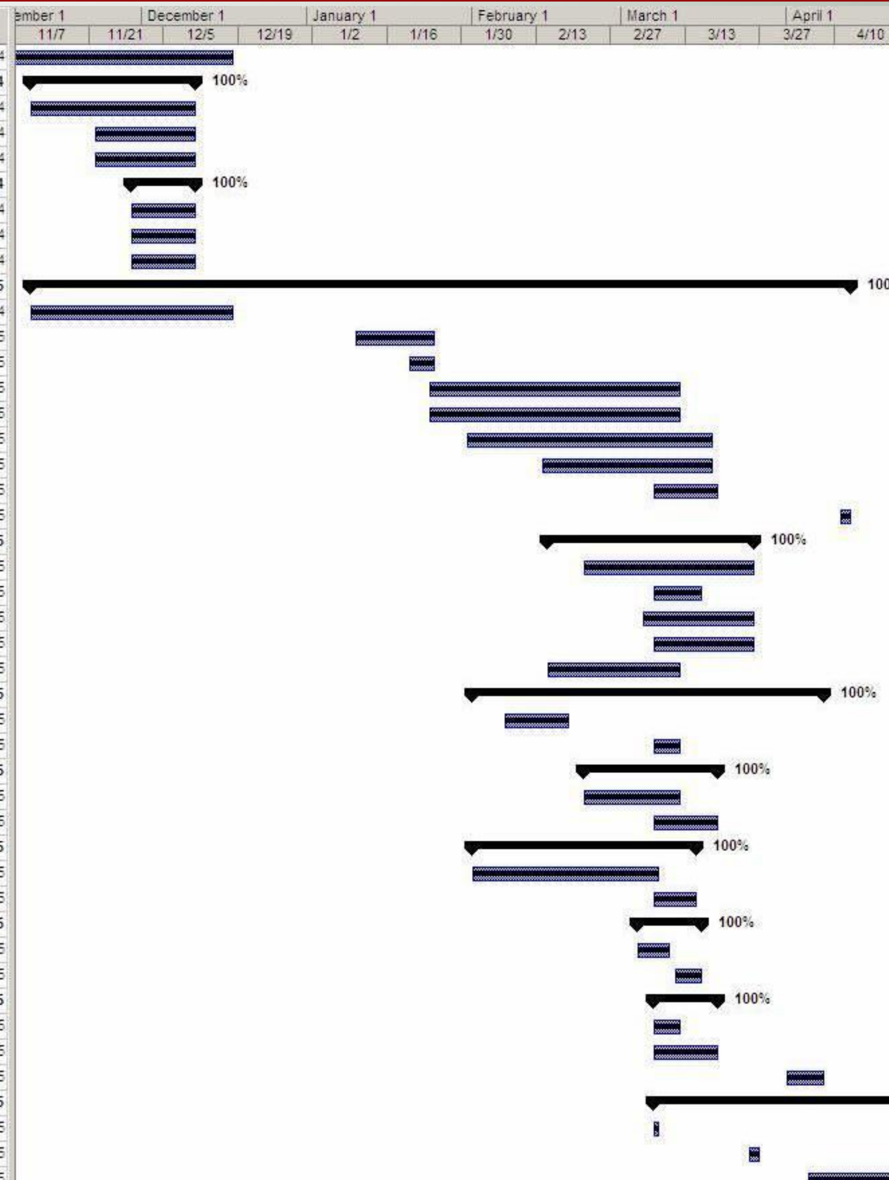

FINAL DESIGN

THANK YOU

- All Terrain Cedar Saw, LLC
  - Ron Cole
- OSU Extension
  - Clay Buford
- Manufacturing Extension
  - Paul Walenciak
- BAE Faculty
  - Dr. Paul Weckler
  - Dr. John Solie
- BAE Lab Personnel
  - Wayne Kiner
- Cowboy Motorsports
  - Ryan Haar

All Terrain Cedar Saw

RANGESCAPING

Colby J. Funk
Wendy S. Sheets
William F. Thomason

Senior Design
BAE 4012

December 17, 2004

Table of Contents

Table of Figures

Introduction

All Terrain Cedar Saw LLC is a small business owned by Ron Cole. The undercarriage, or portion that mounts under the ATV, is built by Cole in his shop located near Vici, OK. The main frame for the cedar saw is built by a company in Oklahoma City. The cedar saws are packaged for shipping in his shop, to be assembled on site. They are shipped in two pieces: the large sub frame and another large box containing the remaining components and parts, with the exception of the cable winch.

Figure 1: All Terrain Cedar Saw

The All Terrain Cedar Saw is currently designed to cut cedar trees at ground level no larger than 5 inches in diameter. It attaches at the front and rear of a 500 cc or larger ATV. A winch at the front and a 2 inch receiver hitch welded to the rear of the ATV are used to carry the cedar saw. A 9 horsepower Briggs & Stratton engine is used to power the 14 inch diameter 60 tooth saw blade via a v-belt. The blade is engaged by an electric clutch via a footswitch.

Problem Definition

A significant problem associated with the current design of the All Terrain Cedar Saw is the design’s failure to evenly distribute the weight of the sawing apparatus. Most of the weight of the All Terrain Cedar Saw is carried by the front of the ATV since all the major components are suspended from the front. Safety is a major concern as well. When the footswitch is disengaged the blade does not stop turning immediately, but rather takes a few seconds.

Besides the problems of weight and safety, several other issues arise with the current design of the cedar saw. One is the freedom of motion at the front end of the apparatus. The blade is allowed approximately 20 degrees of swing in the horizontal plane, which may add to problems in safety. Another operational issue is the need to slow down and lean forward on the ATV to bring the saw blade close enough to the ground to cut the cedar tree below the lowest limb. Also, welding a receiver hitch to the rear of the ATV may void some warranties. Thus, the goals of the project are to:

- investigate weight reduction concepts
- improve the stopping time of the blade
- control the horizontal swing of the frame
- investigate safety concepts concerning blade exposure
- address the operational technique
- investigate actual power requirements

Statement of Work

Ron Cole has identified several limitations of the All Terrain Cedar Saw. The cedar tree must not exceed 7 feet in height and a trunk larger than 5 inches in diameter.

The cedar saw may only be used for small soft wood trees in pasture lands. Continuous use of the winch to adjust the height of the blade is not recommended. The height of the blade will need to be adjusted when operating in rock-covered areas, rough terrain, or loading and unloading the ATV. When the footswitch is frequently pressed and released, the clutch will overheat. Due to the weight of the cedar saw, the handling characteristics of the ATV will change. Thus, the ATV must be operated at reasonable speeds.

Figure 2: Maximum Trunk Size

RangeScaping is a group composed of three Biosystems Engineering students in the senior design class. Ron Cole has sought the knowledge of RangeScaping to help improve the All Terrain Cedar Saw design.

RangeScaping will focus on several goals in making design improvements to the All Terrain Cedar Saw. First, we will explore different options of correcting the weight distribution. Placement of the engine, size of the engine, and using counterbalance weights are possibilities. The second issue addresses safety. Rigidly attaching the cedar saw to the ATV, and using a brake clutch to stop the blade immediately when the footswitch is released will increase the safety features.

Investigation

Patent Search

One of the first tasks RangeScaping undertook in researching the All Terrain Cedar Saw design project was conducting a patent search. Searching was carried out for any patents relevant to a tree saw. It quickly became apparent that no one has ever attached a cedar saw to an ATV. The closest possible matches are patents of saw attachments for tractors. One example is the Rotary Tree Cutter Attachment for Tractor, which uses a circular blade on a pivot arm mounted perpendicular to the tractor's frame outside the wheel path of the tractor. Several patents, like the Cutting Machine and the Tree and Stump Removal device, exist for attachments to earthmoving equipment in place of a conventional bucket for a tractor mounted backhoe or a front-end loader. Finally, it was observed that these saws were typically for cutting larger trees than what the All Terrain Cedar Saw is designed to handle.

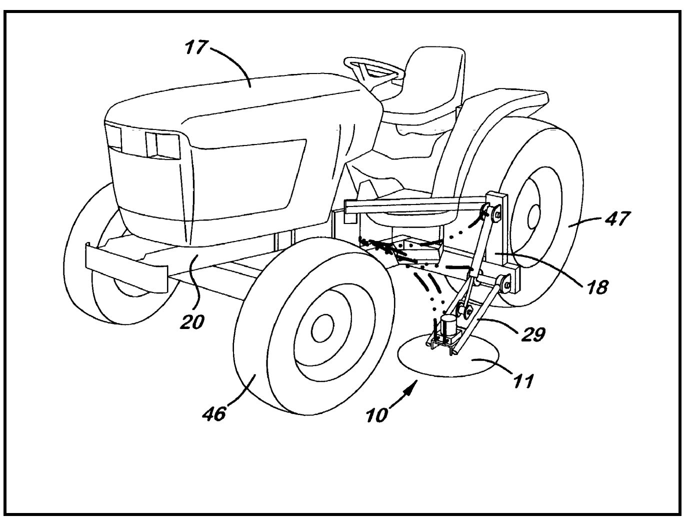

Figure 3: Rotary Tree Cutter Attachment

Testing of Current Equipment

Testing the current All Terrain Cedar Saw was another high priority on the tasks list of RangeScaping. The team exhausted a day traveling to Vici, Oklahoma and operating the cedar saw. Each team member was able to operate the cedar saw, cutting down small cedar trees in one of Cole's fields. Actually having the opportunity to maneuver the All Terrain Cedar Saw in the field was very beneficial for new concept development.

Figure 4: Colby Operating the All Terrain Cedar Saw

Requirements and Specifications

The new ATV cedar saw design that RangeScaping will develop should adhere to several safety criteria. It is to be designed for use on cedar trees with trunk diameter no larger than 5 inches or height no greater than 7 feet. This restriction is due to the safety of the operator when the tree is falling after it has been cut. Any kind of exposed blade on the cedar saw should have some sort of guard for the protection of the operator and any possible bystanders. A controlling device, such as a switch, will be used to allow for the immediate disengagement of the cutting apparatus. The saw should be capable for use with at least a 300 cc ATV. With the cedar saw attached, the ATV should be reasonably maneuverable in the field. Maneuverability also applies to fields with rougher terrain present. Due to the sales of All Terrain Cedar Saws to older persons, if possible the new cedar saw ought not to require much physical exertion to operate. Finally, the overall design should be affordable for ranchers, the target customers.

Concept Development

Once an understanding of the project was attained, RangeScaping began to investigate different design concepts. Due to the uniqueness of the All Terrain Cedar Saw, the team is limited only by their imaginations. Many different ideas were discussed among the team members, from mere improvements in the current design to a completely new design. These concepts were then compiled into plausible designs through evaluating their feasibility. Further refinement has come through dialogue with our sponsors and professors. Cost evaluations and efficiency calculations must be performed before a final design is chosen.

Designs Concepts

Flywheel System

The inspiration behind implementing a flywheel on the current cedar saw design is the ability to use a smaller horsepower engine. This system will be set up very similar to the current All Terrain Cedar Saw with a V-belt drive. A break clutch will be employed for the immediate stopping of the saw blade. A safety shield will be fabricated to cover the circular blade for protection. Stabilizer bars will also be fabricated to rigidly mount the frame to the ATV.

Overall weight of the system decreases due to a smaller engine, e.g. a 6.5 hp engine weighs approximately 40 lb less than a 9 hp engine. A smaller engine would also decrease the cost of the cedar saw. Another advantage would be few necessary design changes to the current cedar saw frame.

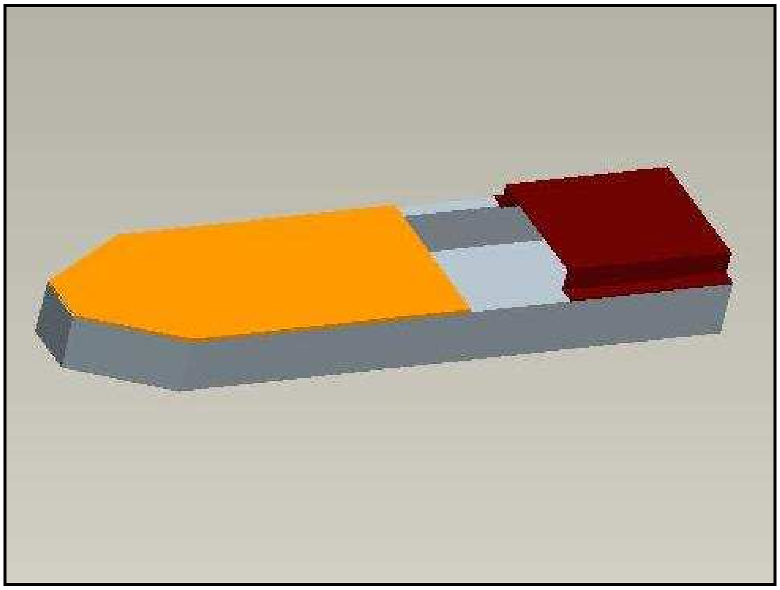

Figure 5: Flywheel System Frame

Hydraulic System

For the hydraulic system, the engine is mounted at the rear of the ATV with a hydraulic pump coupled to the engine. Hydraulic hoses will run to the front of the cedar saw and connect to a hydraulic motor. This motor, in turn, will drive the circular blade. A fluid reservoir and appropriate valves is included as well. A heat exchanger my also be needed to keep the overall efficiency of the system as high as possible by cooling the oil beyond the capacity of the reservoir. A safety shield will still need to be incorporated around the circular saw for safety concerns. Stabilizer bars will be incorporated to rigidly mount the frame to the ATV. Finally, this system would provide for quickly stopping the blade.

Several advantages to the hydraulic system include the weight distribution. Placing the engine at the back of the ATV would correct the front heaviness of the current design. Also, with the use of hydraulic hoses the entire system becomes more flexible. However, the overall weight of the system may increase due to the additional components, such as a hydraulic pump, motor, oil reservoir, hydraulic oil, and valves. Finally, the overall cost of the cedar saw would increase close to $1000 due to these necessary hydraulic components.

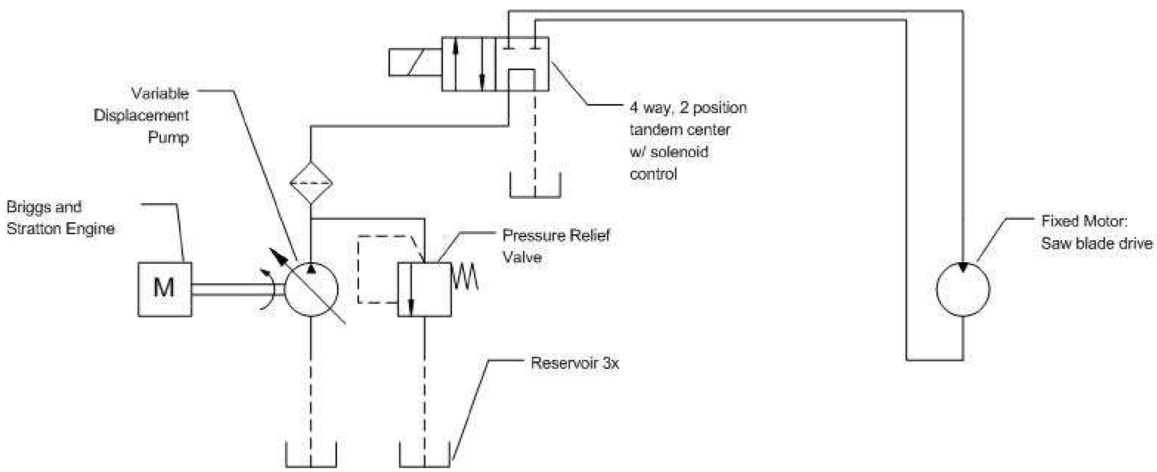

Figure 6: Hydraulic System Schematic

Flexible Cable Drive System

The engine is mounted on the rear of the ATV for this system. The saw blade will be driven by a drive shaft. Due to the considerable costs of using a conventional telescoping drive shaft, bearing carriers and universal joints, it was determined better to implement a flexible cable drive. A brake clutch would immediately stop the saw blade. The drive shaft is coupled to the engine and run the length of the ATV to the saw blade. The other end of the drive shaft is coupled to a gear box. A safety shield will also be fabricated to cover the circular saw blade. In addition, this system will implement stabilizer bars to rigidly mount the frame to the ATV.

The advantages to the flexible cable drive include the transfer of most of the cedar saw weight to the rear of the ATV. Flexibility is another advantage to this system. Though the cost would be lower than that of a hydraulic system, the individual cost of the flexible cable drive is significantly high, approximately $45 per foot.

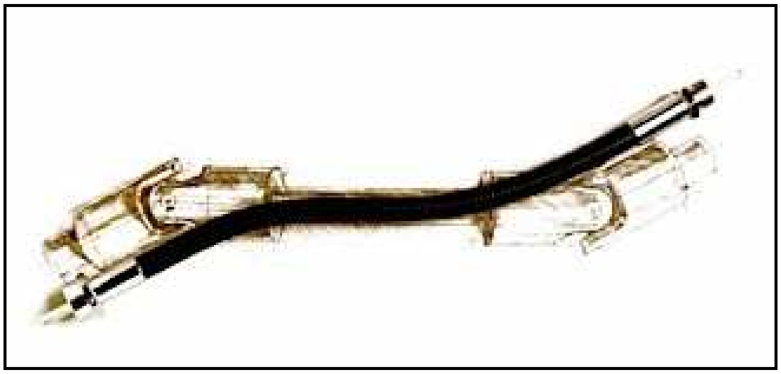

Figure 7: Flexible Cable Drive

Project Future

RangeScaping is unable to make an adequate recommendation for a proposed design at this time. Useful literature related to sawing forces on circular saw blades was not found. This resulted in a lack of ability to determine the appropriate power requirements for sawing through the cedar trees. In addition, the different components for the three design concepts could not be accurately sized.

It is the determination of RangeScaping that further testing of the All Terrain Cedar Saw is required to adequately determine the appropriate power requirements. ATV velocity and saw blade RPM while sawing the cedar trees must be measured. The team plans to test the All Terrain Cedar Saw immediately in the spring semester. With these values accurate power requirements can be determined, and the most effective and feasible design concept adequately determined.

Project Schedule

A Gantt chart for the fall and spring semesters may be found in Appendix B. This includes the projected timelines RangeScaping is intending for the fabrication and testing of the prototype. All timelines are rough estimates.

Project Budget

As mentioned above, exact cost of the three design concepts cannot be determined at this time. However, rough estimates may be made considering RangeScaping's past experience with similar systems. The hydraulic components of the Hydraulic System will cost near $1000. This estimate does not include the cost of the cedar saw frame. Flexible shafts sized for the cedar saw application cost about $500. Again, this does not include the cost of the brake clutch, gear box and cedar saw frame.

Table 1 shows an approximate budget for the Flywheel System. Parts that will be fabricated in the Biosystems and Agricultural Engineering Laboratory include the blade guard, stabilizing bars and sheet metal skid plates. Estimated price of these items does not include the cost of the machinists' labor. The miscellaneous items include the wiring, electronic switch, nuts, washers, bolts, and any other unforeseen assembly parts required.

Part	Price
Frame	$350
Undercarriage	$125
Engine	$277
Brake Clutch	$175
V-Belt Pulley	$65
V-Belt	$15
Blade Guard	$20
Stabilizing Bars	$13
Sheet Metal Skid Plates	$13
Miscellaneous Items	$100
Total	$1,152

Table 1: Estimated Flywheel System Budget

Conclusion

The spring semester will permit for the testing of the current All Terrain Cedar Saw to determine precise power requirements. Determination of a suitable design concept will follow. Fabrication and testing of a prototype will be conducted next. Any necessary design changes and modifications will be made at that time.

Appendix A

Appendix B

RangeScaping

All Terrain Cedar Saw, L.L.C.

Oklahoma State University
10 December 2004
BAE 4012

Colby J. Funk
Wendy S. Sheets
W. Franklin Thomason

All Terrain Cedar Saw

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- The All Terrain Cedar Saw was invented and designed by Ron Cole,
  - Mounted to the front of an ATV,
  - 9 hp Briggs & Stratton engine,
  - V-belt drive, and
  - 14 in. 60 tooth circular saw blade.
- It is intended for quickly clearing rangeland of small cedar trees.

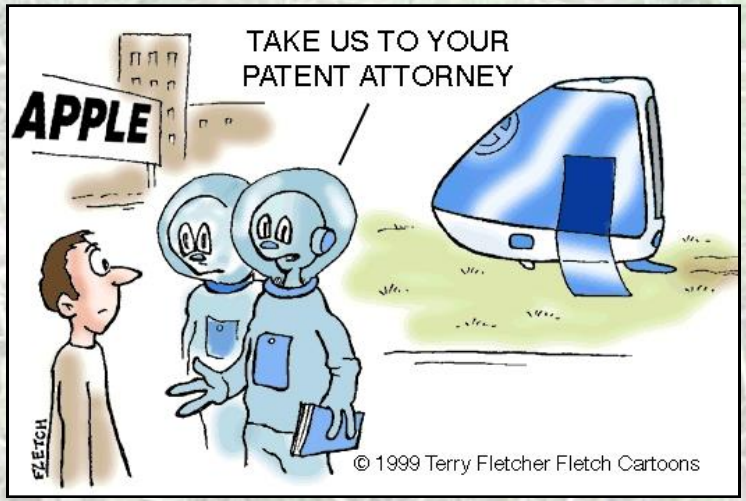
Nobody Does It Like Ron

Problem Definition

- **Areas for improvement include:**
  - **Due to front end weight, a 500 cc or larger ATV is necessary.**
  - **Too much of the circular saw blade is exposed.**
  - **When the blade is disengaged, a few seconds go by before it stops.**
  - **Free to swing in the horizontal plane.**

Patent Research

- United States Patent Office
  - Results involved tree saw attachments for tractors.
  - Most mounted to front end loaders or 3-point.



- Tree saw attachments for ATVs were not found.

Learning the Ropes

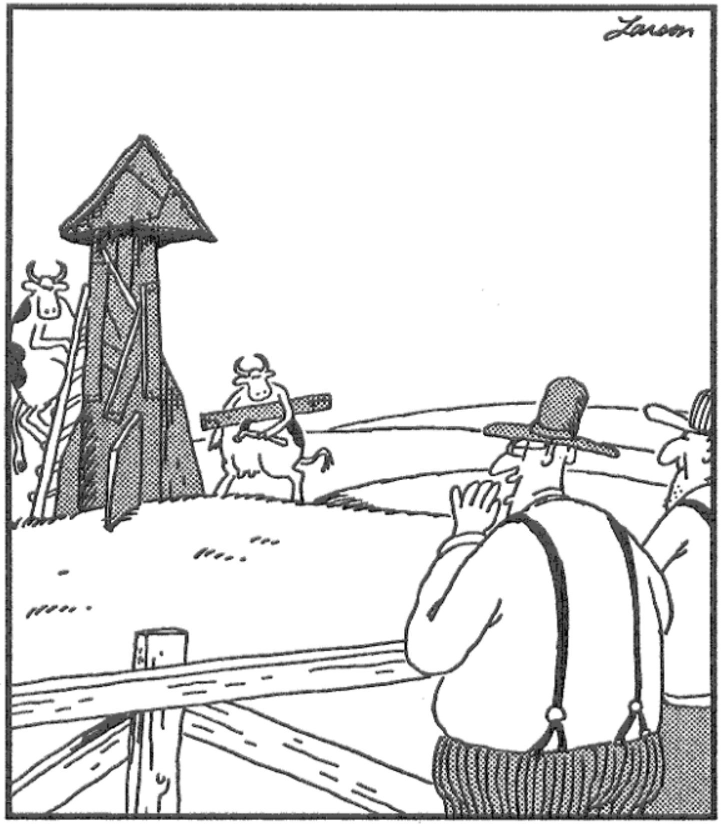
- RangeScaping took a day to operate the All Terrain Cedar Saw in one of Ron Cole's fields.
- Operating the cedar saw helped to fuel the design process.

Design Criteria

- Capable of being used on 300 cc ATV
- Safety shield for exposed blade
- Immediately stop blade from turning
- Mounted rigidly at front of ATV
- Maneuverable in rough terrain

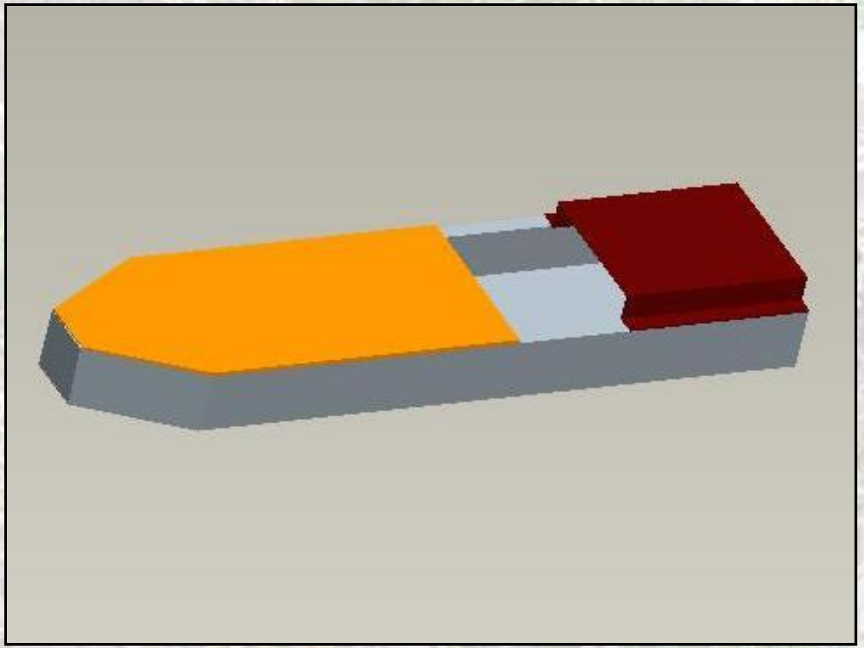
Design Concepts

- **Flywheel System**
- **Flexible Cable Drive System**
- **Hydraulic System**



"Hey, you stupid bovines! You'll never get that contraption off the ground! ...Think it'll run on hay? ... Say, maybe you'll make it to the moooooooon! ..."

Flywheel System



- Flywheel used for energy storage
- Smaller engine
- V-belt used to drive blade
- Brake clutch used to stop blade
- Stabilizer bars fix cedar saw frame in horizontal plane

Flywheel System

Advantages

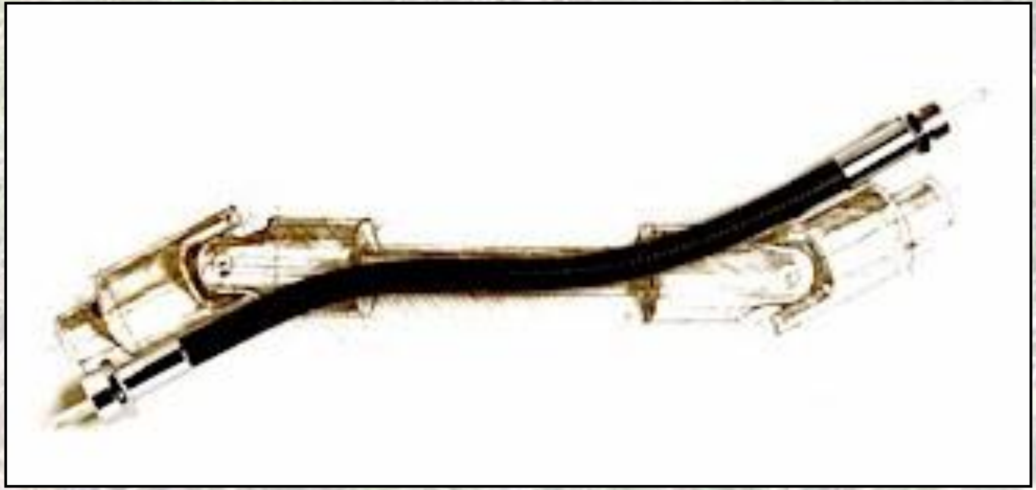
- Decreases weight of cedar saw
- Instantly stops blade
- Eliminates horizontal swing
- Requires few necessary design changes to frame

Disadvantages

- Added weight to front end
- Time required to bring engine to full speed

Flexible Cable Drive System

- Engine mounted to rear of ATV
- Gearbox used to drive circular blade
- Flexible cable connecting engine to gearbox



Flexible Cable Drive System

Advantages

- Distributes weight
- High efficiency of the system
- Overall flexibility of the system

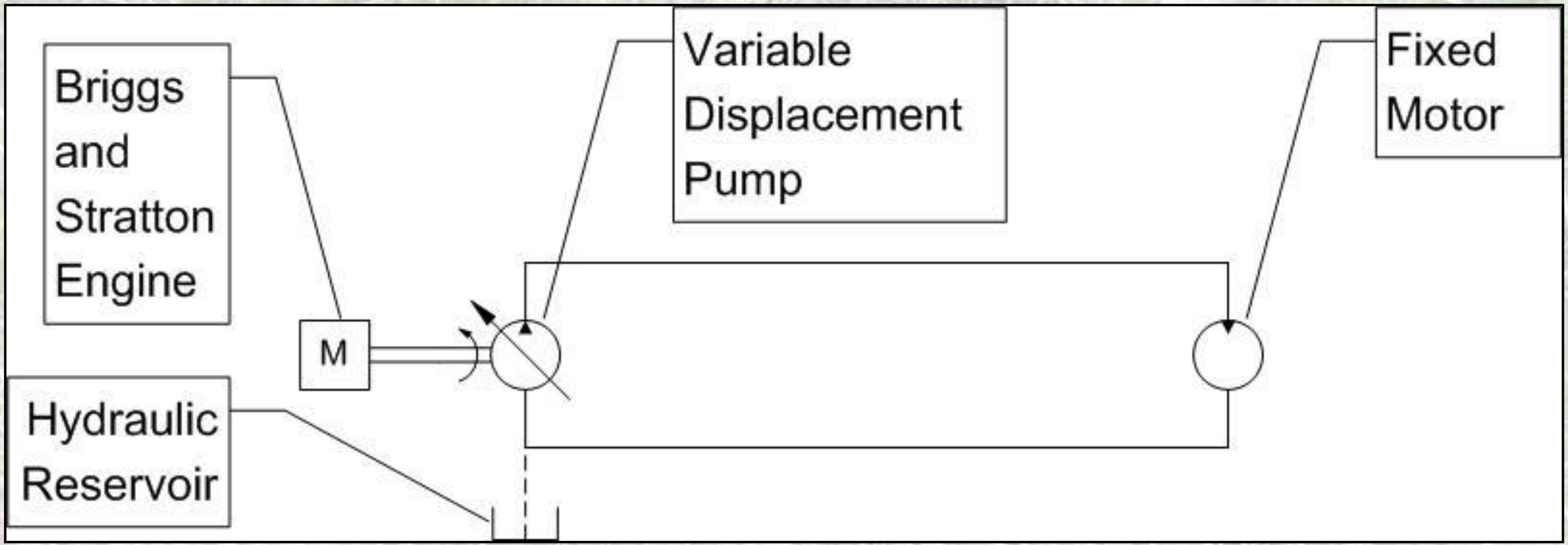
Disadvantages

- Relatively high cost
- Torque loss through bends

Hydraulic System

- Engine mounted to rear of ATV
- Hydraulic pump coupled to engine
- Hydraulic motor used to drive circular saw blade
- Hydraulic hoses run length of ATV connecting pump to motor

Hydraulic System



Hydraulic System

Advantages

- Distributes weight
- Instantly stops blade
- Overall flexibility of the system
- Future possibility of accessories

Disadvantages

- Relatively high cost
- Inefficiency of the system
- Added weight of reservoir and oil

Testing and Analysis

- **Further testing of All Terrain Cedar Saw is required to adequately determine the most effective and financially feasible solution.**
  - **Determine ATV velocity**
  - **Determine saw blade RPM during cutting**
  - **Calculate required torque**

Fall Project Schedule

- Patent Research
- Product Testing
- Design Development
- Saw Blade Force Calculations

Spring Project Schedule

- Continued product testing
- Build prototype
- Test prototype

Recognitions

RangeScaping appreciates the help of:

- All Terrain Cedar Saw, L.L.C.
  - Ron Cole
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  - Clay Buford
- Manufacturing Extension Agent
  - Paul Walenciak
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