THE DIESEL ENGINE IN THE LOGGING INDUSTRY

A SEMINAR THESIS
IN
LOGGING ENGINEERING

Respectively Submitted By

Ralph O. Apperson

SCHOOL OF FORESTRY
OREGON STATE COLLEGE
CORVALLIS, OREGON
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Ever since the logger started to use powered machinery, there has been on foot a means to reduce costs and to eliminate the fire hazard, which has brought ruin to many a good logging concern, and taken from the surrounding area a vast wealth, and made the land almost useless for any further use to all. With this great ultimatum staring us in the face, I have taken a step in the favor of the logger and will try to present his side of the question as a way to reduce the costs, and entirely eliminate the fire hazard by the use of the newly discovered use that diesel engines could be used as donkey engines in the woods.

Power machinery of the first days was small, and the fire hazard was not great. As the operations moved away from the river banks, the timber became larger and more inaccessible, so that larger machinery was needed to get out the logs to mill. This increase in the size of machinery brought about a greater fire hazard as the machines burned more fuel and spread more sparks from their larger fire boxes.

The first fuel used in donkey engines was wood, and some tried coal, but it was too expensive. Then came the oil burning donkey, which was in use a long time before the gas, the electric, and the diesel were introduced into the woods. The wood burning donkey is just about out of date, while the other four forms of engines are just beginning to be used.

I have picked out the diesel engine as the most ideal engine for the logger to use in his woods operation, because of its excellent qualities of low fuel consumption per hour and per a M., elimination of
the fire hazard in the woods, and the cost of cheap operation.

The idea of this paper is to show what has been done with the engine so far, and what an operator can expect from his investment in the future. I am going to deal with engines as used in the woods operations and not deal with the diesel shovels, or other stationary engines.

Most of my material came from the proceeding of the LOGGING CONGRESS, THE TIMBERMAN, THE WEST COAST LUMBERMAN, and letters which I sent to most all of the users of diesel engines in the PACIFIC NORTHWEST. Several of the firms wrote me very nice letters, and were quite willing to cooperate in helping me to get the key to my problem.
The diesel engine was introduced into the logging industry as a means to save on fuel costs, to reduce the fire hazard, to eliminate the water supply troubles, to do away with pipe lines, both water or fuel, to get an engine with lower operation costs, to take advantage of the inherent economics of an internal combustion engine, to get a continuous flow of power, to get a machine that was flexible in moving, to get a machine that could make quick entrance into action, to get a machine that would be in service a long time, to get a machine simple in its operation, to get a machine that would give full power at all times, to get a machine that had low repair and maintenance costs, and to get a machine that was ready to go at all times.
The diesel engine was first tried out in Boston, Mass. in 1872, but the experiment failed due to the lack of due consideration for the escape of the gases, and the rig blew up without hurting anyone. The diesel engine got its name from a German Doctor who patented the machine in 1892. The original machine was built to burn coal dust, but liquid fuel was found to be much more satisfactory, and was substituted for the coal dust for this reason, and because the coal dust made an awfully dirty fuel. The diesel engine was not used in the United States for quite a while after Dr. diesel patented his machine. The first diesel engine introduced into the United States was built in St. Louis, Mo. by Adolphus Busch in 1898. The diesel engine has had much experimental work done on it, and, at the present time, the engine has attained the reputation of being one of the finest engines obtainable.

The diesel engine was first introduced into the logging business in 1923 by J. J. Donovan of the Bloedel-Donovan Lumber Company of Hoquiam, Washington. It was not until the year 1926 that the engine was used to any great extent in the logging industry. In the last five years the engine has come to the front, and has occupied a great deal of discussion at the last few logging Congresses.

The diesel engines are of the four cycle mechanical (frequently termed solid, direct, or airless injection type) retaining all of the advantages of the air injection without its complications; no high pressure blast air is used in the fuel injection type, thus eliminating many complicated adjustments, sensitive high pressure valves, two or three stage air compressors, heavy air receivers, and intercoolers, necessary for the use of the high pressure air. The new diesel engines use the
solid (airless) fuel with low cylinder compression of only 360 to 380 pounds per sq. in.

The ignition and combustion without explosion is done by means of the heat of compression. Air is drawn into the cylinder, and is compressed by the upward travel of the piston to a pressure of approximately 380 pounds per square inch, heating the air to a temperature of 900 degrees F. A few degrees before the piston reaches the top of the compression stroke, the fuel valves is opened and the fuel is sprayed into the heated compressed air which ignites the fuel. The rate at which the fuel enters the piston is so graduated that its ignition and combustion take place without explosive violence.

The engine is started by the aid of compressed air, which is under a pressure of 60 to 200 pounds per square inch from stone cold to full power in from 4 to 10 seconds. The amount of air pressure required depends upon the load the engine is carrying at the time of starting. The entire compressed air system is built and tested for a working pressure of 250 pounds per square inch in order to carry a large reserve for unusual conditions, should they arise. The compressed air also runs the whistle.

The fuel oil system is of the constant pressure type. The pressure is maintained by plunger pumps driven by cranks mounted on the cam shaft. These pumps feed more fuel than is necessary; this fuel is by passed through a hand operated fuel relief valve which is used to regulate the pressure in the fuel manifold. The spray valve is mechanically opened by a cam and properly timed with the cycles of operation to gradually inject the fuel at the proper time for ignition.
The lubricating system for most of the diesel engines is a force feed system which insures proper lubrication to all vital parts of the engine. The system is made up into two parts; a primary system, which consists of a mechanical force feed oiler, which supplies oil to the cylinder walls. New oil is used in this oiler, which when used goes to make up the oil for the secondary system.

The secondary system supplies oil under pressure to all main bearings and wrist pins. The pressure is maintained by a pump which forces the oil through the different passages. The oil is allowed to settle through a strainer before being used again, and in this manner no impurities can reach the bearings. The lubricating oil consumption is a variable factor, depending somewhat on the grade of oil used, but principally on the care given in operation; generally the life of a gallon is about 1500 to 2000 h.p. hours per gallon.

The circulating system is made up of a pump attached to the engine which in turn is connected to the cylinders by the means of a brass pipe. The water is evenly distributed to all parts surrounding the cylinder, and then passes to the radiator where the water is cooled by a large fan, driven off the crank shaft of the engine. The radiator is mounted on a heavy steel frame, which in turn carried on a spring suspension from the frame permitting the radiator to move as a unit, and save it from the shock and strain, when it is attached directly to the frame.

The cycles of operation of the diesel engines are as follows:

**FIRST: INTAKE STROKE**

When the piston descends on the intake stroke, the intake valve is held open, and the cylinder is filled with air from the atmosphere.
SECOND: COMPRESSION STROKE

On the upward stroke of the piston, the intake valve is closed, the air in the cylinder is compressed to a pressure which creates a sufficient temperature to ignite the fuel, at the height of the compression the fuel spray valve is opened by a cam, and the fuel sprayed into the highly heated air within the compression chamber. The fuel oil is maintained at a constant pressure in the spray nozzles at all times by the means of plunger pumps which are operated in coordination with cam shaft action.

THIRD: EXPANSION STROKE

The fuel oil, burning and expanding in the combustion chamber, maintains a high pressure on the piston during the downward stroke, this being the power-creating force within the cylinder. At a fixed period before the piston is at the bottom of the cylinder, the exhaust valve is opened and the piston, having completed the expansion stroke, returns.

FOURTH: SCAVENGING STROKE

As the piston returns to the top of the cylinder, on the scavenging stroke, the exhaust valve is opened, and the piston pushes all of the burned gases out through the exhaust valve and exhaust pipe, thus clearing the cylinder of all gases. When the piston has reached the top of the cylinder, the exhaust valve closes, and the intake valve opens. This completes the cycle of four strokes for the solid injection type of diesel engine.

The types of diesel engines used differ greatly, but most of them range around 180 to 260 h.p. The picture of a 260 h.p. machine follows with its speeds, drum capacities, and other minor details.
YARDING DRUM: 18" diameter 22" long 50" flange  
Capacity 1800 ft. of 1-3/8" rope. 
Capacity 2180 Ft. of 1-1/4" rope.

HAULBACK DRUM: 18" diameter 22" long 45" flange  
Capacity 3450 ft. of 7/8" rope. 
Capacity 4700 ft. of 3/4" rope.

STRAWLINE DRUM: 18" diameter 9" long 40" flange  
Capacity 5300 ft. of 3/8" rope.

HEELBLOCK DRUM: 19" diameter 1041/4" long 46" flange  
Capacity 1550 ft. of 7/8" rope.

RIGGERS DRUM: 7" diameter 4" long 25" flange  
Capacity 780 ft. of 7/16" rope.

SPEEDS:

<table>
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<tr>
<th></th>
<th>Yarding Drum</th>
<th>Haulback Drum</th>
<th>Riggers Drum</th>
<th>Heel block Drum</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>High</td>
<td>Second</td>
<td>Third</td>
<td>Low</td>
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<tr>
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ROPE PULLS:

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<tr>
<td>Bare drum</td>
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<tr>
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<td>15,000#</td>
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<tr>
<td></td>
<td>6,900#</td>
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Straw Drum High Low
  Bare drum 12,300# 36,000#
  Half full drum 7,500# 22,000#

Heel Block Drum High Low
  Bare drum 43,000# 117,000#
  Half full drum 16,000# 48,000#

All drums have thermoid lined brakes with the friction blocks on the main and haulback drums made of cast steel, while on the other drums they are of wood insert with cork.

The weight of the machine as it stands is 80,150 pounds.

AN ATLAS LIDGERWOOD DIESEL YARDER

with 5 drums.
Lidgerwood yarder, powered with an Atlas Imperial full Diesel

LIDGERWOOD YARDER AND LOADER

WASHINGTON YARDER AND LOADER

WASHINGTON YARDER COLD-DECKING
-10-
The reasons for loggers using diesel engines, according to Mr. C. B. Murphy are as follows:

1. Economy of fuel
2. Long life.
3. Simplicity of design.
4. Simplicity of operation.
5. Fire hazard reduced to a minimum.
6. No water supply.
7. Small operating force.
8. No standby losses.
9. Full power delivery at all times.
10. Low repair and maintenance costs.
11. Flexibility of moving and quick entrance into action.

Each one of these distinct advantages will be further elaborated in the following discussion.

ECONOMY OF FUEL.

Diesel engine oil varies in the price from 4 to 7 cents a gallon. The average fuel consumption for 8 hours work costs about $1.00 to $1.35. This is extremely low compared to gas or steam engines. The diesel engine oil should be bought on specifications covering viscosty rather than gravity. The diesel oil should be used that the engine designers specify for the particular engine. The diesel engine when running full speed is using oil as brought in by the oil pump. When the engine is idling, the oil is closed and throttled down. In this way, the engine uses oil when it is under load.
LONG LIFE

The long life of the diesel engine is clearly seen as the care and maintenance of the engine, if properly kept up will last at least ten or more years. Most of the companies use a ten year period for their write off time, and it is of my opinion that they will still have some service in their machine at the end of that time.

The long life of the machine is attributed to the fact that the engine is almost entirely free from the strains that are imposed on a steam donkey. The smooth power tends to lessen the jerks, and gives the engine more life and better service.

SIMPLICITY OF DESIGN

The diesel engine is the easiest engine to understand in its operation. The engine has no spark plugs to become fouled, no ignition system to become worn out, no water troubles, no replacement of parts every so often, no carburetor to adjust, no variable compression, no high temperature exhaust, and no trouble with overheating.

On the other hand the diesel engine has all parts on the outside, so that repairs can be easily made, if they need be, all parts are automatically lubricated from within, and the engine is built on sound engineering judgment that the best engineers can supply.

SIMPLICITY OF OPERATION

The diesel engine has all the equipment fastened to the engine frame, and only needs the auxiliary equipment, such as the tanks for air, water, and fuel to be attached to be able to run. The engine is capable of full power from stone cold in less than 10 seconds. This is one of
the big advantages in the operation of a diesel engine. There is no waiting for a warm engine. You have a warm engine when you start the motor.

The diesel engine operator need not be a trained diesel man. All he has to do is to see that the engine has plenty of lubricating oil, water, and to get the feel of the valves, and he is ready for work. Most of the firms using the engine say that a steam engineer makes a better diesel engineer than a trained diesel man. Most of the diesel engine operators have given their preference for a diesel over a steam engine, due to the ease in operation. One operator quit because the firm wanted him to run a steam rig for a couple of days, and the excuse he gave for quitting was that he tired of coaxing a steam engine along when a diesel engine responded so freely.

**FIRE HAZARD**

In the design of the diesel engine there is no flame exhaust exposed and no cinders to fight against. The only time when the diesel donkey is a menace to fire is when the mufflers are being cleaned and small particles of pure carbon are exposed to the air for a few minutes. With these particles being watched at stated intervals, there is no fire hazard around a diesel donkey engine. With no exposed exhaust, and no flying cinders, the diesel engine is almost as safe as a tank car parked on a siding.

This thing about the diesel engine makes an instant hit with the logger, as in the past many a logger has wished for a fire proof machine. The diesel engine for the woods is an answer to the logger's prayer.
NO WATER SUPPLY

The diesel engine needs water in the radiator, but it does not need a constant supply as do other logging engines. One filling of the radiator will suffice for almost a week. One diesel engine user said that the engine that he was using needed about one small lard bucket full of water a week. This small amount was needed to take care of evaporation. The water cooling system is simple and works off the crankshaft direct. With a diesel engine no water pipes have to be laid or taken up, no delay in operation due to a poor water supply or to the operation of water pumps, no heavy outlay for pumps or pipe, no delay due to the water supply being dry or not available.

SMALL OPERATING FORCE

The diesel engine needs only one man to operate it, while the steam engine needs 4 burning wood, and 2 burning oil. A gas engine needs 2 men to operate it.

In using the diesel engine there has to be no oil lines and men to operate same. The saving of labor alone on one diesel engine just about paid for the upkeep on that engine. Here is another point that the logger will look for as he knows that labor is his most expensive item, and by cutting on labor, and putting that man elsewhere, he can increase production.

NO STANDBY LOSSES

By this term is meant that the diesel engine does not have to wait for its water supply, oil supply, or to wait for steam or for the engine to warm up. Everything for the operation of the engine is with
it on the sled, and immediately upon being rigged, the engine is ready for any use that it is called upon to do. On a steam rig the fire has to be started, and a long wait for steam. On a gas rig one crank or have a starter which is a killjoy, and then wait for the engine to warm up so that it can be used. On a diesel rig, the compressed air is turned on, and the machine is ready to go at full power almost immediately.

**FULL POWER DELIVERY AT ALL TIMES**

The instant the throttle is moved on a diesel engine you have full power delivery. The engine can be stone cold and started with a full load and have full power in 10 seconds. When the machine is not under load, it is automatically throttled down to idle speed with no fuel consumption. The engine can run at full speed or at any other speed for long periods of time and there will be no affects from it. The full power is ready at all times.

**LOW REPAIR AND MAINTENANCE COSTS**

Due to the accessibility of each part and the manner which each part relates itself to another part, the repair and maintenance costs are very low. The engine is built in such a way that if the machine is kept up properly in oil and grease there will be very little to do on the engine in the way of repairs. The firms using the engine have reduced their repair costs to about a half as compared to the steam engine.

When a part of a diesel engine wears or is broken, that one piece can be removed, and a new part put in without the whole engine being disturbed. This speeds up the lost time and adds to the efficiency of the machine.
FLEXIBILITY OF MOVING

The diesel engine is a prime mover. By this is meant that it is not dependent on anything to go where it is to be used. The engine is supplied with a fuel oil tank capable of lasting the engine at least thirty (30) days away from its source of fuel supply. The engine is capable of moving itself anywhere at any time under its own power. The only fault of the first diesel mounted donkey was that the sled was too short but this is easily taken care of by a 60 or 72 foot sled, depending on the horse-power of the machine.
The operators of diesel engines have given many and varying reports about the suitability of the diesel engine to their operations. Most of the men have spoken quite freely on the performance of the engine, and have shown that they heartily approve of the engine being used in the woods. I am quoting some of the operators at this time.

Mr. Lloyd Curtis of the Snoqualmie Falls Lumber Company said this: "The chief reason for the installation of the diesel engine in our operations is that the machine gives a lower fuel cost per hour. We have been using the machine in the toughest country and in the hardest kind of cold-decking set-ups with very good results. We look for the diesel engine to come into the logging game just as soon as the logger can see its economical worth."

Mr. J. T. Shull of the Crown Willamette Paper Company says, "The diesel engine at our operations has proven itself worthy of its initial cost, and the administration is well pleased with its performance. On shows where a 11 x 13 steam donkey just made expenses, the diesel is making money. The reason this company bought the diesel was to save on fuel, and to cut labor expense."

Mr. A. L. Raught of the Weyerhaeuser Timber Company says, "The diesel engine has proven its worth, and is the most efficient prime mover ever developed. We use five of the machines and have found them all efficient and worth their initial cost."

Mr. R. P. Conklin of the Weyerhaeuser Timber Company says, "The experiences with diesel engines of this company have found that the engine saves wear and tear on rigging, lessens breakage of logs, saves on fuel, has no water and pipe-line troubles, eliminates the fireman and other accessory help, and does away with the oil lines and
torpedoes. With all of these savings and eliminations we have put out more logs at a less expense."

Schafer Brothers say, "The reason we bought the diesel engine was to reduce fuel costs, eliminate water supply troubles, and to take into consideration the inherent economics of the internal combustion engine. We log up to 1000 feet with the engine with a fuel cost not to exceed $1.25 a day for fuel and lubricating oil."

Mr. H. Synnestvedt of the Washington Iron Works says, "The diesel engine has no equal from the standpoint of efficiency and low operating costs. The logger has been slow to realize the possibilities of the engine. The logger was slow to accept the engine due to the lack of opportunity for further study. The engines were first used experimentally with good results, and have shown since their sturdiness and reliability. The engine is used now as a rule rather than an exception. The engine increases output per man, lowers fuel cost, and saves money in operating expenses."

The Coos Bay Lumber Company say this, "We bought the diesels to save on labor costs, and to increase our output of logs. Both of these things we have accomplished. Our recent machine was a loader, and we used it in place where a steam engine had been. We got just five cars of logs loaded in an hour with three less men, and just eight more cars a day with the diesel than we got with the steam. We bought this light engine to use it as a loader, cold-deck yarder, or a slack-line machine. We have used it in all of these roles, and we have complete satisfaction. By the money we will save on this machine we can pay for the machine in ten years. By this is meant that the
machine will pay for itself besides the larger output and a lesser fuel bill."

The logging Congress proceedings have the following, "The logger is looking for larger and more economical machines with plenty of power. The reason for this is that the logger is trying to find a machine that cuts the expense of fuel and water. The diesel engine holds the same relative position in the logger's mind as the steam engine did 45 years ago. The diesel engine uses less fuel with an equal or greater output than any other engine made. The only reason that the logger hasn't used the engine before is because of the high initial cost, and the natural resources were so plentiful, and the logger was prone to stick to the old method rather than change. Lately the logger has watched his expenses go up and no increased output, and has looked around to find an engine suitable to lower expenses. The diesel engine has taken the eye of the logger and seems to be the solution of his problem. Another reason that the logger did not use the diesel before is that a plant suitable for his needs was not adopted, but now this has been changed, and a plant of reasonable horsepower and design has been perfected which just fits into the logger's needs. The diesel engine weighs more per horsepower than a steam or gas donkey, but due to its low center of gravity, it is easier to move from place to place."

Markham & Callow say this about their diesel conversion job, "We changed from a 11x13 Willamette yardez to a 10x13 diesel engine with results far beyond what we expected. The diesel engine is doing the work of a 12x14 steam engine. We save on a night watchman's sal-
ary and having one operator. No one has to start a fire every morning, and the operator runs the engine like a veteran after being on it only a little more than a week."

There are two companies in the PACIFIC NORTHWEST that handle diesel engines with a third company doing the actual conversion jobs. The companies referred to are the PACIFIC IRON and STEEL CO. of Tacoma, Washington; the WASHINGTON IRON WORKS of SEATTLE, WASH.; and the WILLAMETTE IRON and STEEL WORKS of Portland, Oregon. THE WASHINGTON IRON WORKS use their own type of engine; the PACIFIC IRON and STEEL WORKS uses the Atlas imperial engine, and the WILLAMETTE IRON and STEEL WORKS uses FAIRBANKS MORSE engines. THE WILLAMETTE IRON and STEEL CO. only assembles jobs which are being converted from steam to diesel for the WESTERN LOGGERS AND MACHINERY SUPPLY CO. of Portland.

The engines being used are of all sizes and capacities with the six cylinder machine being used most with a brake test horse power of 200. The conversion jobs have a 160 h.p. engine instead of a 200 h.p.
AFTER exhaustive tests extending over a period of several months, Schafer Bros. Logging Co., of Montesano, Wash., has been completely won over to the merits of the diesel yarder for cold decking and general utility purposes. This Turney-Fairbanks Morse two-speed diesel yarder, whose fuel and operating economics were predicted in advance of actual operation have been borne out with amazing accuracy in the field, with the result that the test machine has recently been made a part of the permanent equipment of the Schafer camps. In cold decking work, the diesel yarder has shown a saving of $2.50 per thousand over a steam machine in similar service. The fuel cost of this machine will not exceed $1.50 per day. Proportionate savings have also been made in water cost and direct labor. This machine was designed by H. L. Turney, of the Western Loggers Machinery Co., of Portland, Ore.
There has been some talk of converting a steam donkey to diesel, and the Schafer Brothers Logging Company and Markham and Callow tried it to see what the suitability of diesel engine could be from steam to diesel. Markham & Callow had a 11x13 steam engine, and the Schafer Bros. had a 12x14 steam donkey to try on the conversion job. The boiler and engine from both machines were removed, and a 10x13 Atlas Diesel engine was substituted. The gear box was placed between the engine and crankshaft. The engine was placed crosswise with the frame. A chain connects crankshaft with the transmission box, which has two shafts and two sets of friction gears actuated by air which gives two speeds of both main line and haulback. A better braking service was needed than for the steam. The straw line was placed on the right side and a 1500 gallon fuel oil tank was mounted on the rear of the sled. This fuel supply is capable of lasting 50 days under full operation.

The speeds of the main line are 170 feet per minute in low, and 430 feet in high gear. The speed of the haulback is 1200 feet per minute. This set up proved to have plenty of power, and low gear had just slightly less power than the old steam engine. The engine is equipped with four drums as follows:

<table>
<thead>
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<th>Line</th>
<th>Feet of 1 and 3/8&quot; rope.</th>
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<tbody>
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<td>1500</td>
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<tr>
<td>Tripline</td>
<td>4000 &quot; 3/16&quot;</td>
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<tr>
<td>Strawline</td>
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<tr>
<td>Riggers line</td>
<td>500 &quot; 1/2&quot;</td>
</tr>
</tbody>
</table>

A large air tank was placed alongside the engine on the side opposite the operator. A 3 and 1/2 horsepower gasoline engine furnishes the air for starting and the frictions. A built in compressor
supplies air during operation.

The engine assembled for Schafer Bros. was almost identical except the engine was placed parallel to the sled runners.

The cost of the conversion job for the firm of Markham & Callow was $11,000 and included everything from the gears and drum mechanism to the new wire rope. The machine uses 24 gallons of fuel oil a day, and one gallon of lubricating oil. The machine is logging 1600 feet, getting better than 60,000 board feet a day with a cost of $40 a day for labor and fuel and depreciation. This gives the firm a figure of about 0.66 cents a M.B.D. Ft.

Schafer Bros. did not figure out their total cost and the only thing they could get figures for was the fuel. The engine uses 30 gallons of fuel oil at .04 cents a gallon. The lubricating oil costs a dollar a gallon. The firm figured out the following costs with fuel taken as 4,000 bd. ft. at $10 per M. and wages at $5.00 a day. Fuel quoted for steam engine for one year.

<table>
<thead>
<tr>
<th>Description</th>
<th>Diesel</th>
<th>Steam</th>
</tr>
</thead>
</table>
| Interest at 6%| $1,500 | .....
| Depreciation at 10%| 2,500      | ..... |
| Fuel          | 450    | 11,000|
| Repairs       | 250    | 500   |
| Fireman       | .....
| Crew of 7 men | 8,000  | 8,000 |

Total cost $12,000 $21,500
The Schafer Brothers found that the diesel engine had a cost over fifteen days of .54 cents, and the steam engine had a cost of .79 cents over the same period.

By these figures the two firms have shown that it is profitable to change from steam to diesel with very good results and with a good return on the investment. The saving alone in one year almost pays for the cost of conversion. With the lower fire risk and total elimination of the fire hazard, more time will be spent in actual work with still greater returns and more savings.

*Turney Fairbanks-Morse diesel type yarder employed in cold deck service*
Three-quarter view of Fairbanks-Morse-Turney Diesel yarder showing drums and transmission

Completed Diesel Converted Yarder

Engine, transmission and drum arrangement of Fairbanks-Morse-Turney three-speed Diesel yarder

Plan of Converted Yarder
<table>
<thead>
<tr>
<th>No.</th>
<th>Company Name</th>
<th>City, State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Markham &amp; Callow</td>
<td>Independence, Wash.</td>
</tr>
<tr>
<td>2</td>
<td>Cascade Timber Company</td>
<td>Alder, WA.</td>
</tr>
<tr>
<td>3</td>
<td>Clemens Logging Co.</td>
<td>Tacoma, WA.</td>
</tr>
<tr>
<td>4</td>
<td>Coats Driving &amp; Boom Co.</td>
<td>Tillamook, OR.</td>
</tr>
<tr>
<td>5</td>
<td>Coos Bay Lumber Co.</td>
<td>Marshfield, OR.</td>
</tr>
<tr>
<td>6</td>
<td>Crown Willamette Paper Co.</td>
<td>Eatonville, WA.</td>
</tr>
<tr>
<td>7</td>
<td>Eatonville Lumber Co.</td>
<td>Vancouver Island, BC.</td>
</tr>
<tr>
<td>8</td>
<td>Island Logging Co.</td>
<td>Longview, WA.</td>
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<tr>
<td>9</td>
<td>Long Bell Lumber Co.</td>
<td>Physt, WA.</td>
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<tr>
<td>10</td>
<td>Merrill &amp; Ring Lumber Co.</td>
<td>Shelton, WA.</td>
</tr>
<tr>
<td>11</td>
<td>Simpson Logging Co.</td>
<td>Vale &amp; Longview, WA.</td>
</tr>
<tr>
<td>12</td>
<td>Weyerhaeuser Lumber Co.</td>
<td>Tillamook, OR.</td>
</tr>
<tr>
<td>13</td>
<td>Wood &amp; Iverson</td>
<td>Foss, OR.</td>
</tr>
<tr>
<td>14</td>
<td>Hammond Tillamook Lumber Co.</td>
<td>Deep River, WA.</td>
</tr>
<tr>
<td>15</td>
<td>Deep River Logging Co.</td>
<td>Jewell, OR.</td>
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<tr>
<td>16</td>
<td>Tidewater Timber Co.</td>
<td>Montesano, WA.</td>
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<td>17</td>
<td>Schafer Brothers Logging Co.</td>
<td>Snoqualmie Falls, WA.</td>
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<tr>
<td>18</td>
<td>Snoqualmie Falls Lumber Co.</td>
<td>Union, WA.</td>
</tr>
<tr>
<td>19</td>
<td>West Fork Logging Co.</td>
<td>Ripple, OR.</td>
</tr>
<tr>
<td>20</td>
<td>West Oregon Lumber Co.</td>
<td></td>
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</tbody>
</table>
The diesel unit at Eatonville, Washington has the following performance for one year:

200 H.P. motor with car spot and loading drums.

Yarding up to 1200 feet with fair topography.

Largest fuel bill for 1 month 1,170 gal. @ .07 $81.90
Largest lub. oil bill for same period 52 gal @ .95 49.40
Largest grease bill for same period 22 lbs. @ .25 7.25

Total cost of operation $138.55

Cost of labor for 1 month of 25 days $1563.28

Cost of labor and fuel $1721.83

Cost per day $68.88

Output per day 95,361 B.M.

Cost per M $.72

$.72 includes moving, rigging, repairs, etc.

Total cost per M is as follows:

.722 labor and fuel
.117 depreciation
.176 wire rope
.031 repairs
.035 tools
$.971 per M.B.M.

A steam rig on the same setting produced the logs for $1.96 a M. This shows a saving for the diesel of $.99 per M.

The crew working on this machine was as follows:
The crew working on this machine was as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>Rate</th>
<th>Cost per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hooker</td>
<td>$9.00</td>
<td></td>
</tr>
<tr>
<td>1 rigger</td>
<td>6.50</td>
<td></td>
</tr>
<tr>
<td>2 choker setters at $4.75</td>
<td>9.50</td>
<td></td>
</tr>
<tr>
<td>1 whistle punk</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>1 engineer</td>
<td>8.00</td>
<td></td>
</tr>
<tr>
<td>1 loading engineer</td>
<td>7.00</td>
<td></td>
</tr>
<tr>
<td>1 head loader</td>
<td>7.00</td>
<td></td>
</tr>
<tr>
<td>1 2nd loader</td>
<td>5.25</td>
<td></td>
</tr>
<tr>
<td>1 chaser</td>
<td>4.75</td>
<td></td>
</tr>
</tbody>
</table>

LABOR COST PER DAY $60.75
The Eatonville Lumber Company has another diesel engine besides the diesel unit. This diesel yander has also been put to tests with the following results:

6 cylinder 10x12½ standard diesel yander.
Sled mounted the same as any other yander.

910 gallons of fuel oil at .07 cents a gallon $63.70
60 gallons of lubricating oil at .80 a gallon 48.00
25 pounds of grease at .25 a pound 6.25

Cost of oil and grease $117.95
9 men at $56.00 a day for 25 days 1400.00
Cost of labor and fuel $1517.95

Cost per day $1517.95 - 25 = $60.72
Produced 96,687 Ft. B. M. per day
Cost per M. B. Ft. $.63

*One of the big Washington Diesel yanders, being used for cold decking.*
The Cascade Timber Company of Alder, Wash., has an 180 h.p. diesel engine which they say has just as much or more power than the old 12x14 steam engine. The company has been shown that the diesel works in any kind of weather and gets 25% more wear out of their chokers. The company uses 1 3/8 inch mainline, and 11/16 inch haulback. They are reaching out on an average of 1100 feet for their logs. The following figures are based on one months operation of 25 days.

Labor (includes moving and rigging time, and Yarding 2,292,530 feet of logs.) $1,226.56
Fuel oil 42.00
Lubricating oil 18.75

Cost of labor and fuel $1,287.31

Cost per day for 25 days $51.49
Produced 91,701 feet a day.
Cost per M.B.M. $.56 per M. for yarding alone.

The initial investment for this machine was $22,000 bare of rope and necessaries.
The Long Bell Lumber Company of Ryderwood Washington has a 200 h.p. full diesel engine which is a self-contained unit. The machine is mounted on a regulation donkey sled made a little longer than for a steam plant. The machine runs three drums which are capable of holding the following lines:

- Mainline: 1,700 feet of 1 3/8" rope
- Haulback: 4,800 " 11/16" "
- Strawline: 4,500 " 3/8 " "

The speeds of the different drums are as follows:

- Mainline: High 600 feet per minute, Low 90 " "
- Haulback: High 1,200 " "
- Strawline: Low 200 " "

These speed changes are made and controlled by compressed air, as well as the friction blocks in the transmission.

A big oil tank capable of holding 25 barrels of oil which will last almost 7 weeks of constant running is mounted in rear of the radiator.

This machine worked 544 hours without a hitch, and produced during this period 3,410,105 feet B.M. The daily average for period was 54,661 ft. B.M. During the whole period the machine used 1,750 gallons of fuel oil, and 248 quarts of lubricating oil, and 6 pounds of grease. The daily fuel bill came to $2.25 a day. The haul for the machine was averaged up to be 741 feet on a 20% grade.
The Weyerhaeuser Timber Company at Vale, Washington have made an interesting study on the merits of the diesel and gas donkey engines. Here are some figures that were taken for the two machines to determine the relative efficiency of each one.

**DIESEL**
- Produced 348,280 ft. B.M.
- Fuel oil used 135 gallons
- Lubricating oil 8 gallons
- Ft. B.M. per gal. of oil 2,680
- Bt. B.M. " " Lub. oil 43,535

**GAS**
- Produced 724,660 ft. B.M.
- Gasoline used 760 gallons.
- Lubricating oil 24 gallons.
- Ft. B.M. per gal. of gas 954
- Bt. B.M. " " oil 30,152

The diesel yarader got 270.44% more feet per gal. of diesel oil than the gas yarader secured on one gallon of gasoline.

The diesel yarader got 144.41% more feet per gallon of lubricating oil than the gasoline yarader got.

This test was made on the same setting under the same conditions.
The diesel loader which the Coos Bay Lumber Company purchased has surpassed all expectations and has saved the company many dollars in the last few months of its operation. The object for the purchasing of the engine was to get a light machine for cold-decking, for slack-line operations, and for a loader, and for general utility purposes. The engine is a 4-cylinder 150 horsepower rig. It is equipped with four drums as follows:

- Mainline drum 1,500 feet of $1\frac{3}{16}$" rope
- Hoisting " 3,000 feet of 3/4" "
- Swinging " 3,000 feet of 7/8" "
- Rigging " 1,000 feet of 5/8" "

The machine has been used lately for loading purposes and loaded 225,000 ft.B.M. a day. The loads averaged 8,500 ft. per car. The total cars per day was 33. This figure was just 8 more cars per day than a steam engine could do under the same conditions. The machine turned out as high as 5 cars of logs an hour. The machine will pay for itself in 10 years on labor savings alone.
The prices of the diesel engines put out by one of the leading manufacturers are as follows:

6 cylinder, 10x12½", 3 drum, 4 speed Standard Diesel yarder.

- Weight...........................76,000 pounds
- Price...........................$22,500.00

2 extra loading drums can be added to this machine at a cost of $2,500.00 to make it a yarding and loading unit.

6 cylinder, 8½x10" Intermediate Diesel yarder.

- Weight...........................56,000 pounds
- Price...........................$18,000.00

6 cylinder, 8½x10" V-type Junior Diesel Yarder

- Weight...........................51,000 pounds
- Price...........................$15,500.00

The extra weight of the loading drums on the first machine is about 600 pounds.
With the preceding figures before us we can plainly see that the diesel engine has come to stay, and is out of the experimental stage, and has entered the field in actual competition. When a machine can log 4,089,023 ft. B.M. at a cost of .022 per M. for fuel alone that is cheaper than any other machine can duplicate that the logger is using today.

When a machine can produce logs for $93.88 against $142.75 for steam, the engine has something wrong with it, or it is worth looking into from the standpoint of cheaper logs. As figures do not lie, a logger can well spend his money on an engine that will save him at least $50.00 a day every day that the engine is in operation.

A machine that can load 225,000 feet B.M. of logs a day has to be good to keep this up almost indefinitely. Five cars of logs an hour for eight hours is a record that a logger should be willing to challenge to any other machine that a logger uses in his woods operations today. Any machine that can pay for itself inside of ten years on labor saving alone is worth while looking into.

Any machine that can and will save enough to pay for itself through one years operation is worth the logger's investment. One machine that has operated every day of operation of one company in the year of 1930 saved $22,100.00 while the unit cost $25,000.00. This saving was caused from the elimination of fireman, water troubles, and fuel. Fuel being the biggest item of saving as the logs not burned were sold and a profit made from them.

Any machine that is new in the minds of its possible users is acted upon with a sneaking hunch that the machine is not good or is
a fake. The loggers were prone to pass up the diesel engine until they were shown that they could save money in the operation of the diesel engine. Now all of the companies have one or more of the machines, and are willing to back them to the limit against all comers. One operator is quoted to have said that the steam engine was out of his operation entirely as far as he was concerned.

The logger has taken excuse that the diesel engine costs too much and does not pay for its expense. The answer to this is that in one years time, the engine can almost pay for itself by the savings incurred by using the engine. Another excuse given is that the excessive weight of the engine is a disadvantage to the movement of the machine. The weight of the engine is excessive, but the weight is placed so low that the machine is more stable. With the use of new alloys, the weight of the machine can be cut down considerably.

I think that the logger can afford to take advantage of the availability of the diesel engine in his woods operations for the following reasons:

1. Low fuel cost.
2. Decreased fire hazard.
3. No water lines.
4. No oil lines.
5. Low maintenance costs.
6. Full power at all times.
7. Ease of operation.
8. Small operation costs.
9. Quick entrance into action.
10. Long life.
The Timberman:

1925 November
1926 November
1927 July, September, November
1928 February, June, August, November
1929 June, July, November
1930 February, April, November
1931 January, November

The West Coast Lumberman

1930 September, November
1931 November

The Washington Iron Works

Bulletin "E"

The Atlas Imperial Engine Company

Bulletin 630-C
Bulletin 600-A

The Lidgerwood Pacific Company

Specifications for Six Cylinder Diesel Engine

The Crown Willamette Paper Company (Letter)
The Snoqualmie Falls Lumber Company (Letter)
The Weyerhaeuser Timber Company (Letter)
The Coos Bay Lumber Company (Letter)
Mr. George Cornwall Jr. (Personal Interview)
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