THESIS

Development of Power Yarding, Roading, and Loading on the Pacific Coast

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Development of Power Yarding, Roading, and Loading on the Pacific Coast

The Region

The Douglas Fir Region includes practically all of Oregon and Washington west of the Cascade Mountains and a large part of British Columbia. The portion included in the west of Oregon and Washington, which is the part particularly referred to in this paper, has a width of from 70 to 170 miles and a length of 600 miles, embracing an area of some 54,000 square miles.

The country varies greatly in its topography. In every part of it there are valleys, rolling hills, high tablelands, rivers, lakes, and mountains. A considerable portion is mountainous, especially the timbered areas. Mild winters are the rule, and logging may be carried on throughout practically the entire year.

Hand Logging

Hand logging was common on the Pacific Coast for many years before the industry reached its present development. The timber was felled on slopes close to tidewater or some driveable stream. The logs were rolled into the
water, made into rafts, and sold to other loggers or manufacturers who transported them to market. Often the stumpage was not the property of the logger who cut it and the timber was sold at a price slightly above the cost of the labor expended upon it. The increase in the value of stumpage and the greater care given to timber properties by owners has largely eliminated this class of loggers in the United States. In British Columbia hand logging is still practiced to a limited extent by virtue of "hand logger's" permits issued by the Provincial Government.

Animal Logging

For many years animals constituted the only draft power used in logging in this region; first, oxen; later, horses. As long as the haul was short the ox was preferred, because it could live on coarse feed, draw heavier loads, stand rougher treatment, and required an inexpensive harness which could be made in camp. When the hauls became long, the horse was used because it was more active than the ox. The ox, however, continued to divide the labor of transportation with the horse, the former being used to deliver the logs from the stump to the skid road, the latter to haul the logs without the use of a vehicle over the skid road to the mill, or driveable stream. Horses were introduced at
about the same time as logging engines, and are still used to a very limited extent in second-growth timber.

The logs were first dragged out over trails, from which only such obstructions had been removed as were necessary to make the method feasible. In order that it would not be necessary to move the logs over the ground for a distance greater than 300 ft., skid roads were brought close to the timber. This, however, was not practical at all times, and frequently logs were dragged over the ground for 1,000 feet or more on hand skids.

The next step was to drag the logs over skid roads, for distances ranging up to a mile or more. The skid roads carefully located, stumps were removed, cuts and fills made, and the roadbed leveled to give the best possible grade. Skids about 10 feet long and from 10 to 14 inches in diameter were laid across the completed grade at 10-foot intervals and partly buried in the ground. A "saddle" was cut out of the center of each skid for the logs to ride in. On curves the outer ends were elevated slightly. On level stretches the saddles were greased to reduce friction. The logs were fastened together by means of grabs or dogs into long turns; each averaging about 1,000 ft. board measure per horse. A team on a road of this character consisted of from 5 to 10 yoke of oxen or from 4 to 14 horses.
Chutes and Pole Roads

Pole roads and chutes have been used extensively in this region, both in early days and at the present time. The slides called "fore and aft" roads or "pole chutes" are used for trailing logs from yarding engines to a landing, when power for moving the logs is provided by a road engine.

A fore-and-aft road has a trough from two to five poles wide made from long straight timber with a minimum diameter of 10 inches. The ends of the poles are beveled, fitted together and drift-bolted to skids placed transversely under them at intervals of from 10 to 15 feet, thus providing a stable foundation. The slide follows the ground level except where it crosses deep depressions or streams, when it is supported on crib work. The roads are built as straight as possible to decrease the loss of engine power through friction.

Chutes were also used on the Pacific Coast as the terminus of a skid or pole road, where the logs are dumped into a stream, pond or other body of water. Chutes are only used when no other form of transport is feasible for even under the most favorable operating conditions many logs are broken or damaged.

Pole roads were formerly used because the material for construction could be secured on the operation at no expense except for labor and stumpage. Animals were used as draft power, although on down grades the cars may descend by gravity.
Two horses were commonly used although as many as eight were employed on some of the roads.

**Introduction of Steam Power**

With the rapid removal of timber from the easily accessible places, steam machinery of necessity replaced the horse and oxen. Power yarding was first used in the Douglas fir forests of the Pacific Coast in 1890 or one or two years before, in connection with a ground rope system. The step from ox and horse teams to the donkey engine was revolutionary in the industry because the work of getting the logs out of the woods had to be done in a different way. No one was familiar with the new way, yet one had to be developed. It was one thing for a laborer to be efficient as a hook tender or rigging slinger for a team of oxen or horses, but it was very different indeed to tend hook or sling the rigging when steam power was to be applied. There was necessity for a radical change in the road making, even the timber must not be felled as before, and the old time method of selective logging was forthwith abandoned.

When it was a recognized fact that steam power had displaced the teams, and that it was entirely applicable in every emergency if intelligently used, several steam engines
builders began to build logging engines to meet the special requirements of the logging woods. Each engine builder had his hobby type of construction, usually based on the experience of successful loggers. All types built and used gave a helping hand in bringing about the modern logging engine. The engine builder was most interested in his special type of engine, while the logger, the man who witnessed the performance of all of them, was interested in a logging engine always yet to be built.

The piledriver, or hoist, type of donkey engine was one of the first to enter the field, and it is a development of this type which has resulted in the modern engines of the present day. These engines were similar to the present single drum hoist, and later on the double drums were used. In a good many cases the second drum was used for loading before a haulback was used, and in some cases was still used for loading with an extra drum put on the machine for the haulback line.

The size of these small donkeys which were of the direct geared type, ranged from about 5 x 7 cylinders and up, and a considerable improvement took place in this type of machine, particularly as large road donkeys which are still in use today. This type of machine, however, for yarding
logs was not built in such large sizes, as it was too large
to move from one setting to another, and that was probably
one of the reasons which prevented development of the direct
geared yarder along the lines of the present design.

There were several strong disadvantages to this
type of machine for yarding logs as they were then built,
and one of the greatest disadvantages was that they did not
pull enough according to their size and weight. Also, in
order to get the maximum line pull within the limit of the
engine power and gear ratio, it was necessary to have very
small drum diameters which resulted in excessive line wear.
Line speed in those days was not much of a factor.

Roading

Roading was used extensively in the early days of
logging on the coast. The country was comparatively flat
and the logs could be hauled advantageously long distances
over the ground on pole roads. Simple-geared, wide drum
engines were used for roading, the size and drum capacities
depending on the size of timber, character of road, and
length of haul. They were mounted on sleds and moved over
the ground from one setting to the other by their own power.

While it was sometimes economical to haul logs 2,000
feet or more over a dirt road, as a general thing a pole
road was built when the distance from the yarding engine to the stream or mill exceeded 2,000 feet. Skid roads were also used to a large extent. This was the type of road used in connection with draft power, and it was natural for the logger to continue using it for awhile with the logging engine.

The logs were yarded and made into turns ranging from 6,000 to 12,000 feet and hauled by the roading engine. One road engine may be ample since under ideal conditions such an engine can haul logs for a little more than a mile. Not infrequently, however, a battery of road engines is necessary to haul the logs out of the woods, the rear machine taking the logs from the yarding engine and delivering them to the tail block of the succeeding road engine, and so on to the landing. It is seldom economical to employ more than two or three machines in a battery, because of the cost for labor, wire rope, maintenance, etc.

The operation of a roading system is about the same as that of a ground yarding layout. The main or hauling line is operated on the slack rope principle, with the road engine located at the landing and a heavy tail block swung a short distance above the yarding engine. The main cable follows the road and is kept in place with blocks or collars where turns are made. From six to eight logs, depending on their
size and the character of the road, are fastened one behind the other by means of grabs or dogs, forming turns, which are fastened to the main cable.

During the early period of logging in the Northwest the road engine sometimes was replaced by a geared locomotive and the logs were dragged between the rails from the yarding engine to the landing. As a rule, the logs were dragged over the crossties, but on a road of some permancy planks were spiked on the ties to protect them. A water tank was also used to wet the track to facilitate the passage of the logs.

It is practically impossible to say how far a road engine works on the average. Unless conditions are particularly favorable one machine will not be able to haul farther than 3,000 feet, in many cases less than this. At this distance a road engine should generally be able to handle the output of two yarding engines.

**Ground Yarding Engines**

There are two standard types of engines used for ground logging, the compound geared and tandem drum logging engines. As a rule, the narrow drum, compound geared engine is used, the compounding of the gears having proved the best method of securing the proper relation between the two drums in regard to speed and pulling power. The wide drum, simple
geared engine is also used, but principally for swinging and roading, where high speed in the lines and large drum capacity are of major importance. Wide-drum engines bear special trade names, depending on whether they are adapted for yarding and swinging or roading, the chief differences lying in the drum proportions and friction devices. The engines and boilers of a long haul road engine are, of course, larger than those of an engine adapted to haul at relatively shorter distances.

Probably no other class of machinery is called upon for such extremely severe service as logging engines. The demands made upon them are frequently far beyond their normal capacity. The frame of the machine, on which the security of all fastenings and the permancy of alignments of all working parts depends, is strong and rigid, being made of the heaviest standard section of steel beams spaced by heavy crossbars of cast iron or steel.

Ground logging engines are equipped with high pressure boilers of the vertical type, built of 60,000-pound flange steel. They have a working pressure of from 150 to 200 pounds (generally 200 pounds), and are guaranteed to pass Hartford inspection. They range in size from 48 inches in diameter and 96 inches in height to 80 inches in diameter and 153 inches in height.
The extreme height and high working pressure of these boilers, the limits of which have been reached, is the result of constant increase in the cylinder sizes. The width of the engine frame, by limiting the diameter of the boiler, has restricted the dimensions of the round fire box, resulting in too small a proportion of grate to heating surface. To overcome the steaming difficulties resulting from insufficient grate area, most new logging engines are equipped with a fire box which is oblong or elliptical in shape and extends about 2 feet beyond the cylindrical portion of the boiler on the front side. This design increases the grate area considerably without correspondingly increasing the width of the engine frame.

All of the engines are double, that is, have two cylinders. Ordinarily, logging engines are classified by the size of the cylinders, the diameter being given first. The engines are of the heavy duty type, the valves and valve gear differing with the make.

Standard drum engines have two drums, placed either tandem or opposite or nearly so. These rotate upon their shafts and are held fast when pulling by means of friction. Several types of friction are used. They are operated either by hand or steam, the steam friction being particularly desir-
able on the larger engines. The main, or hauling drum is made of steel, the trip drum, which carries the return line, is made of semisteel. These engines can be equipped with loading and straw line drums, driven either by their own gear or pinions or by a chain drive. In the case of the simple-geared engine, the cut-steel gears of the main and trip drums are driven by a cut-steel pinion on the engine crank shaft. The trip drum of the compound-geared engine is driven in a similar way. The main drum in the latter type, however, is driven through a compound train of gears by an internal or external gear, a second pinion keyed on the trip-drum shaft driving the gear of the main-drum shaft.

In ground logging systems the yarder is set up at one end of a landing along a logging railroad or at some intermediate point between the stump and the railroad if a "swing" machine is to be used at the landing. The area logged from one set-up is determined chiefly by topography and stand of timber per acre. It is often irregular in shape, due to topography, being limited by ridges, gullies, or the practical yarding range. The latter may be as short as 500 feet when conditions for railroad construction are very favorable. As a rule, the average distance is from 600 to 900 feet, but in some cases logs are skidded for distances as great as 1500 feet.
The daily output of ground yarding equipment is extremely variable, but ranges between 40,000 and 80,000 board feet. In some cases a higher output has been secured for short periods and in other cases it has fallen below the minimum mentioned.

**High Lead Yarding**

High lead yarding involves no great modification of ground yarding; the lead block is simply attached to a spar tree as high as practical from the ground instead of to a stump, so that the hauling line tends to lift the front end of the log from the ground.

As early as 1906 a logging company in British Columbia used a high-lead system of the type used in the East; that is, with the yarding and loading engine mounted on a swivel truck car. This installation was not immediately followed up by others. About 1912 another logging company in British Columbia started to use a high lead yarding system that resembled those in use at present. It seems that the company's major reason for trying the system was to get away from the construction of landings. In 1916 a large number of operators were using the high-lead yarding system.

The chief advantage of the high lead system over the ground system is that there is a lift to the logs as they come in, so that they are not stopped so much by stumps.
and other obstructions, and travel faster. This advantage is greater the higher the lead block is fixed, but is lost in practice when the yarding distance exceeds 500 to 600 feet. It has been indicated that the high-lead system does not require landings, the resultant saving just about offsetting the extra expense of preparing the spar tree and swinging the lead block. In addition, yarding may proceed more constantly because the logs delivered at the landing place may be piled one on top of the other for some time, regardless of whether loading is going on or not.

A close study of high lead yarding develops two important facts: first, that very little power is required to yard the greater majority of logs, which means that, with a large machine, pull can be sacrificed in favor of speed; second, that heavy pull is required for but a few moments to free even the largest log from its bed, or occasionally, to overcome obstructions encountered on the road to the spar trees.

Until recent years, the extensive use of the two-speed machine as yarding engines was greatly restricted by the fact that all early designs of this type of engine for instantaneous change of speed had been of the direct geared pattern. This restriction was due to the fact that it was impossible to secure a sufficient range of speed be-
tween the low and high gears on direct geared two-speed machines. Logging engine designers had considered this the most serious obstacle to development in the two-speed field. The result had been a constant effort to obtain a system of gearing which included a compound train of gears on the low speed and a direct train of gears or its equivalent on the high speed.

The Willamette Iron and Steel Works have successfully worked out a speed change mechanism, in which the change is accomplished instantaneously at full speed of the engine without any rocking, jarring, or undue strain on any part of the equipment or rigging. The standard engine as now manufactured by them has a gear ratio on the low gear of 13.8 : 1, and on the high gear 6.3 : 1. This makes the speed of the line about twice as fast in high gear as in low.

When ground conditions are good and the timber is medium in size, economical yarding can be done with a direct geared two-speed machine. In this engine both the low gear and the high gear are driven directly from the crank shaft. The gear ratio is such that the speed of the low gear is about 55 percent of the speed of the high gear.
Overhead Yarding

With the passing of the timber from the lower lands, logging operators in the region are confronted with the problem of handling logs—in many cases smaller logs—on rougher and steeper ground and over greater distances from the spur railroads. To do this work at the cost of past logging or less another method was necessary. Resort is being made, therefore, to an overhead or tight-line system.

While overhead logging methods have been employed for many years in the east, it is only within the last few years that they have been used to any extent by loggers of the Pacific Northwest. During a relatively short period they have reached the stage of dependable rigs, the output of which can be predicted with some degree of certainty.

One operator has come to certain tentative conclusions with regard to the use and adaptability of overhead systems in coast timber, which may be summarized as follows:

(a) That overhead systems have little advantage over ground yarding systems in level or slightly sloping country and that they are not so satisfactory as the high lead system on short hauls.

(b) That overhead logging can be successfully and economically employed on almost any kind of ground, provid-
ed the quantity of timber justifies the necessary expenditure for proper equipment.

(c) That the length of overhead line which can be successfully employed depends on the support which can be given the line, the weight of the load to be carried, and the deflection of the line.

(d) That machinery designed and built for ground logging is not adapted for overhead logging. Ground logging machinery is built for power and to withstand strains. Overhead logging engines should have high speed drums and be so constructed as to refuse to handle any load in excess of that allowed by the factor of safety in the overhead line.

Three methods which are used successfully are described. Two of these require special engines. It should not be understood, however, that they are the only methods that have been used or that no other types of engines or line arrangements have been thought of.

Lidgerwood Overhead System

The first Lidgerwood overhead skidder on the Pacific Coast was introduced in 1904. It was of the tree rigged type and was the largest machine of this design.
built up to that time, having 10 by 12 inch skidding and 9 by 10 inch loading drums.

The steel-spar machine of the type that has been installed within the last few years is made up of two sets of double engines, one for skidding and one for loading. The main, or skidding engine, has three drums. The back drum, the one next to the boilers, is known as the skidding line drum. The middle drum carries the trip line. The third drum is the slack pulling drum.

The loading engine has double cylinders and four drums, two friction and two clutch drums. The friction drums are used in loading but only one of them at a time. The two make it possible to shift the loading line from one side to the other, so that it is unnecessary for the loading engineer to look over the machine when loading is in progress. The two clutch drums are used for raising the main cable, rigging, etc.

The machine, as a rule, is mounted on a steel car, and is equipped with a jack at each corner and swivel trucks. With this equipment it is possible to jack up the car, turn the trucks, lay short pieces of steel rail under the car wheels at right angles to the track, and move the car from the track.
The steel-spar type is provided with a steel head spar built upon the skidding car and carried with it. This steel spar carries all the head blocks and rigging with all the lines reeved and in place.

The rigging consists of a standing wire cable suspended between the steel head spar and a tail tree. A slack pulling skidding carriage travels on the cable, being moved toward the head spar by the skidding line and toward the tail tree by the trip line. This carriage also carries the slack-pulling line, which enables the engine to give out the length of skidding line necessary to reach the logs lying to one side or the other of the overhead cable.

In operation, the outhaul and skidding drums are interlocked, and when the outhaul rope is wound on its drum, the carriage is drawn out toward the tail tree, carrying with it the skidding line and the slack-pulling line. When the carriage reaches the point at which logs are to be secured the drums are stopped and the interlocking device freed. When the slack pulling line is wound on its drum it operates the slack puller which runs out the slack for the skidding line. The logs are attached to the skidding line and drawn to the carriage. The skidding and outhaul drums are then interlocked and as the skidding line is
hauled in, the outhaul rope runs out, and the log is held suspended.

The yarding distance ranges from 800 to 1400 feet on flat ground. On steep mountain sides, the skidder may be riged to yard logs 2,000 feet or more; in rare cases up to 3,000 feet. In general the output with this system ranges from 50,000 to 100,000 feet per day. On steep mountain sides the output may range from 50,000 to 75,000 feet.

MacFarlane Sky-Line System

The MacFarlane sky-line system was originated in 1905. In that year Mr. C. E. MacFarlane was confronted with the problem of moving logs about 900 feet down a steep slope to the Kalama River, the elevation of the bench above the river amounting to 600 feet.

The equipment adapted to this method is much the same as that used with other methods of overhead logging. In 1911 a logging engine with four drums was built especially for use with this system.

It differs from other overhead systems in that no slack line is drawn from the carriage. The standing line, upon which the carriage travels, is raised and lowered in its operation. The rigging consists of a main cable sus-
pended between a head tree and a tail tree. Upon this
line the carriage travels. The standing line passes over
a special shoe on the tail tree and through a block on
the head tree to the engine. Two lines are required to
operate the carriage one, the skidding line to haul it in,
and the other, the haul back line to take it out.

The daily output depends on the yarding distance.
At one camp where the logs were moved 1500 feet down a
steep slope the output averaged about 60,000 feet per day.
In the same camp the output averaged from 85,000 to 100,000
feet per day on practically level ground with a yarding
distance which did not exceed 1,000 feet.

**North Bend System**

The evolving of the striking features of what is
now known as the North Bend System is credited to Mr. R. W.
Vinnedge. It is very extensively used because of its sim-
plcity and the fact that it may be worked successfully
with an ordinary ground yarding engine.

The carriage travels on a fixed standing line. It
has no outhaul line attached to it. The skidding line is
fastened to the base of the carriage, passes through a fall
block, then through a head block on the spar tree to the
engine. By means of the haul-back line the fall block and the bight of the skidding line are carried into the woods. The carriage, floating on the standing line, comes to rest at a position opposite and above the log, being hooked to the fall block. Upon pulling in the skidding line the load has a constant tendency to raise up at the forward end and thus avoid obstructions.

It is a very efficient means of yarding or swinging where conditions are favorable. The system has given entire satisfaction when yarding as far as 1600 feet an output of about 75,000 feet per day being obtained.

**Loading**

Loading logs on the cars occupies the logger's most serious attention. Many operators find this phase of the logging cycle controls their output, as it is often possible to yard more logs than can be loaded in the same length of time. A variety of methods of loading are being used in an effort to solve this problem. The aim is toward a system that will do away with expensive landings, and require considerable labor and the use of merchantable logs to build.

The power used in loading may be furnished by a loading drum on the yarding or roading engine, or by a separate loading engine. The use of a separate loading
engine is thought to be safer, since the engineer has only
the loading to occupy his attention.

The cylinders of loading engines range in size from
6½ by 8 inches to 11 by 13 inches. The engines are built
with one, two, three, or four drums. On most types there is
a gypsy on the extended drum shaft. All loading engines
have steel frames, high or double high pressure boilers, and
liberal friction drums with brakes, pawls, etc.

The single-drum engine is adapted for use with the
single gin-pole loading method. The double-drum engine is
designed for use with overhead loading methods that do not
require a standing line. The three-drum engine is used to
operate the same sort of overhead system. When the third is
not needed for loading purposes, it may be employed to good
advantage in switching and spotting cars. The four drum
ingine is adapted for operating a system of loading that
uses a standing line upon which a carriage travels.

**Duplex Loading**

When logging by any overhead or high-lead system,
a special method of loading can be used to advantage, as
the logs do not come to the landing parallel with the track.
Where the spar tree is located adjacent to the track, the
necessity of building a landing can be avoided by the use
of the Duplex Loading System.

In this method of loading, two loading blocks are located on guy lines directly over the center of the car to be loaded, and two sets of loading lines are used.

In operation the tongs are carried out to the log and the front end of the log broken out of the pile and suspended until it is free. The other tong is then fastened to the back end of the log, and as this end is lifted from the ground the log swings parallel to the car, directly over the center of it. It can then be easily lowered into place, with the least amount of danger to the men. This method of loading is capable of very high speed operation, and in most cases will keep pace with any yarnder.

To successfully load with this system, it is necessary to use a special type of loading engine. This engine is similar to the cargo winches used on shipboard. The drums are keyed rigidly to the shaft, and the engine runs in either direction. Each drum has an entirely independent set of engines, so that each line is operated independently of the other.

**Loading Boom**

The log loading boom has proved itself to be a feasible system of loading logs where high-lead and sky-
line logging is used. The salient feature of the loading boom is the method of leading the crotch lines through blocks which are hung in between spreading bars which offset the angles at which the boom swings across the track, and suspending the log directly over, and parallel with, the car on which it is to be loaded.

The space blocks are spaced about 14 feet apart at the outer end of the boom, the boom being supported by two lines from the spar tree. The yoke for the inner end of the boom is made so that the boom swings freely around the spar tree.

The haulback line pulls the boom around to the log pile. When a log is picked up by the loading line its tail hold, which is attached to a guy line eight or ten feet the other side of the track, swings the boom back to its position directly over the car. The slack puller, traveling on one of the boom guy lines, pulls the slack of the crotch lines and makes it easy for the men to handle the hooks or tongs.

An size donkey engine with two drums can operate this system. A third drum is used for spotting the cars. The boom is built up of two piles 66 feet long with 12 inch and 21 inch butt.
Crotch Line System

This method of loading has been used to a great extent in the Northwest and has given good results.

The system consists of two wire-guyed gin poles, which are from 100 to 200 feet apart. The head pole is about 60 feet high and erected on the side of the track opposite the landing. The tail pole is placed back of the landing. The loading line leading from the main drum of the loading engine is reeved through a single sheave corner block suspended at the top of the head pole and a single-sheave fall block hung in the bight of the line, the tail hold being taken on the head spar tree. The trip line leading from another drum on the engine passes through a corner block at the top of the head pole, than through another block on the tail pole and then fastened by two crotch lines to a spreader. A set of loading lines are suspended from the spreader.

With this system wide landings can be used, no yarding time is lost because of blocked-up landings; and the loader can select the most desirable logs from the stand point of making up a carload. The largest yarding output can easily be handled with this method.
Electrical Equipment

Within recent years logging by electricity has become quite common. The Snoqualamie Falls Lumber Co. was one of the pioneers in the use of electrical equipment.

In October 1918 this company was using a Willamette Humboldt three-drum yarder, equipped with a General Electric Co. 200 H. P. motor for motive power. Early in the game it was noticed that more speed on the main line was necessary if the output of the steam machine was to be surpassed. Consensus of opinion pointed to 600 feet per minute as about the right speed to change to, but 450 feet per minute was decided on as radical enough departure from the original design of 300 feet per minute.

Increasing the line speed decreased the pulling power of the motor so it was necessary to install 300 H. P. motors on later machines.

In June 1920 the Willamette Iron & Steel Works delivered to the Snoqualamie Falls Lumber Co. an electrically operated yarder and loader. Both units were mounted on a 60 foot sled.

In operation the speed of the loading lines was found to be too low. This was remedied by lagging the
loading drum to increase their diameter.

This first electrical equipment used in the woods equaled the output of the steam yarders, even though its design was far from satisfactory. At the present time electrical logging equipment is used by a few operators, and due to improvements in manufacture good results have been obtained. The logging industry is just on the door step in the use of electricity and within the next few years its use will become greater.

**Diesel Engines**

The Willamette Iron & Steel Works has pioneered the development of the Diesel Engine in the logging industry. In 1925 they furnished the Manary Logging Company with a Diesel chunk-out donkey. This machine has given entire satisfaction.

The diesel engine as developed today will give the necessary even flow of power and meet the ever-changing and heavy over load demands, equally as well as steam. Transmission of this power is vitally important to the successful use of the Diesel engines. The experimental work done so far clearly indicates that the solution is in sight. The general adaptation of Diesel to yarders, skidders, loaders and chunk-out donkeys will be realized in the near future.
In conclusion the general advantage of Diesel engines over other types of prime movers are; economy, elimination of fire hazards, large water supply unnecessary, small operating force and simplicity in operation.

**Recent Improvements**

One of the suggested improvements in yarders is the application of crawler traction. This development has not been looked on in favor by operators in this region.

Mr. C. W. Kline of the Chaney Logging Company states, "I believe this type of mounting would have few advantages over the present type of wooden sleds and some disadvantages. It would add possibly an additional 20 or 30 percent to the cost of a new machine. In the average operation I do not believe that 25 percent of the distance moved could be negotiated with traction power on account of the roughness and steepness of the ground. It would be necessary to use the lines from the drums just as we do with the sled donkey."

Another recent development is the installation of an air compressor on donkeys. The operators also think this an added expense which would not be justified. Mr. Neil of the J. Neil Lumber Company says; "I do not feel that an air compressor mounted on a donkey engine would
be a great advantage for any one operating locomotives with air equipment; the average air compressor on a locomotive is sufficient to use pneumatic tools and for the reason that tools of this kind are used all over the woods the one air compressor on the locomotive is sufficient while a compressor or mounted on a donkey is available only on the particular setting the donkey may be working on."

In conclusion it may be stated that the manufacturers of logging machinery have kept pace with the needs of the industry. In the future logging machinery will probably be built on a smaller scale since the large timber is rapidly passing.
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