# A STUDY OF MOTOR TRUCK LOG TRANSPORTATION IN THE DOUGLAS FIR REGION AND ITS APPLICATION TO THE PHILIPPINE LOGGING INDUSTRY

by

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# A STUDY OF MOTOR TRUCK LOG TRANSPORTATION IN THE DOUGLAS FIR REGION AND ITS APPLICATION TO THE PHILIPPINE LOGGING INDUSTRY

## INTRODUCTION

The last twenty-five years marked the development of the use of motor trucks. The people employed it in many industries like mining, road building, farming, and as a common utility carrier. In the United States logging industry, it may be said without any fear of contradiction that the transportation of logs with motor trucks has long passed its experimental stage. It has become more and more popular in the Douglas fir region. Its wide use is indicative of its productive usefulness, and many believe that motor trucks have come to stay.

However, in the Philippines, its use as a means of log transportation is still in its development stage. This is due to the fact that its intricate ecomomical operation is not generally understood by most cperators in the Islands. For "like other equipment, the motor truck can be used in the wrong place with more or less disastrous results from a financial standpoint, but within its proper sphere of usefulness, it has no competitor". (1)

(1) R. W. Pratt, "Motor truck performance", Motor Logging Supplement, The Timberman. Vol. XXXIX, No. 5, March 1938, p. 2.

Certainly, the small loggers need something faster that would carry a bigger load over longer hauls than the water buffalo presently used for log hauling. Very soon the old growth concentrated in big tracts will be logged over and it will be unprofitable for big concessioners to use railroads. Another equipment more flexible and more adoptable for logging smaller and scattered timber located in rougher grounds will have to be employed. Then, too, the use of railroads requires a big outlay of capital, allowing only big business to engage in the lumber industry. Most Philippine capitals are small and a change of equipment would make logging a more popular industry among the masses.

Scattered very valuable timber located on small islands covered with public roads which are obtaining in the Philippines at present, should make the use of motor trucks very desirable, and should bid fair to become as an important factor in the progress of the lumber industry. The importance of motor trucks as a means of log transportation today calls for the necessity of an inquiry on use of trucks.

It is the object of this study to investigate the different phases of truck log hauling and organize the knowledge which makes possible the profitable use of trucks in log transportation in the Douglas fir region of the United States with the aim in view of looking into their wide application in the Philippine logging industry.

## HISTORY OF MOTOR TRUCK LOG HAULING

Experimental Period - 1913 to 1922.

The use of motor trucks for log hauling has been developed in recent years. As far as is known, motor trucks in the Douglas fir region was first used in 1913 by Palms and Shields near Covington, Washington (1). The pioneer logging truck was a four-wheeled unit with a single axle semi-trailer provided with either solid steel or solid rubber tires (Fig. 1) which oftentimes had to be wound with cables to act as skid chains to provide traction when the truck went down or up 10 per cent grades. The trailer was not loaded on the truck on the return trip, making it hard to turn the truck around in limited space, necessitating the use of a turntable for this purpose. Brakes were poor and in some cases a snubbing machine was used to lower the loaded truck on grades of 30 per cent. Weak chassis and motor did not allow big loads as are

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(1) Frederick M. Knapp, Motor truck logging methods (University of Washington, Engineering Experimental Station Series, Bulletin No. 12. Seattle: University of Washington Press, 1921) pp. 5.

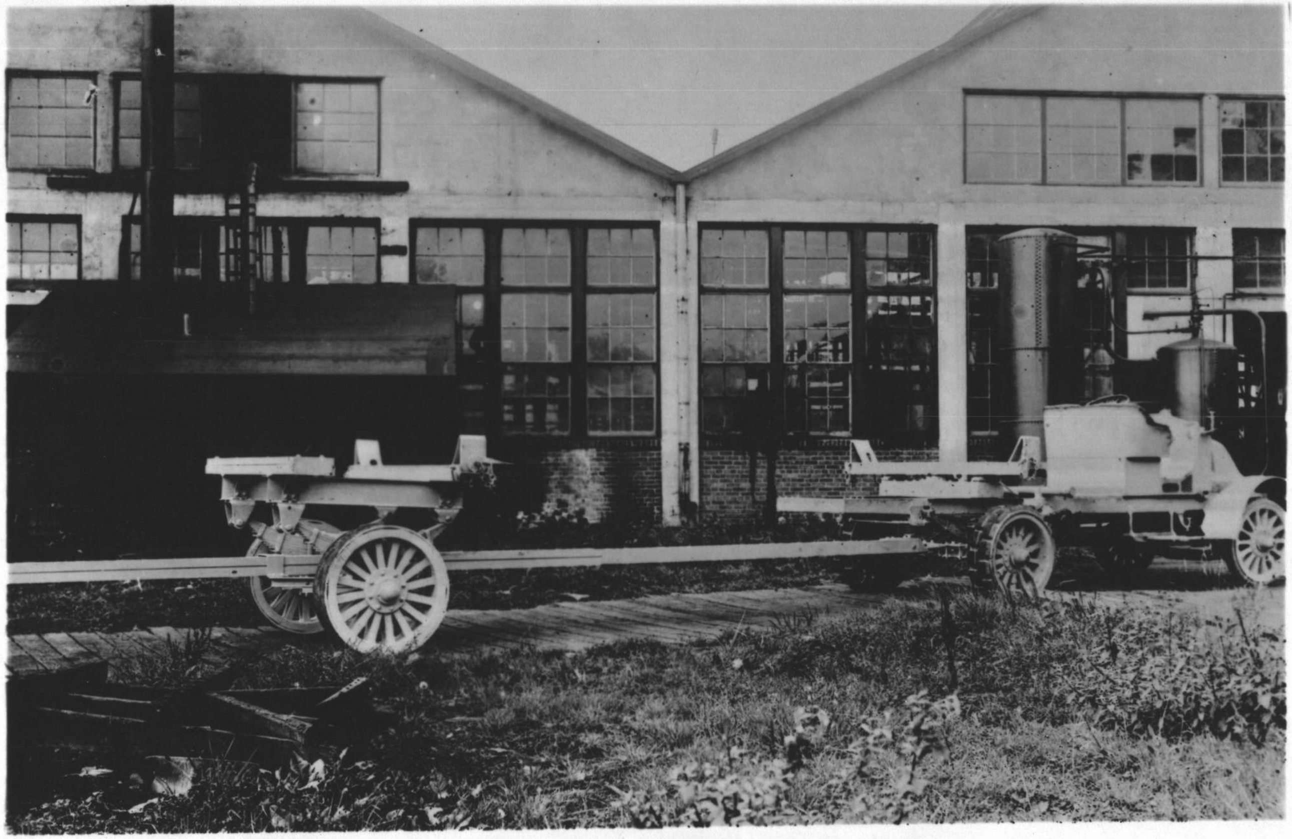

Fig. 1 The Pioneer Logging Truck

made on present trucks. The speed was only 12 to 15 miles per hour in high gear.

Plank roads were the rule, and earth roads were not thought of as good at all. The best road considered was a fore and aft pole road constructed with hewn logs with a surface 16 inches wide on one side and dapped over cross ties. Because of hard tires and lack of knee action in the axles, planks less than six inches in thickness were not used to build for and aft plank roads as they broke under the hard tires.

Very few used the trucks during this period, and it was estimated that there were only 500 trucks hauling logs in the entire Pacific Northwest of the United States in 1919. (1) This is due to the fact that people were not acquainted with the proper use of the truck. There was no urgent need for its use as the timber was still on easy grounds adaptable for the use of railroads.

The Period from 1922 to 1932.

Up to 1932, the majority of motor trucks employed in log hauling was used by "gyppo" loggers. The construc-

(1) S. W. Barker, "Motor truck logging in Western Wash.," Proceedings Tenth Session, Pacific Logging Congress, Portland, Ore., Oct. 8-11, 1919. Compiled and Issued by The Timberman, Portland, Oregon, pp. 18-19.

tion of roads by the government had been pushed progressively since the World War and truck hauling on numerous public roads became very profitable. Timber owners realized that they could get more returns from their timber holdings if they bought their own trucks and conducted their own logging. The depression in 1929 to 1930 caused financial stress and small capital was possible only to investment in trucks. Thus, timber owners began to buy trucks and became competitors of "gyppo" loggers. These operators were "strippers" constructing only two to four miles of private road from the public highway which served as their main road. Additional incentive to truck users came about with the coming out of new type of equipment with better design, stronger materials, more powerful motors; with the introduction of pneumatic tires and with increased speed of trucks of from 35 to 40 miles per hour. These improvements increased the ratio of the net payload to the weight of the chassis.

Unprecedented Development - 1932 to the Present Time.

The present truck unit has been the result of many developments that took place from 1932 to the present time. Among the achievements of the equipment manufacturers are: (1) the detachable self-loading trailer or one that could be loaded easily on the truck, giving the advantage of increased traction to the truck as well as saving trailer tires on the return trip, (2) prior to 1932, single axle trailers were the rule, but preference is now given to a newly developed dual-axle trailer which permits heavier payload and provides better tire bearing surface on the road, (3) knee action which serves to keep loads on a stable plane, eliminating the pound when going into chuck holes or over bumps and reducing both road and trailer upkeep, (4) more powerful and more economical motors, (5) better synchronized gear ratios and drives, (6) development of pneumatic tires of longer life (7) development of Diesel motors that could be installed in standard trucks, which motors give lower cost of operation and maintenance than the gasoline engines.

The use of motor trucks in logging has become so popular that it has replaced wagons, narrow gauge-railroads, spur lines of standard railroads, animal haul, sled haul, chutes and flumes in many parts of the Union; has reduced the skidding distance in the ponderosa pine region, and even replased standard railroad in the Pacific Northwest. The West Coast Lumberman estimated that in 1935, half of the logs cut in the Pacific coast were transferred part of the way from the stump to the mill by truck units. (1)

(1) Editorial Article, "Trucks and trailer", West Coast Lumberman, Vol. 63, No. 4, April, 1936. pp. 9.

In 1937 in the State of Oregon alone, over 1500 (1) trucks were used to haul over two and one half billion board feet of logs.

Road building technique developed and the introduction of new equipment made it easy to construct good roads. Tractors, bulldozers, shovels and maintenance equipment played important parts in road building on an economical basis.

The rapid development of truck log hauling in the Douglas fir region was possible by the cooperative efforts of several entities. The loggers through the auspices of the Pacific Logging Congress conducted studies and discussions in truck hauling. They developed technique in engineering truck logging shown in the form of better synchronized yarding, loading and hauling, better methods of loading, construction and maintenance of better roads, control of hauling, better upkeep of equipment, and better skill developed in making choice of equipment. Equipment manufacturers helped build trucks more adopted for logging work. Studies conducted by the government through the Forest Experimental Stations helped dessiminate knowledge in truck hauling to truck loggers.

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(1) Data furnished by the Secretary, State Highway Commission as per letter, May 1, 1939.

## ENGINEERING THE MOTOR TRUCK

### Property Evaluation

The general practice in engineering motor truck shows calls, first of all, for the survey of the timber property for the determination of the following: (1) the timber stand---its amount for the whole area and distribution per acre, its species with percentage of each, its quality indicating the log grades in each species, its age, and the sizes of logs, (2) the topography and drainage, soil conditions and presence of stones and rocks, (3) the climatic conditions indicating amount of rainfall, number of dry and rainy days, snow depth and amount of water on streams during early spring, (4) location and distance of the area with reference to existing roads, railroads, and streams to serve as outlet of timber. Also, it is important that the management determine the delivery of logs, whether it is to be made throughout the year or during the dry months only, or whether logging is to support a mill, or to supply logs in the open market. Utilization of different species found in the stand like the utilization of hemlock for pulp, fir for pilings and poles, and cedar for bolts, is another important thing to look into. Then, a topographic map of the area is usually prepared. All of the above are important in the working out of a plan of explôitation.

Choice and Location of Roads

Once trucks are chosen to be used, the logging engineer spends plenty of time making logging plans, determining the kind of road suitable for the area and how to lay and construct them. The selection and location of the roads are very important. Cautions truck loggers first project their roads, together with landings, campsites and other constructions on a topographic map. The Grande Ronde, Pine Company, Podosa, Oregon, not only utilizes topographic maps but also a scale relief map for this work. (1) The topography is the most important factor in locating and building the road. Other factors determining the location and choice of roads are: (1) the amount of timber available in the whole area, (2) the footage to be hauled from a given section, (3) soil conditions and presence of snow on the ground, (4) sizes of timber to be hauled, (5) types of gravel available in the area, (6) the type of road requirement--temporary, intermediate of main line road. Synchronization in road location and construction is made to get the lowest cost

(1) Editorial Article, "Truck logging with Grande Ronde Pine Company", West Coast Lumberman, Vol. 65. No. 4. September, 1938. pp. 9.

of operation, maintenance, both for the trucks and for the roads.

Choice of Equipment

Then, the equipment is selected. It is the general practice to fit the equipment to the logging show and not the latter to the equipment. Factors that are considered in the selection of equipment are as follows:

1. Size of trucks. Small trucks are used for small timber and for small operations.

2. Grades. Heavy adverse grades call for heavier trucks and heavy favorable grades require special braking equipment.

3. Utility of public roads. If the operation is done on a 100 per cent private road, the choice has a wide range but if the operation is to be done partly on public roads, trucks must be within the limit specified by statutes in regard to axle weight, tire weight, width, height and overall length. Trucks most nearly adapted for public highways are those with big load distributed in many wheels. Truman Collins (1) says, "In our experience on private roads, the very large sized trucks obtainable have been

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(1) Truman Collins, "How to select the motor truck", West Coast Lumberman. Vol. 65, No. 4, April 1938. pp. 11.

found to yield the lowest cost".

4. Question of finance. Light standard trucks require a small initial investment. They are easily sold and have high trade-in and resale value which the operator can take advantage of when he desires to make a quick shift to another type of equipment to take advantage of new improvements. With special big trucks, there is the chance that one will be forced to stay by it throughout its life, since the resale and trade-in values are likely to be far below the real one.

5. Time over which logging work will extend. Since it is best to use equipment adapted to the particular shqw, it is important that equipment be amorticized before transferring the operation to another region which may not allow the use of the old equipment.

6. Amount of timber to be delivered per day and the length of the haul. The haul may be long and to have a specified amount of timber delivered, more and larger sized trucks may be necessary.

7. The weight and sizes of timber. Large and heavy timber will require larger trucks for a definite load.

8. Initial cost vs. low cost of operation. The initial costs of Diesel trucks are high but it has been found that operating them in the long run, is cheaper. On the other hand some operators are forced to buy small

trucks because they could not afford the large ones.

9. Hauling capacity of trucks. Hauling capacity should be available in order to negotiate maximum adverse grades of the road to be constructed and it should have enough carrying capacity to carry large loads.

Determining Hauling Capacity of Motor Trucks.

A knowledge of the hauling capacity of the motor truck is important in log truck transportation. The truck hauler needs it in the selection of his truck, in the construction of his roads, in the computation of the amount of timber that could be hauled in a certain time and in the computation of the number of trucks needed in the operation. Carlson (1) summed up the importance of this knowledge to the logger as follows: (1) to be able to choose intelligently the right equipment fitted to the show, and (2) to be able to lay roads adapted to use with equipment already on hand.

The hauling capacity of motor trucks is affected by many factors. Rim pull or the power developed at the drive wheels may express this capacity, its quantity, depending upon the amount of torque developed by the

(1) Roy C. Carlson, "Calculating hauling ability of motor trucks." West Coast Lumberman. Vol. 64, No. 4, April 1937, pp. 32.

engine, the total gear reduction, the efficiency of the transmission gears, the amount of load as affecting the loaded radius of the tire, and the altitude of the place of operation. Expressed in a formula given by Pratt: (1)

$$\text{Rim Pull} = \frac{T \times TGR \times F \times L \times 12}{LR} \qquad (1)$$

Where
LR = Loaded radius in inches
T = Engine torque in foot-pounds
TGR = Total gear reduction
F = Efficiency of the speed reduction machine in per cent
L = Factor, representing the effect of altitude on relative volumetric efficiency in per cent or per cent of rated horsepower available at various elevations.
12 = Factor to reduce loaded radius into feet.

Torque (T) is the twisting effort produced by the crank shaft of the engine. Torque produced by a certain engine is found by test with an instrument called dynamoeter. Automotive engineers (2) calculated that torque is equal to 5/8 of the total displacement of the engine which displacement may be computed by the formula: (3)

Piston Displacement = area of cross-section of cylinder x length of stroke (both in inches) x the number of cylinders.

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(1) Pratt, op. cit., pp. 12.

(2) Carlson, op. cit., pp. 32 and 34.

(3) Fred R. Jones, Farm gas engines and tractors. (New York and London; McGraw-Hill Book Company Inc. 1938) pp. 50.

All truck specifications give out torque of trucks of different makes and sizes. Also, the size of cylinders and the number, as well as the total displacement of the engine are given and the determination of torque is easily made.

The total gear reduction (TGR) affects the rim pull and speed of motor trucks. The question of total reduction may well be understood by an example given by Dagner (1) as follows:

> "Example: Given a motor truck equipped with a 4-speed transmission and a rear axle ratio reduction of 6.29 to 1. First, assume that the transmission is in direct gear. In this case, one revolution of the rear wheel will equal 6.29 x 1 or 629 revolutions in the crank shaft. If the crank shaft turns 1800 r.p.m., then the rear wheels will turn 1800 ÷ 6.29 or 286 revolutions...Next, assume that the transmission is first gear, which provides 6.546 to 1 reduction. In this case, if the rear wheels turn one revolution, the propeller shaft will turn 6.29 x 1 or 6.29 revolutions and the engine crank shaft will turn 6.29 x 6.546 or 41.2 revolutions. So the total reduction in first gear equals 41.2 to 1. With 1800 revolutions of the engine per minute, the rear wheels will turn 1800 ÷ 41.2 or 43.7 r.p.m."

From this example, it is evident that the greater the total reduction, the greater is the revolution of the engine crank shaft to make one revolution of the wheel, producing a slower speed but giving more pulling power. Therefore, the higher the total reduction, the greater is

(1) Ed. Dagner, "Engineering the logging truck operation". West Coast Lumberman. Vol 65, No. 4. pp. 15. April, 1938

the pulling capacity of the truck and vise versa. Truck manufacturers have developed in modern engines different combinations of transmissions and rear axle ratio reductions and a careful consideration of this item would bring benefits to the operators. Transmission and axle reductions available for certain types of trucks are given in standard truck specifications.

The whole power produced by the engine does not reach the wheel due to different efficiency of the reduction mechanism. Only a certain per cent (F) of it is utilized. According to studies made by Carlson (1) in direct drive, a mechanical efficiency factor of 90 per cent is usually obtained and in lower gears, one of 85 per cent. This efficiency ratings depends upon the kind of drive and with conditions of gearing which change with use, badly worn gears being more efficient than those well fitted. Dagner (2) gives efficiency rating for the different drives as follows:

| | D/R Single Axle | Worm and Gear Dual D |
|---|---|---|
| In direct gear | 90% | 85% |
| In transmission gear | 85% | 80% |
| In auxiliary and transmission gear | 80% | 75% |

(1) Carlson, *op. cit.*, pp. 34 and 36.

(2) Dagner, *op. cit.*, pp. 16.

Effect of altitude on the rim pull. Studies of Carlson (1) reveal that for every 1,000 feet increase in elevation above sea level, the fuel consumption and consequently torque decreases at the rate of approximately 3½%. It is necessary, therefore, to consider the effect of altitude (L) on truck performance if the operation is to be conducted on areas over 1,000 feet in elevation in as much as all truck ratings are based on sea level. Per cent of rated horse power or torque available at various elevations given by Carlson (1) is as follows:

Table I

Per cent of torque or horsepower available at various elevations.

| Elevation above sea level | Per cent of rated torque or horse power available |
|---|---|
| 0 | 100.0 |
| 1,000 | 96.5 |
| 2,000 | 93.1 |
| 3,000 | 89.9 |
| 4,000 | 86.7 |
| 5,000 | 83.7 |
| 6,000 | 80.8 |
| 7,000 | 77.9 |
| 8,000 | 75.2 |
| 9,000 | 72.6 |

The pulling power or rim pull is inversely proportional to the loaded radius. The greater the loaded radius, the weaker is the pulling power. Tire specifica-

(1) Carlson, op. cit., pp. 34 and 36.

tions give rated loads of the tires with corresponding loaded tire diameter. The following table taken from Pratt (1) gives tire specifications for different tires:

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(1) Pratt, op. cit., p. 10.

Table II

TIRE SPECIFICATIONS

Heavy Duty, Lug-Type Traction Tires

| Tire size | Ply | Rim size | Lbs. rated load | Pres-sure | Sect. width | Sect. depth | Over-all diam. | Un-load-ed ra-dius. | Load-ed ra dius | Def. | Rev. per mile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BALLOON | | | | | | |
| 6.00-20 | 6 | 5"-20 | 1400 | 45 | 6.05 | 6.63 | 33.25 | 16.63 | 15.70 | .93 | 632 |
| 6.50-20 | 6 | 5"-20 | 1700 | 50 | 6.65 | 7.20 | 34.40 | 17.20 | 16.35 | .85 | 607 |
| 7.00-20 | 8 | 6"-20 | 1950 | 55 | 7.30 | 7.80 | 35.60 | 17.80 | 16.80 | 1.00 | 591 |
| -24 | 8 | 6"-24 | 2225 | 55 | 7.35 | 7.88 | 39.75 | 19.88 | 18.90 | .98 | 525 |
| 7.50-20 | 8 | 7"-20 | 2200 | 55 | 7.85 | 8.33 | 36.65 | 18.33 | 17.30 | 1.03 | 574 |
| -24 | 8 | 7"-24 | 2500 | 55 | 7.95 | 8.45 | 40.90 | 20.45 | 19.40 | 1.05 | 512 |
| 8.25-20 | 10 | 7"-20 | 2650 | 60 | 8.40 | 9.13 | 38.25 | 19.13 | 18.05 | 1.08 | 550 |
| -24 | 10 | 7"-24 | 3025 | 60 | 8.50 | 9.13 | 42.25 | 21.13 | 20.05 | 1.08 | 495 |
| 9.00-20 | 10 | 8"-20 | 3250 | 65 | 9.55 | 9.95 | 39.90 | 19.95 | 18.75 | 1.20 | 530 |
| -24 | 10 | 8"-24 | 3650 | 65 | 9.60 | 9.95 | 43.90 | 21.95 | 20.75 | 1.20 | 494 |
| 9.75-20 | 12 | 8"-20 | 3900 | 70 | 10.05 | 10.55 | 41.10 | 20.55 | 19.35 | 1.20 | 513 |
| -20 | 12 | 9-10"-20 | 3900 | 70 | 10.53 | 10.65 | 41.30 | 20.65 | 19.40 | 1.25 | 512 |
| -24 | 12 | 8"-24 | 4400 | 70 | 10.05 | 10.55 | 45.10 | 22.55 | 21.30 | 1.25 | 466 |
| -24 | 12 | 9-10"-24 | 4400 | 70 | 10.53 | 10.65 | 45.30 | 22.65 | 21.40 | 1.25 | 464 |
| 10.50-20 | 12 | 9-10"-20 | 4700 | 75 | 10.95 | 11.25 | 42.50 | 21.25 | 19.90 | 1.35 | 499 |
| -24 | 12 | 9-10"-24 | 5200 | 75 | 11.00 | 11.25 | 46.50 | 23.25 | 21.85 | 1.40 | 454 |
| 11.25-20 | 14 | 9-10"-20 | 5450 | 80 | 11.30 | 11.85 | 43.70 | 21.85 | 20.40 | 1.45 | 487 |
| -24 | 14 | 9-10"-24 | 6050 | 80 | 11.35 | 11.85 | 47.70 | 23.85 | 22.40 | 1.45 | 443 |
| 12.00-24 | 14 | 11"-24 | 6950 | 85 | 12.80 | 12.70 | 49.40 | 24.70 | 23.10 | 1.60 | 429 |
| 13.50-24 | 16 | 11"-24 | 9100 | 95 | 14.05 | 14.25 | 52.50 | 26.25 | 24.45 | 1.80 | 406 |

Table II (con't.)

| Tire size | ply | Rim size | Lbs. rated load | Pres- sure | Sect. width | Sect. depth | Over- all diam. | Un- load- ed ra- dius | Load- ed ra dius | Def. | Rev. per mile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HIGH PRESSURE | | | | | | | | | | | |
| 30 x 5 | 8 | 5"-20 | 1700 | 75 | 5.95 | 6.45 | 32.90 | 16.45 | 15.70 | .75 | 632 |
| 32 x 6 | 10 | 6"-20 | 2200 | 80 | 7.05 | 7.50 | 35.00 | 17.50 | 16.65 | .85 | 596 |
| 36 x 6 | 10 | 6"-24 | 2500 | 80 | 7.05 | 7.50 | 39.00 | 19.50 | 18.65 | .85 | 532 |
| 34 x 7 | 10 | 7"-20 | 2800 | 85 | 8.05 | 8.33 | 36.65 | 18.33 | 17.25 | 1.08 | 575 |
| 38 x 7 | 10 | 7"-24 | 3200 | 85 | 8.05 | 8.33 | 40.65 | 20.33 | 19.25 | 1.08 | 515 |

All of the terms in the formula for finding the rim pull or hauling capacity of the truck have been explained. However, rim pull depends on the rolling resistance exerted by the road surface and the gradient of the road which may be equated in the following formulas: (1)

$$G = \frac{\text{Rim pull}}{\frac{GVW}{10}} - RF \qquad (2)$$

Simplifying : $\text{Rim pull} = 10 \times G \times GVW + RF \times GVW$ (3)

$$GVW = \frac{\text{Rim pull}}{10 \times G + RF} \qquad (4)$$

Where
- GVW = Gross vehicle weight in thousands of pounds.
- RF = Factor of rolling resistance in pounds per thousand pounds of gross vehicle weight.
- G = Grade angle in per cent
- 10 = Grade resistance in pounds per thousand pounds of gross vehicle weight for each per cent of grade.

That means that the amount of rim pull necessary to pull a certain gross vehicle weight is affected by the gradient of the road and the rolling resistance factor for different road surfaces. The resistance of offered by grade is usually considered by engineers as 10 pounds per thousand of gross load for each per cent of grade rise.

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(1) Pratt, <u>op. cit.</u>, p. 16.

Inasmuch as the speed of loaded logging trucks is very slow, the air resistance is negligibel and for practical purposes it is not considered as affecting the hauling capacity of logging trucks. The coefficient of rolling resistance depends on the surface of the road and is given in the table taken from Pratt (1):

(1) Pratt, op. cit., pp. 15.

Table III

AVERAGE ROLLING RESISTANCE

| Surface--- | Condition Smooth | Average | Rough |
|---|---|---|---|
| Concrete | | | |
| Fine grained, dry | 11 | 14 | 15 |
| Fine grained, wet | 14 | (16) | (17) |
| Non-skid, dry | (12) | (15) | (16) |
| Cold asphalt or bituminous | | | |
| Fine grained, dry | 12 | 15 | (16) |
| Non-skid, dry | 13 | 14 | (15) |
| Softened asphalt, fine grained, dry | 15 | (18) | (19) |
| Water-bound macadam | | | |
| Dry | 18 | 22 | 33 |
| Wet | 20 | 26 | 43 |
| Bituminous macadam, dry | 15 | (21) | 26 |
| Brick | | | |
| Monolithic | 14 | 17 | 20 |
| Asphalt filled | (11) | 13 | (15) |
| Wood block, dry | 13 | 15 | (16) |
| Hewn timber, dry | (12) | (14) | (15) |
| Rough plank, dry | | | |
| Lengthways--fore and aft | (12) | (14) | (15) |
| Crossways, closely spaced | (13) | (15) | (16) |
| Crossways, spaced 1 or 2 inches | (15) | (18) | (20) |
| Gravel | | | |
| Best, clay-bound, dry | 18 | 22 | 27 |
| Best, clay-bound, wet | 18 | 24 | 28 |
| Frozen | 18 | 25 | 30 |
| Ordinary pit-rum material, dry | 18 | 25 | 28 |
| Spongy, damp to wet | 20 | 32 | 58 |
| Bituminous treated | 15 | 21 | 26 |
| 3 inches loose gravel, firm roadbed | | 32 | |
| Uncompacted spread, new grade | | 80 | |
| Natural dirt | | | |
| Best sand-clay type, dry | 16 | 22 | 25 |
| Ordinary, unsurfaced, dry | 22 | 29 | (34) |
| Spongy, damp | 20 | 32 | (45) |

Table III (con't)

| Surface--- | Condition | | |
|---|---|---|---|
| | Smooth | Average | Rough |
| Sand, damp to dry | (100) | 175 | 250 |
| Snow, fairly smooth road way | | | |
| Packed | | 25 | |
| 2 inches, loose | | 30 | |
| 4 inches, loose | | 45 | |
| 6 to 8 inches, loose | | 65 | |
| Mud, 2 inches deep, or deep dust | | | |
| Hard roadway | | 60 | |
| Spongy roadway | | 90 | |

A knowledge on the computation of the speed of logging trucks is also necessary in truck log hauling. For practical purposes Dagner (1) recommends the following formula:

$$MPH = \frac{D \times .003 \times RPM}{R} \qquad (5)$$

Where D = Rolling diameter of loaded tire in inches
RPM = Engine revolution per minute
R = Total reduction in gears between the engine and rear wheels.
MPH = Vehicle speed in miles per hour

Application of the knowledge of truck performance. With the formulas just described, a truck logger could make calculations for the determination of kind of equipment to buy, road to construct, amount of gross weight a certain truck could haul under certain conditions, etc. To illustrate we use the following problem: (2)

"Up what grade and at what speed can a 50,000 pound load be hauled on a poorly maintained dirt road, when controlling factors are:

Torque - 250 foot-pound at 3,000 r.p.m.
Total gear reduction - 20 to 1

Mechanical efficiency of the speed reducing machine - 85 per cent.
Altitude of operation - 2,200 feet above sea level.
Loaded radius - 20 inches.
Frontal area - 60 square feet.
Rolling resistance - 30 pounds per thousand pounds of gross vehicle weight."

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(1) Dagner, op. cit., pp. 16.
(2) Pratt, op. cit., pp. 16.

The speed, using formula (5) above, will give the following:

$$MPH = \frac{D \times .003 \times RPM}{R} = \frac{40 \times .003 \times 3{,}000}{20} = \text{18 miles per hour}$$

and

Grade, using formulas 1 and 2 above, will give the following:

Formula (1) $$\text{Rim pull} = \frac{T \times TGR \times F \times L \times 12}{LR}$$

$$= 250 \times 20 \times .85 \times .925 \times 12$$

$$= \text{equals 2359 pounds.}$$

Formula (2) $$G = \frac{\frac{\text{Rim pull}}{GVW} - RF}{10} = \frac{\frac{2359}{50} - 31.5}{10} = \frac{47 - 31.5}{10}$$
equals 1.5 per cent.

The truck would be able to haul 50,000 pounds gross load or 25 tons on a 1.5 per cent grade at a speed of 18 miles per hour.

If the road conditions are fixed, the equipment through its specifications of torque, total gear reduction and efficiency of gearing could be found to fit in the given conditions on the ground.

The above conditions presupposes that traction is normal. Traction, however, may not always be had due to many factors, one of which is the lack of sufficient weight on the drive wheels to hold the rim pull of the wheels to move the load, and another is the lack of sufficient coefficient of friction on the road surface. The road surface may be too slippery. This explains the necessity of sprinkling salt or sand or stapling wires on plank roads to increase the coefficient of friction of the road surface. Besides, surfaces of different roads vary. The coefficient of friction on the road may be high, yet there is not enough traction because of insufficient weight on the drive wheels. Lack of weight on the driving wheels may be due to over concentration of the load on the trailer or there may be too many wheels bearing the load. According to studies of Carlson (1), "for every pound of rim pull there must be a pound or more of weight to hold the wheels down...And as the coefficient of friction decreases, the ratio of pounds of load on the driving wheels to pounds of rim pull naturally increases". The following table from Carlson (2) indicates the average coefficients of friction for various road surfaces when wet and when dry and the corresponding ratios of pounds of weight on driving wheels to pounds of rim pull.

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(1) Carlson, op. cit., pp. 34 and 36.

(2) Carlson, op. cit., pp. 34 and 36.

Table IV

Average Coefficient of Friction Between Tires and Road Surface

| | Wet Surface | | Dry Surface | |
|---|---|---|---|---|
| | Coefficient | Ratio of weight to rim pull | Coefficient | Ratio of weight to rim pull |
| Portland Cement, 2 yrs old | 0.89 | 1.12 | 0.96 | 1.04 |
| 5 yrs old greasy | .96 | 1.04 | .64 | 1.56 |
| Asphaltic concrete | .87 | 1.15 | .86 | 1.16 |
| Bitulithic | .69 | 1.45 | .73 | 1.37 |
| Wood Blocks | .82 | 1.22 | .81 | 1.23 |
| Brick, Monolithic | .91 | 1.10 | .60 | 1.67 |
| Brick, sand filled | .87 | 1.15 | .62 | 1.61 |
| Brick, asphalt filled | .85 | 1.18 | .81 | 1.23 |
| Gravel | .75 | 1.33 | .79 | 1.27 |
| Earth | .68 | 1.47 | --- | ---- |
| Hard-packed snow on pavement | --- | ---- | .17-20 | 5.9-5 |
| Ice and Sleet on pavement | --- | ---- | .80 | 12.5 |

The principles discussed above simply mean that if the rim pull of the wheels is 2359 pounds, the weight on the drive wheels should be 2359 pounds or more. In this connection, many log haulers placed two axles at the rear end of the truck, one or both of them driving axles. In the case of only one axle driving, the weight on each driving wheel of the truck decreases without increasing the rim pull of the wheels. Addition of the extra axle, therefore, increases the carrying capacity of the rear wheels of the truck but decreases their pulling power. In this case the coefficient of friction of the road surface must be increased to provide enough traction on the wheels, otherwise, the wheels will spin or slide, or the number of driving wheels must be increased to proportionally increase the rim pull with the load. The following table shows the increased hauling capacity of the truck with the number of driving wheels. (1)

(1) Carlson, op. cit., pp. 34 and 36.

Table V

Adverse grades negotiable by empty light truck with various axle combinations drawing empty semi-trailer on dry gravel road.[1]

| Types of trucks | Weight in Pounds | | | Max. per cent adverse* Grade negotiable |
|---|---|---|---|---|
| | Front | Rear | Trailer | |
| 4-wheel | | | | |
| 2-rear-wheel drive............ | 2,235 | 3,205 | 5,000 | 21.7 |
| 4-wheel drive.... | 2,680 | 3,051 | 5,000 | 39.7 |
| 6-wheel | | | | |
| 2-rear wheel drive............ | 2,235 | 4,565 | 5,000 | 12.8 |
| 4-rear-wheel drive............ | 2,240 | 4,705 | 5,000 | 28.6 |
| 6-wheel drive.... | 2,670 | 4,726 | 5,000 | 44.6 |

1. coefficient of friction, 0.79; rolling resistance, 25 pounds.
* Neglecting loss of weight through effect of grade.

## TRUCK ROADS

All loggers are agreed on the importance of roads in truck log hauling. Many consider it the most important engineering phase of truck transportation. For this reason, they spend much time and money in determining its type, location, construction and maintenance. Joe Zauch, a successful truck logger of many years of experience of Index, Washington said: (1)

> "I would like to say that in my opinion the most important phase of truck logging operation is roads. You are licked before you start if you do not put in good roads and keep them in good condition winter and summer."

Roads are constructed to connect the timber property to a public highway, or they may be constructed as private roads so that the operators may avoid the stringent regulations and taxes imposed by statutes to truck haulers using the public roads.

### Types of truck roads.

There are three types of truck roads generally used in the Douglas fir region classified according to requirement, namely: (1) main line roads, (2) intermediate or secondary roads, and (3) temporary or dirt roads. The main line roads serve as the main trunk road to which many

(1) Joe Zauch, "How to select the logging truck". West Coast Lumberman, Vol. 65, No. 4. (April, 1938) pp.11.

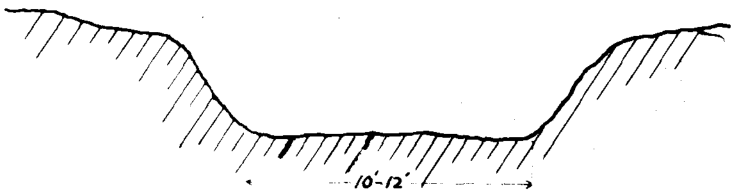
smaller roads from different parts of a logging area may lead. In many instances the public highways serve as main roads for small operators. Privately constructed ones serve as main line roads for big truck operations. Main line private roads are, in general, two-way-gravelled roads with low grades and wide curves.

Intermediate roads are feeder roads, and are constructed, generally inside the property. They connect big landings on which big cold decks are formed by yarding donkeys and tractors. They may also serve as main branches of dirt roads. They are usually constructed one-way with gravelled or planked surface. Turnouts at every 500 feet provide meeting places of trucks.

The temporary roads bring the truck nearer to the stump and reduce skidding distance to the minimum. They are usually one-way dirt roads with sharp curves, heavy grades, with no side ditches, crown, but with culverts. Fig. 2 shows a typical cross-section of a dirt road.

Location and Construction

Most experienced loggers do plenty of work in planning, surveying and locating good roads. First, road systems are planned and located on the topographic map of the logging area. Then, a general reconnaissance of the route is made on the ground. Preliminary and final location




CROSS SECTION OF A DIRT ROAD

Fig. 2

surveys follow. Center line stakes indicating cuts and fills as well as slope stakes are driven on the ground to serve as guides to the construction men. In important lines, computations of cuts and fills are often done to balance cuts and fills and avoid extra cost of borrowing pits and at the same time secure the best grades, curves, and width for the road. In some cases, in intermediate and temporary roads such refinements are not necessary. Alignment is done by ocular inspection.

The different types of road call for various grades, curvatures and widths. Main line roads are generally 22 to 32 feet wide or more with grades ranging from 5 to 7 per cent but not exceeding 6 per cent adverse grade, with curvature from 25 to 30 degrees (1); intermediate, usually 12 to 14 feet wide to 15 per cent grades but not exceeding 10 per cent adverse, with curves as sharp as 50 feet in radius; tertiary, up to 20 per cent grade with 10 to 12 feet in width. Rapraeger (2) found that the ability of trucks to go up on the return trip determines the maximum grades of temporary roads. However, the majority of haulers operate on maximum of 10 to 11 per cent adverse

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(1) Edward Baker, "Truck roads in fir region". The Timber-man, Vol. XXXVIII (September 1937).
(2) E. J. Rapraeger, Motor truck log hauling in Oregon and Washington. The Timberman, Vol. XXXIV Vol. VIII(Aug. 1933 pp. 15-16)

grades on dirt roads.

Not much attention is paid in regard to curves because of the flexibility of trucks allowing very sharp curves which may be widened to allow room for the semi-trailer. Figure 3 indicates a diagram and formula used to widen curves for different widths of road and radius of curvature of the road as well as for different lengths of the reach of the trailer. The problem of curves is also solved by special devices calculated to direct the trailer wheels to follow very closely the tracks of the truck wheels as shown in Figure 4.

On plank roads, grades up to seven per cent adverse and 12 per cent favorable are used on cross plank. Fore and aft plank and pole roads are usually constructed on level grounds and when constructed on grades are sprinkled with sand or salt to provide traction. A 16-per cent favorable grade is used successfully by L. H. Christensen on fore and aft plank roads with wire stapled on them.(1)

It is a known fact among experienced loggers that it is expensive to operate trucks on adverse grades, and it is the general practice to keep the grades as low as possible. The question of adverse grades is not very big among

(1) L. H. Christensen, "Road building". The Timberman, Vol. XL No. 5. (March 1939) pp. 16, 17 and 20.

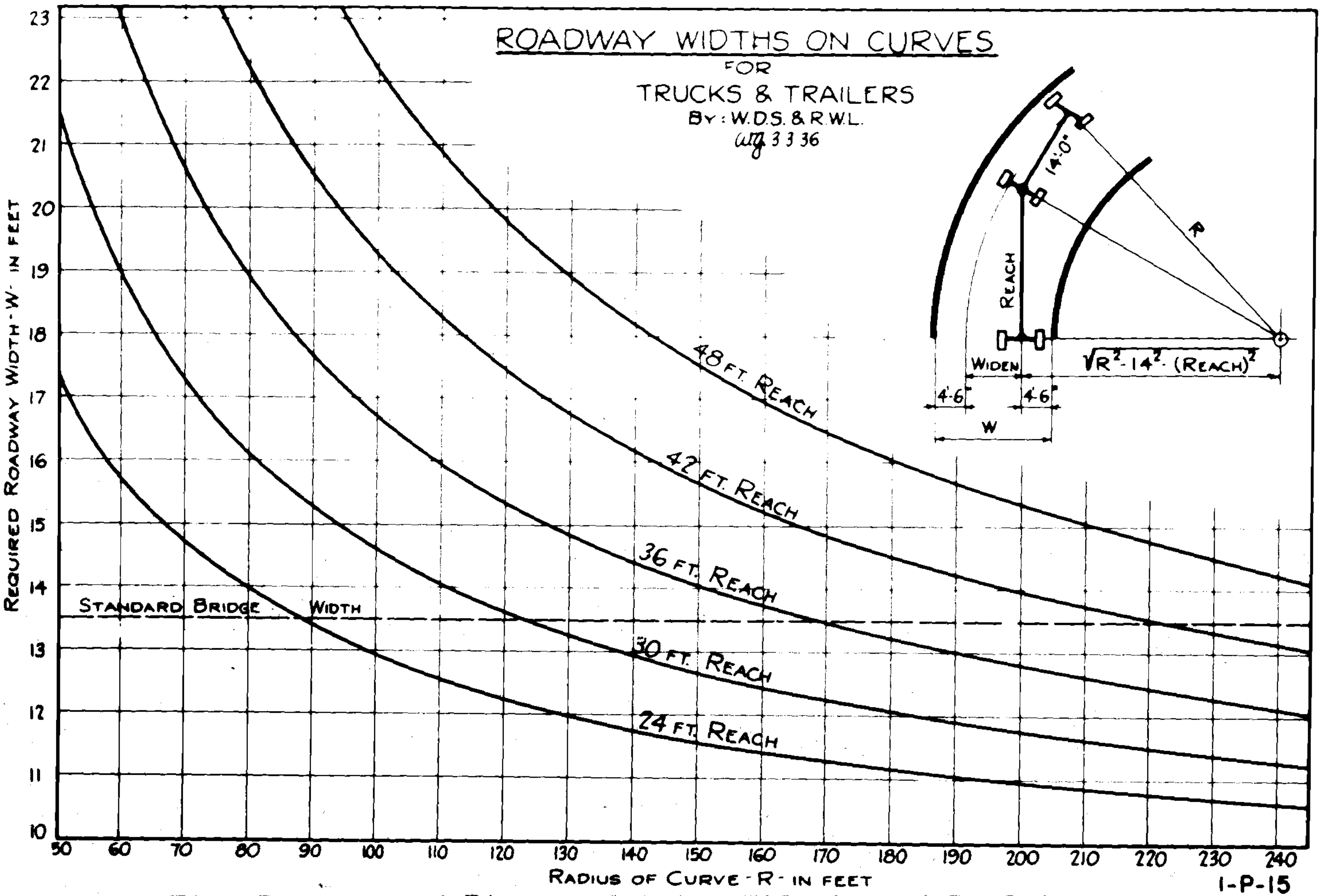
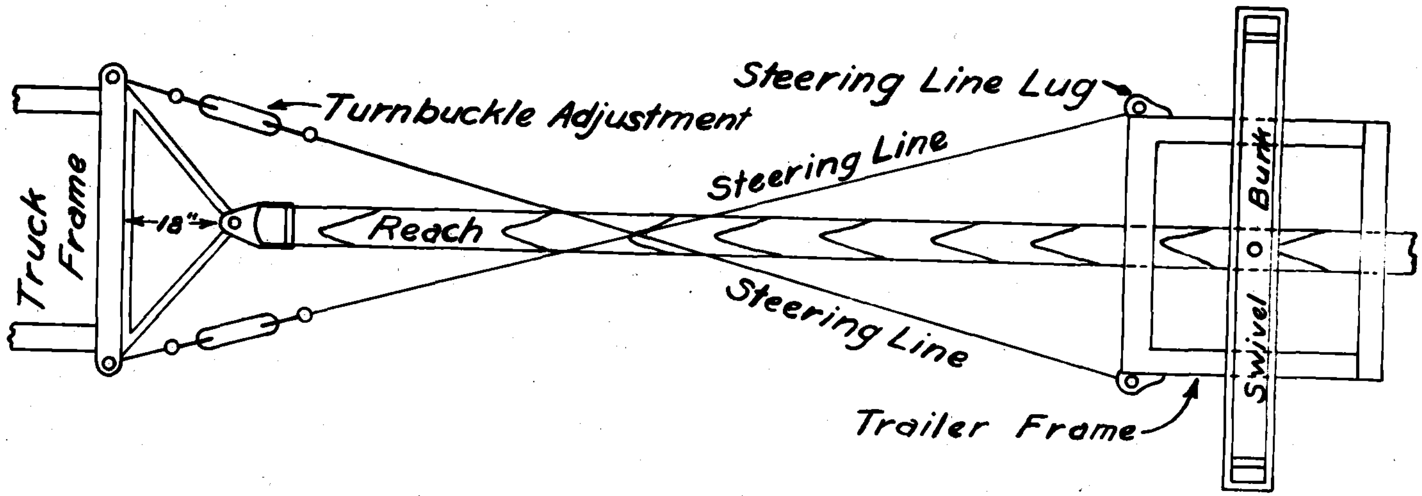



Fig. 3 Graph and Diagram Showing Widening of Road Curves




CASTLE ROCK TRAILER STEERING RIG

Fig. 4

loggers, however, as most truck shows are on high elevation allowing roads to go on favorable grades with the loads. The adverse grade that could be negotiated by a certain truck depends upon the torque developed by the motor, the various gear ratios, the resistance of the road surface and the elevation of the logging shows as will be shown later in this paper. Rapraeger (1) gives adverse grade limits for certain truck sizes as follows:

Adverse Grade Limits for Laden and Unladen Vehicles Pulling Trailers Over Good or Poor Roads in Dry Weather.

| Rated Capacity of Trucks in Tons | Adverse Grade Limits | | | |
|---|---|---|---|---|
| | Laden Vehicles | | Unladen Vehicles | |
| | Good Roads | Poor Roads | Good Roads | Poor Roads |
| 1½ and 2 ton | 5-8% | 4-7% | 8-12% | 5-8% |
| 2½ ton and larger | 7-12% | 6-10% | 11-18% | 8-14% |

Road construction is not a hard matter with the used of new equipment. The first operation in construction is the clearing of the rights-of-way. This is done by felling all trees and chunking them out of the road bed. Chunking and pulling of small stumps is done by tractors with large stumps removed by stumping dynamite. In blasting large stumps with dynamite, it was observed in a study made

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(1) Rapraeger, op. cit., pp. 17.

by the Oregon State Engineering Class in blasting (1) that there is a definite ratio of the number of caps to the diameter of the stump for proper removal of the whole stump from the ground as can be seen in Table VI below:

Table VI

Result of Blasting Work, Class in Blasting OSC, Winter Term 1938-1939

| Stump No. | Diam. of stump in inches | Species of stump | No. of sticks of dynamite | Remarks |
|---|---|---|---|---|
| 1 | 18 | Douglas fir | 10 | Good shot, clear |
| 5 | 14 | " " | 9 | Good |
| 13 | 10 | " " | 7 | Good even shot |
| 16 | 9 | " " | 6 | Good |
| 18 | 9 | " " | 6 | Good, stump clear |
| 21 | 26 | " " | 24 | Clean, well centered shot |
| 24 | 8 | " " | 6 | Good shot |
| 26 | 9 | " " | 6 | Good, open shot |

By computation, it is found that one stick is necessary for every 1.4 inches of diameter of the stump. This

(1) Class was under the auspices of the Dept. of Ag. Eng., Logging Eng. and Civil Engineering, Oregon State College Corvallis, Oregon.

number of sticks in one stump, however, differs in different species, kind of sil, and the amount of water present in the soil, and, before attempting blasting in a certain site, trial shots should be made to determine the number of sticks required to fully blast a stump.

Grading is very easily done by tractors and bull-dozers. Chunking, blasting, and grading as well as the placing of culverts and landings can easily be done by three men.

Gravelling. There is a trend to gravel all main and intermediate roads to insure all-year round operation. Road grades are usually kept one year to allow it to settle before it is gravelled. There are two kinds of rocks, used, namely: (1) crushed rocks, and (2) natural gravel obtained from pits and stream beds. The former is usually used on main trunk roads and the latter on inter-mediate roads. Crushed rocks are not commonly used on intermediate roads because of its high cost and hardship to secure. Natural gravel is usually abundant in the place of construction where its accebility is taken ad-vantage of by most loggers. On the other hand, natural stones are not desirable to use in main trunk roads because it does not bind well and have the tendency to work up producing an uneven road surface. Depth of gravel in main lines is from 12 to 18 inches and 6 to 8 inches on intermediate roads. The thickness of the gravel necessary for a certain road depends on the character of soil conditions, the weight of the load expected to travel on it, and the width of the road. There is a general agreement among loggers to use wider roads when surfaced with gravel. Wider roads allow the trucks to travel all over the surface keeping the road level and smooth. In narrow roads the tires are forced to travel on the same track leaving two grooves on the road where water settles and makes the road unfit for hauling as shown in Fig. 5. Crowning the road is not practiced as the crown causes uneven wear on the dual tires. Some, however, believe in crowning the subgrade and keeping the surface level. One authority (1) believes in eliminating the earth shoulders of roads common in public highways and recommends gravelling clear out to the side of the road as shown in Fig. 6, so that water on the road may easily flow to the ditches. Muddy shoulders detain the water on the road bed and make it soft.

Planking. Although the general trend is for gravel roads in the fir region, plank roads are still used and will probably be the conventional material to be used in muddy and wet places, and where gravel could not be

(1) Editorial Article, "Building truck logging roads." West Coast Lumberman. Vol. 63, No. 11 (Nov. 1936) pp. 4-18.

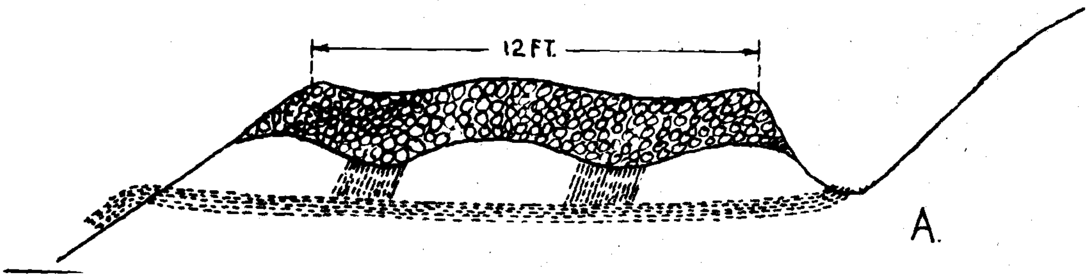


Fig. 5 Cross-section of Narrow Road Showing Groove on Road Surface Made by the Constant Pounding of the Wheels.

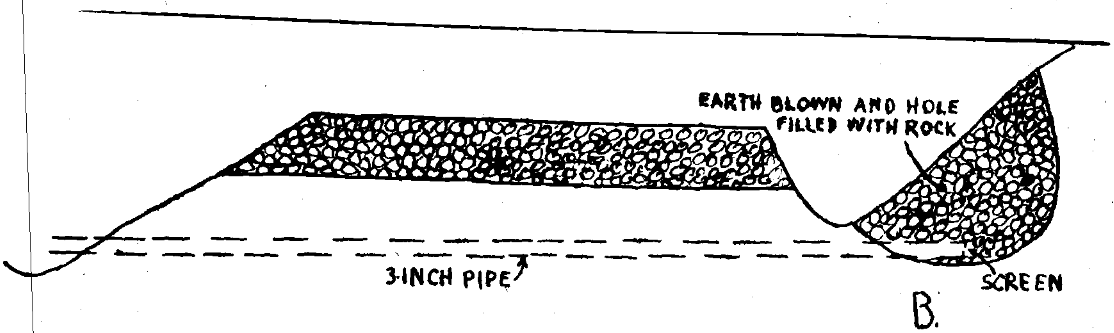


Fig. 6 Cross-section of Road Showing Method of Gravelling Entire Surface, and Method of Draining Springs on Roadside.

procurred economically in or near the logging area. For one-way road on level ground, the general method of laying lumber plank roads is to place cross-ties 4" x 12" x 10' four feet apart from center to center, over which three planks 4" x 12" x 22'-32' long are placed side by side under each wheel, nailed with 3/8" x 5" wire nails, at the ends on the ties. Christensen (1) believes in nailing the planks on the ties next to the ends of the piece to avoid the easy loosening of the nails as is the case when placed at the very end of the planks. He uses three planks if logs to be hauled do not exceed 40.0 feet, but it has been found better to use 4 planks if the length of the logs is from 64 to 80 feet. Figure 7 shows the construction of a typical fore and aft plank road. On muddy places and where there are depressions to bridge, a mud-sill is used as a foundation where cross-ties are dapped as shown in Fig. 8.

Cross planking on grades and on curves is done by placing side by side planks 4" x 12" x 10' over two lines of 3-4" x 12" lumber placed on the ground as shown in Fig. 9. Sometimes these cross planks are not nailed to the foundation as the case with the cross plank road of the Comox Logging and Railway Company at Ladysmith,

(1) L. H. Christensen, "Road building". The Timberman, Vol. XL (March 1939) pp. 16, 17 and 20.

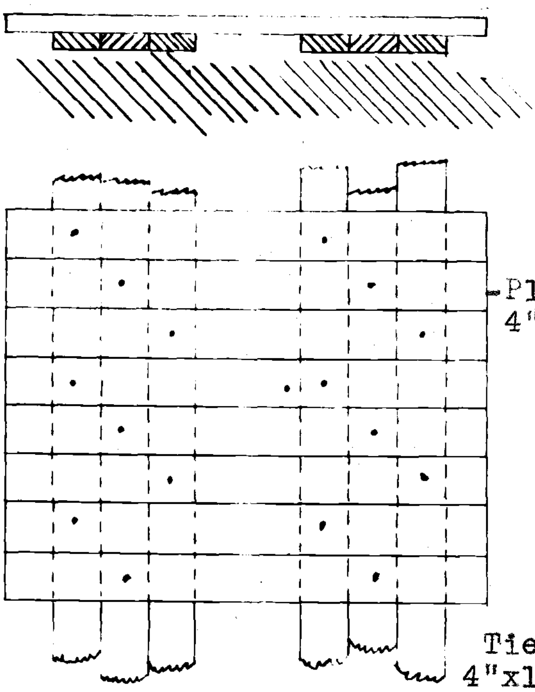


Fig. 9

Cross Plank
Road

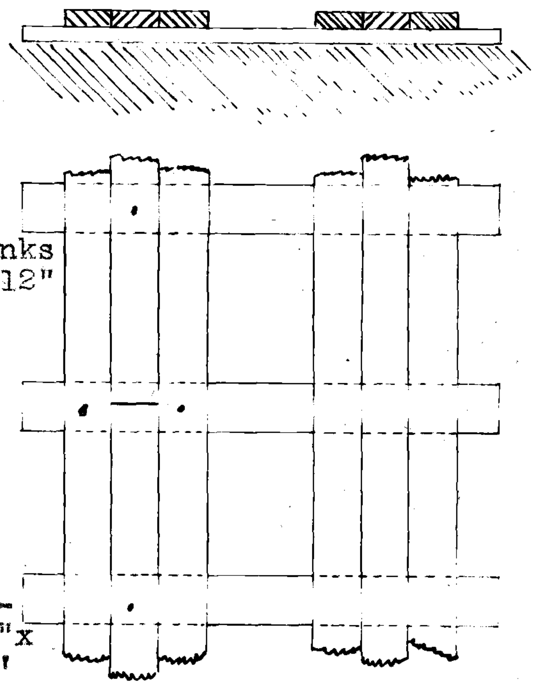


Fig. 7

Fore and Aft Plank Road

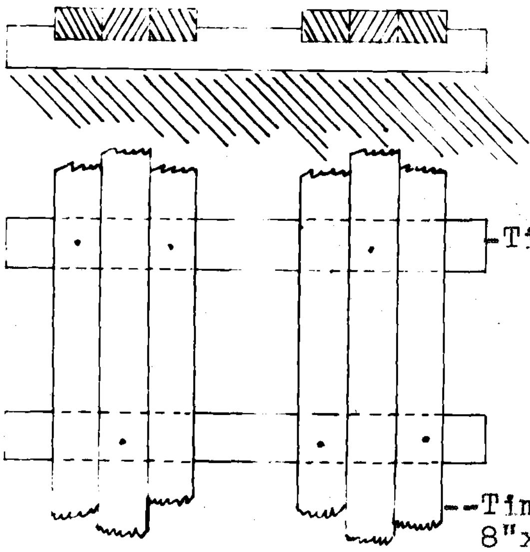


Fig 10

Fore and Aft Timber
Road

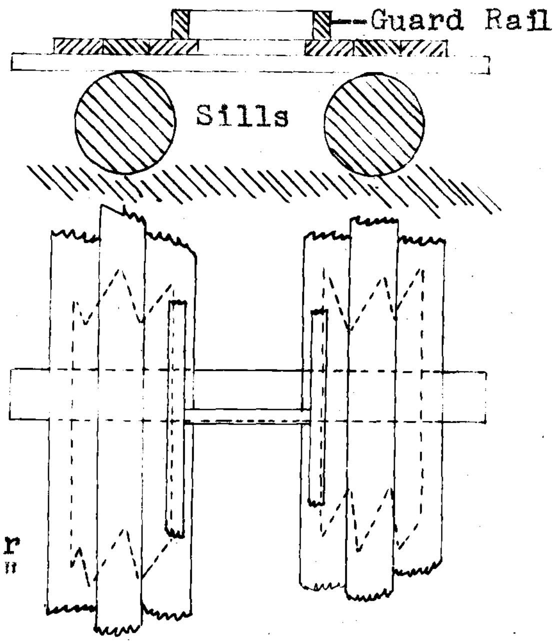


Fig 8

Fore and Aft Plank
Road With Sills

B. C. (1) which uses random width planks five inches thick 18 to 24 feet long laid over slabs laid diagonally on the ground surface.

Another type of plank road which has been tried with success in the Douglas fir region is the fore and aft timber road, an improvement of the fore and aft pole road. Round logs are employed as ties which are dapped to receive three 8" x 12" timbers on each side shown in Fig. 10. No sills are employed except on bridges. Only occassional ends are spiked.

Ditches and culverts. One of the requisites of good roads, gravel or plank, is drainage if it is to operate during the rainy season. Experienced loggers provide adequate drainage systems by side ditching and by placing culverts at every 500 feet. Sizes of culverts depend upon the amount of run-off. They should always be cleaned out so that the flow of water will always be well below the level of the gravel. For culverts, the most generally used are the box culverts made of 3-inch lumber as shown in Fig. 11, the "A" log or 3-log culverts shown in Fig. 12, and 2-log culverts shown in Fig. 13.

Truck road bridges. The tendency in modern truck

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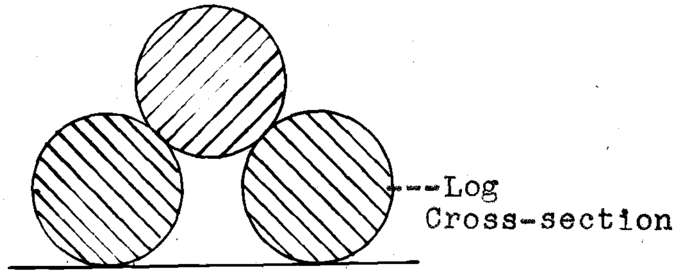
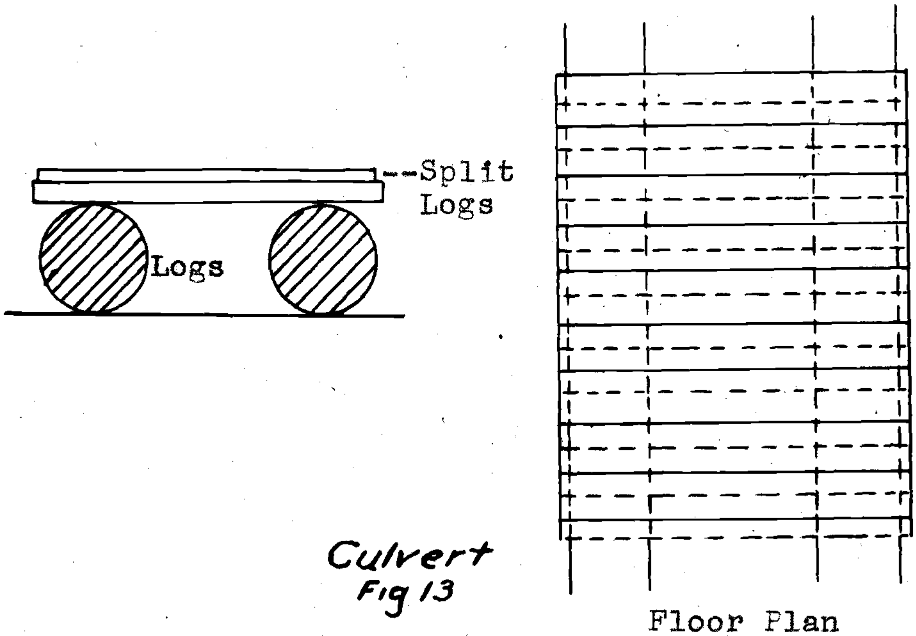
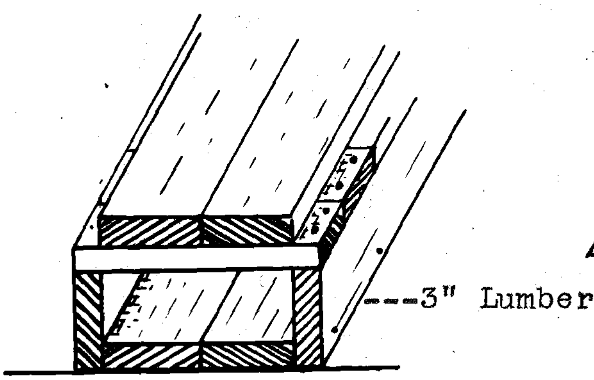
(1) James Sheasgreen, "Road building". <u>The Timberman</u>, Vol. XL (March 1939) pp. 16, 17 and 20.




3-Log Culvert
Fig 12




Culvert
Fig 13




Box Culvert
Fig. 11

road construction, is to eliminate all small bridges and trestles with earth fills. With the use of bull dozers and shovels fills are very easy and inexpensive to construct. Also, fills are fireproof unlike the trestles. Maintenance in fill is low. However, fills are desirable only up to a certain height limit. In this connection Webb (1) found that "for less height than 25 feet the first cost of an embankment will generally be less than that of a trestle; this implies that a permanent trestle should never be constructed with a height less than 25 feet"....He continues, "Although local circumstances may modify the application of any set rules, it is probably seldom that it will be less expensive to build an embankment 40 to 50 feet high than to maintain permanently a wooden trestle". However gulleys with very steep side slopes that would not hold fills have to be bridged. Also, streams with a large volume of water flowing as well as marshy places that are hard to fill need bridges. The Cahill Logging Company, Tillamook County, Oregon (2) had to build a cable suspension bridge 191 feet in span (Fig. 14) over the Wilson River to avoid the large amount of freshets that are had during the early spring.

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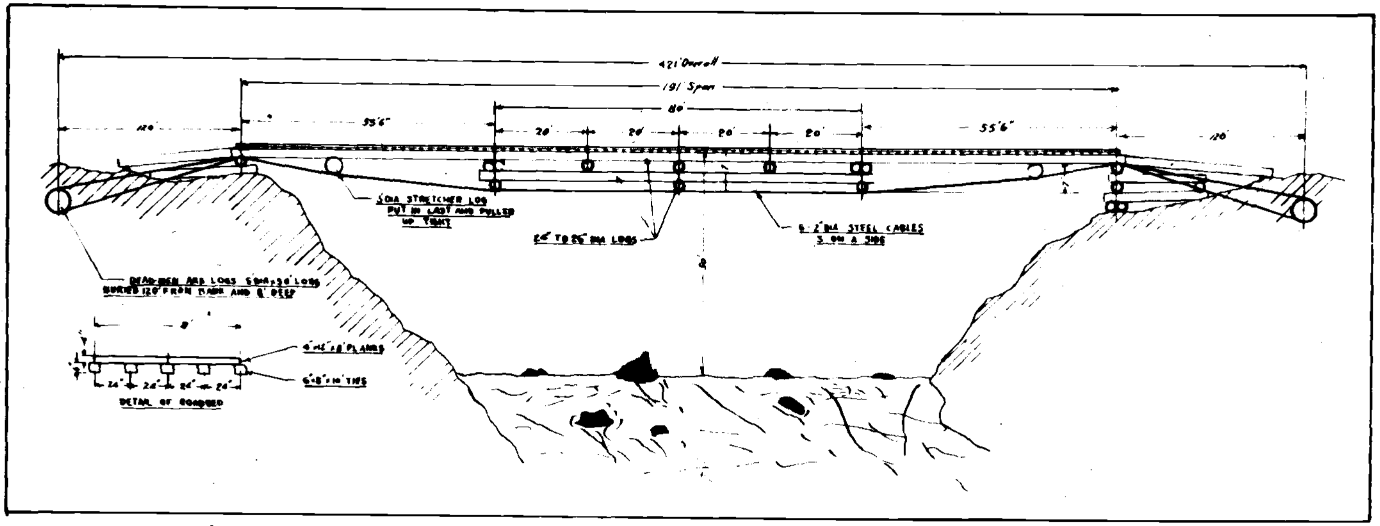
(1) Webb, Walter L., Railroad construction. New York. John Willey & Sons. 1932 pp. 197.
(2) Editorial Article, "Cable span log bridge." The Timberman. Vol. XXXVIII No. 11. Sept. 1937. pp. 11.




CABLE SUSPENSION BRIDGE OF CAHILL LOGGING COMPANY OVER WILSON RIVER, OREGON

Fig. 14

The more common bridges used in truck roads are low crib bridges, Fig. 15, stringer bridges (Fig. 16), and simple bent trestle bridges. Cribs are used on marshy grounds, stringer bridges over narrow streams, and trestles over wide gulleys as shown in Fig. 17.

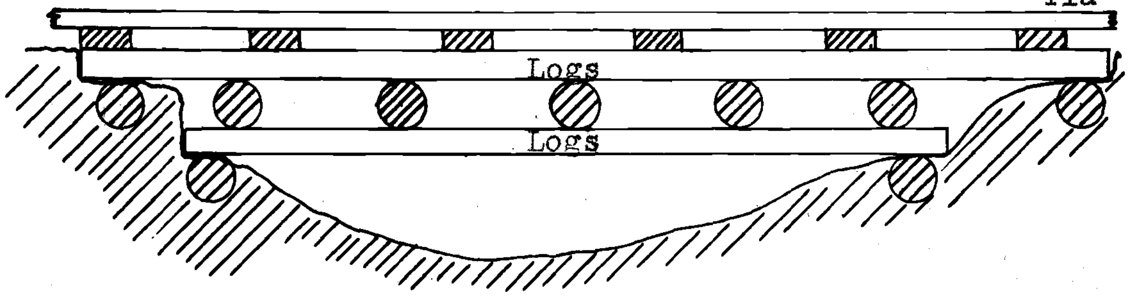
## Maintenance

Maintenance is necessary to keep the road in good condition. The hauling of he vy loads causes the development of weak spots from time to time. This calls for the blading of the surface to keep the road bed level. Watering is done to keep dust down. Dust prevents good traction and good vision resulting from clouds which lead to accidents. During the rainy season the ditches and culverts are kept in good working condition. The Comox Logging and Railway Company, Ladysmith, B. C. spends $ .01 to $ .02 per thousand board foot for maintaining their private road.

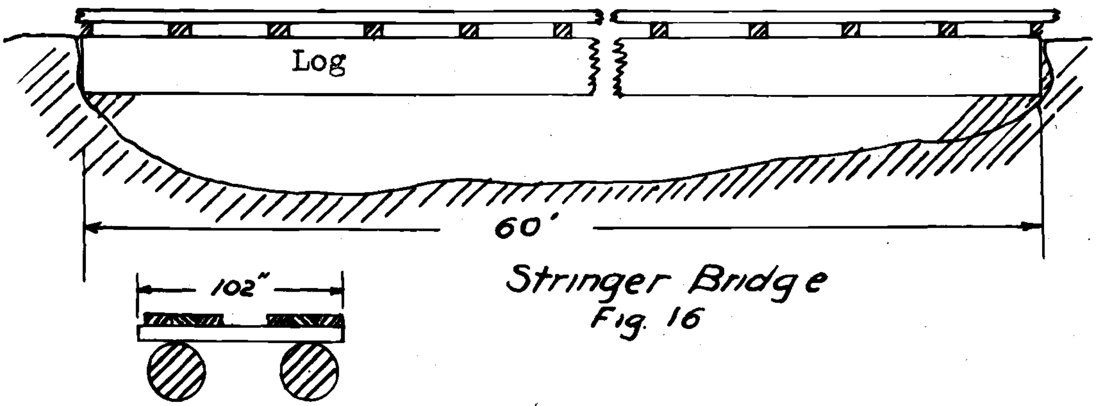
## Cost of Road Construction

Cost of road construction varies within wide limits due to differences in amount of clearing, amount of fill and cuts, kind of soil and the amount of bridging necessary. Rapraeger (1), found a case in Oregon in which

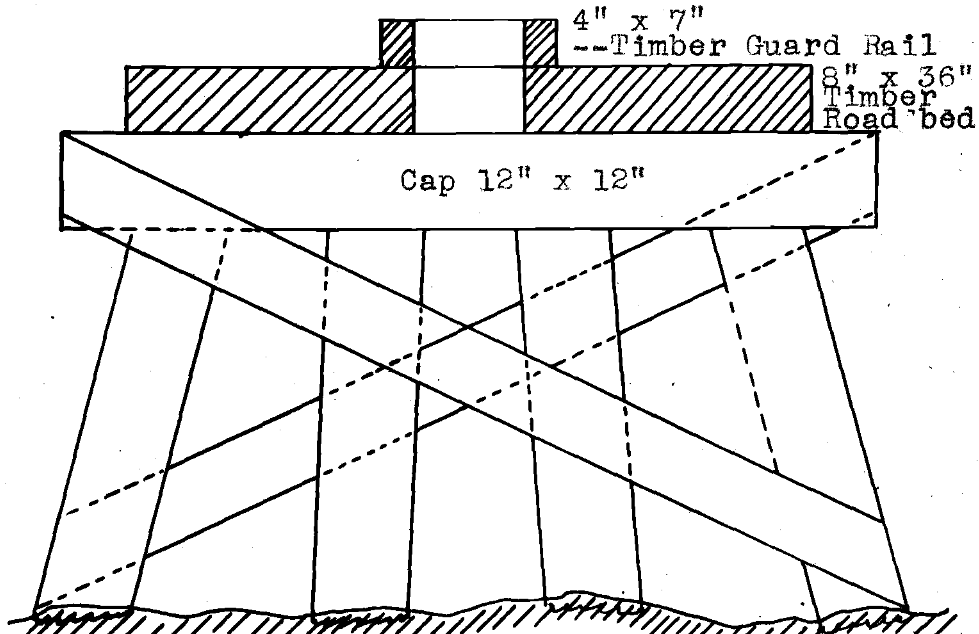
(1) Rapraeger, Op. cit., pp. 17.




Crib Bridge
Fig. 15




Stringer Bridge
Fig. 16




Cross Section
of Truck Trestle
Supplement to Fig. 17

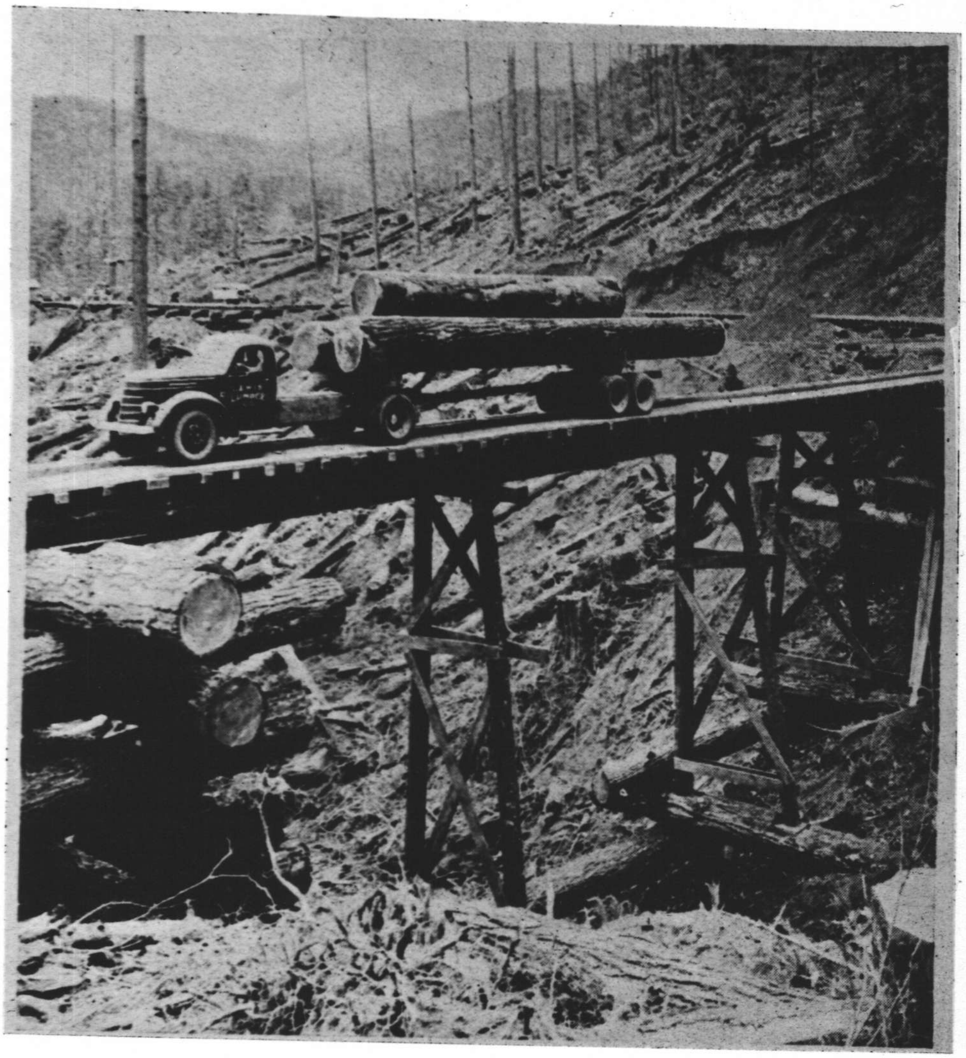


Fig. 17 Truck Road Trestle Bridge Over
A Wide Gulley
Lewis Lumber Co., Dexter, Oregon

a dirt road costs from $100 to $130 per mile where swamping is light, the ground level and the soil free from large stones and outcropping rocks. The fore and aft plank road of H. L. Christensen (1) cost $60 to $70 per station or $3168 to $3960 per mile. West Coast Lumberman (2) found that plank roads cost as high as $5,000 per mile and gravel roads from $1000 to $8000 per mile(3).

(1) Christensen, *Op. cit.*, p. 17.

(2) Editorial Article, "Truck Logging cost." *West Coast Lumberman*, Vol. 59, No. 4. April, 1932, p. 18.

(3) *Op. cit.*, p. 18.

## EQUIPMENT

Most logging trucks in general use in the Douglas fir region are regular factory models provided with a semi-trailer. They are, however, modified to be adaptable to rough hauling. The body is made stronger by rivetting steel plates or a piece of timber 6" x 6" on the frame bearing the bunks. Both the rear end of the truck and the semi-trailer are provided with steel I-beam bunks resting on steel frames which are bolted to the truck frame and on the springs in the case of the trailer. The bunks are usually swivel bunks and are free to rotate on the steel plates on which they rest. The semi-trailer is connected to the truck by a square timber 8" x 8" x 32' called the reach. The wheels of the trailers may be provided with single wheels with dual tires, but the most popular ones are with dual axles with dual tires. The rear wheels of the truck are usually of single axle with dual tires, although there are also some in use with dual axles with dual tires. Other auxiliary parts of the trucks are the brakes and the water tank, the latter usually placed under the bunks of the trailer and rear end of the truck. Figures 18 to 22 show different styles of present trucks and trailers.

Fig. 18 Semi-trailer for a Light and Medium Truck.

Fig. 19 Semi-trailer for a Heavy Truck

Fig. 20 A Logging Truck With a Single Axle Drive and a Single Axle Trailer.

Fig. 21 A Logging Truck With a Dual Axle Drive and a Dual Axle Trailer.

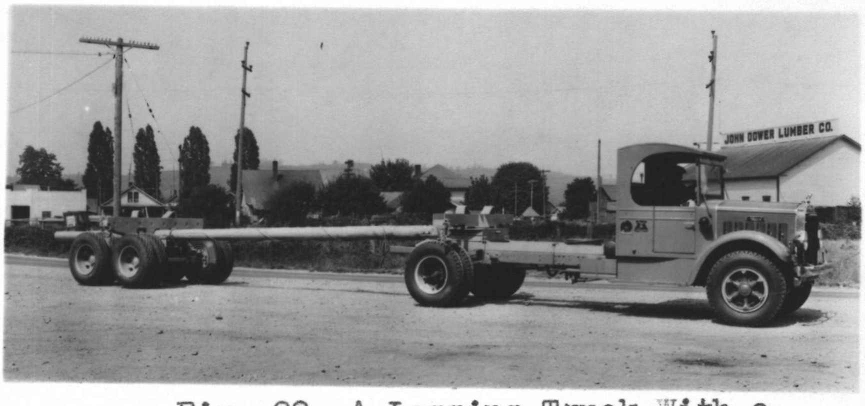



Fig. 22 A Logging Truck With a Single Axle Drive and a Dual Axle Trailer.

Classification

The logging trucks widely used in the Douglas fir region are classified by the Pacific Logging Congress (1) as follows:

1. Light trucks (1½ to 2 ton) with piston displacement from 200 to 300 cubic inches.
   - (a) Ordinary rear end, dual tires and single axle trailer dual tires.
   - (b) Special rear end, dual tires and single-axle trailer dual tires.
   - (c) Ordinary or special rear end with dual-axle trailer dual tires.
   - (d) Dual rear end with dual-axle trailer.
   - (e) Four or six-wheel drive with dual-axle trailer.

2. Medium sized trucks, gas or diesel, piston displacement 300 to 450 cubic inches.

   With the same rear ends and trailer equipments as in the light trucks.

3. Heavy trucks, gas or diesel, piston displacement 450 to 700 cubic inches.

   With the same rear ends and trailer equipment as in the light trucks.

According to studies of Rapraeger (2), in 1932, about 69.4 per cent of logging trucks used in Oregon were light trucks, 25.5 per cent of medium-sized trucks, and 5.1 per cent of the heavy class. At the present time the light class still predominates in the Douglas fir region, although more and more of the larger operations are turning

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(1) Advance copy of the Logger's Handbook, pp. 3.
(2) Rapraeger, <u>op. cit.</u>, pp. 16.

to big trucks. The light trucks are preferred because they require small investment, they are easily traded-in or sold with high values, they have high utility for other hauling work during the closing of the logging season, they are easily serviced due to accessibility of parts, and they are within load limits allowed on public roads.

Large trucks on the other hand, according to recent studies (1), when used in large operations have lower operating costs. Besides this, larger trucks could negotiate steeper and longer grades than the light trucks. At the present time the heavy trucks could be "Dieselized" which usually is more economical in fuel consumption and at the same time produces more power than gasoline trucks.

Specification of trucks

Cab. Unlike the pioneer truck, the modern logging truck is provided with a comfortable and strong cab with glass windows and windshields.

Bunks. Bunks are usually made of I-beam steel provided with V-shaped chock-blocks held by chains when the bunks are loaded to keep the top in place. Highway regulations in Oregon and Washington require that there be

(1) Experience of the Grande Ronde Pine Co., Pondosa, Ore., and the Comox Logging and Railway Co., Ladysmith, B. C.

a maximum length of eight feet for the bunks. In many private operations, however, 10 to 12 foot bunks are used.

<u>Springs</u>. Springs used in logging trucks are provided with enough power to carry heavy loads. Enough safety factor is allowed to take care of bumping. There are two types of springs generally used: (a) The semi-elliptic type, and (b) the flat type with wide and few leaves. The semi-elliptic type when under full load does not get below the horizontal position, while the flat type sags as it is loaded.

<u>Brakes</u>. Generally strong brakes are installed in the logging trucks. It is necessary especially if the hauling is done on steep roads and congested highways where the truck speed should be under control. The popular ones employed in logging are:

1. Hydraulic brakes. Most of the light and medium-sized logging trucks are equipped with hydraulic brakes. The popularity of this brake is due to its merrit. Smooth and even pressure can be exerted on all of the brakes at the same time and efficiency is secured. The objection in this type is that a leakage in one point in the tubing would render the whole truck brake out of order as lack of pressure at one point of the tubing will release pressure which is the life of the whole brake unit. It is

not adaptable for heavy work.

2. Compressed air brake. It is used by heavy trucks because of its power and good equalization of pressure in all of the wheels. The mechanism of this brake is like that of the hydraulic brakes, only, the power is supplied by compressed air. The power in the hydraulic brakes is supplied by fluid. The advantage of this brake is that quick application or release can be secured with a smooth and positive action. Unlike the hydraulic brakes, a leakage at one point in the tubing may affect only the leaking tube and other wheels may still function.

3. Vacuum booster. The vaccum booster is very common among small trucks and trailers. One very great objection to this type of brake is that it functions only when the motor is running.

4. Mechanical brakes. Mechanical brakes are becoming unpopular in the logging truck because equalization of braking in all wheels is hard to attain due to the construction of the different parts which, because of use, get out of proper bearing and adjustment.

On continuous long grades brakes become very hot necessitating the use of water for cooling. For this purpose a water tank is installed under the bunks in most logging trucks to supply a small, continuous stream of water flowing on the outside part of the brake drum.

There is a danger that the drum will break easily if water is poured to it when it is hot, and the water pipe should be open before the truck decends a slope when the brake drums are still cool and allow water to flow until the bottom of the slope is reached at which time the water pipe is closed again.

<u>Tires</u>

Tires used in logging trucks have changed since 1913. At present pneumatic tires are used. Pneumatic tires as defined by the Oregon Motor Vehicle Law are those which are inflated with compressed air. Pneumatic tires are preferred above solid tires because: (1) they give better traction (2) they cushion the vehicle and load on the roadbed, and (3) they protect the road. There are two types of pneumatic tires used in logging---(1) the balloon tires, and (2) the high pressure tires. High pressure tires are preferred on bad roads in the woods because they snag less readily. The balloon tires are good on paved highways.

<u>Trailers</u>

The most important appendage of the truck is the semi-trailer. Its use is based on the theory that well-built trucks have more power available in excess of normal needs when the rated load is carried. Such a truck may be loaded to capacity while the engine remains half idle.

Under the right conditions the surplus power may be used to draw a trailer that supports one end of the load. With the use of the trailer, great savings are made both in fuel and labor. The writer observed that about two-thirds of the load is carried by the trailer when the truck unit is with a single rear end axle and a trailer with double axles. Therefore, actually the total load of the truck and trailer is three times that of the capacity of the truck alone. According to Everhart,(1) a truck and a trailer combination uses only 10 to 20 per cent more gasoline than the truck alone, thus reducing the cost per ton-mile of payload. Likewise, cost of labor, tires, and depreciation are decreased. The most popular semi-trailers today are the dual-axle unit with dual tires provided with brakes.

Motor

Many operators found that larger bore and longer stroke engines with slower speed produce the most economical operation. This is naturally the case because with a larger displacement in the engine a larger torque is produced for heavy hauling. Also, experienced loggers found that greater load with slower speed is more economical than

(1) H. E. Everhart. "Nine good reasons for trailers", The Timberman, Vol. XXVII, No. 2, Dec. 1926, pp. 164.

small loads with high speed because in the former case, truck wear and maintenance cost is smaller. Large Dieselized engines are preferred in larger operations. Sleeve-lined cylinders have practical value as they can be replaced and would render old engines renewed efficiency.

Rear wheel drive

The power from the shaft is transferred to the rear axle by different kinds of drivess. The most common ones used in trucks employed for log hauling are: (1) the chain drive; the chain drive is considered the strongest and most efficient drive and is usually installed in large trucks for heavy hauling on adverse grades. It does not develop too much heat since the chain is placed out in the air. This is the advantage it has over the other drives. It pulls the wheel down in both ends of the axle and in that way more tractive power is obtained. The only objection to this drive is that it is apt to catch dirt and soil which would cause trouble. This defect is not a big problem. It is easily repaired. Most light truck manufacturers do not install chain drive and it is only in the large sized truck that they are available. (2) The double reduction drive is the strongest and most efficient next to the chain drive. It is run by gearing enclosed in a case and avoids the possibility of dirt and soil obtained in the chain drive. It has, however, the tendency to develop too much heat besides losing some of its efficiency. It is used in the medium-sized trucks very extensively. (3) The worm drive is not very popular to loggers. It is very expensive and has very low efficiency because of its inherent character of developing excessive heat. (4) The Bevel drive is famous for its simplicity. It is very adaptable to light work and is used extensively in the light class of logging trucks. It is inexpensive.

Upkeep

The upkeep of trucks is important because of the many factors that tend to disrupt its efficient use. The main object of upkeeping is to see that all of the parts are in good working order.Upkeep insures the continues use of the truck. Neglect to repair a small damage may soon cause trouble leading to complete destruction of the whole unit. For this reason the general practice among loggers in the Douglas fir region is to maintain their own repair shops under expert mechanics. The more experienced loggers believe in a complete overhaul of the equipment once a year in addition to day-to-day upkeep. Christensen (1), a veteran log truck hauler said, "I have found that a general overhaul of a truck is very necessary. The truck should be completely dismantled, even to the transmission,

(1) L. H. Christensen, "Upkeep of motor trucks". West Coast Lumberman. Vol. 64, No. 4, April, 1937. pp. 20-21.

the differential and spring shackles". He found it necessary to check all parts of the truck and restore them to proper working condition, like the piston and accessories, water pump, radiator tubes, the ignition system, generators, clutch, transmission, differential, springs, frames, wheels, brakes, and air line in the brake system. For day-to-day upkeep, the general practice is to keep records of the performance of the truck. The driver reports any trouble and makes recommendations as to what is to be repaired. The records keep the management posted on the necessity of replacements such as tires, grease and oil after a certain mileage, checking for the correct performance of important parts such as the valves, magnets and spark plug points. Repairs are mostly done during the day.

Garaging the truck

It is necessary to place the truck in a garage to protect if from the inclement weather and to have it repaired. There is, however, the danger of the whole fleet being burned especially in the cold weather when it is hard to start the engine as happened with the fleet of Haley and Haley, Kinzua, Oregon (1). To remedy this danger, J. F. Coleman, Manager of Kinzua Pine Mills, Kinzua, Oregon

(1) Editorial Article, "Garaging logging trucks." West Coast Lumberman, Vol. 65, No. 4, pp. 40, April, 1938.

suggested the following: (1) that the garage be built separate from other buildings, and (2) that the floor of the garage be built in an incline with enough slant so trucks could roll out without power and quickly enough in case of a fire. The installation of automatic sprinkler systems on the roofs of the garages as is done in the lumber shed should be another precaution for the prevention of fire in the garage.

Special devices to increase the efficiency of trucks.

Ingenious equipment manufacturers and truck haulers have engineered the truck for more efficient performance. Many devices have been discovered and calculated to increase the hauling capacity of trucks as well as to reduce its cost of operation.

Proper use of tires. Higher mileage is obtainable for tires at the present than in 1932. This is due to better makes and more efficient handling by truckers. For example, loggers learned that higher mileage is obtained from tires by using dual tires in one wheel and by removing the drive wheel tires before they are entirely destroyed and place them at the trailers, by using the same size and kind on the same wheels, by correct inflation, and by regulating the load. The Christensen operation saved 2770 miles on each tire by using dual-axle trailers and by transferring drive wheel tires to the trailers. Data are available on the correct loading of tires and speed that a certain truck should run with them. Figure 23 shows the effect of overloading the tires. According to studies (1) the tire will give 156% normal service if loaded only to 80 per cent of the normal load, but would give only 70 per cent normal service if overloaded 20 per cent, 51 per cent normal service if overloaded 40 per cent, and 25 per cent normal service when overloaded 100 per cent. "Loading a pneumatic tire beyond its rated capacity causes excessive flexing of the side walls and distortion of the thread, even if the correct air pressure is had. This results in broken fabrics, rapid and spotty thread wear, tread and ply separation and complete failure of the tire", said W. T. Hess (2). Speed and temperatures at which tires are run also effect tire mileage. Increasing the speed 30 to 60 miles reduces tire life to 60 per cent and increasing temperature of running tires from 70 to 100° F. lowers the tire life 60 per cent.

The following are advises of two tire experts on how to get the most of the tires.(3)

(1) Editorial Article. "Evils of overloading tires". West Coast Lumberman, Vol. 64, No. 1, Jan. 1937, pp. 16.
(2) W. T. Hess, "Getting the most of tires". West Coast Lumberman, Vol. 65, No. 4, April 1938, p. 26.
(3) W. T. Hess and M. C. Skelton, "Getting the most out of tires". West Coast Lumberman, Vol. 65, No. 4 April 1938.

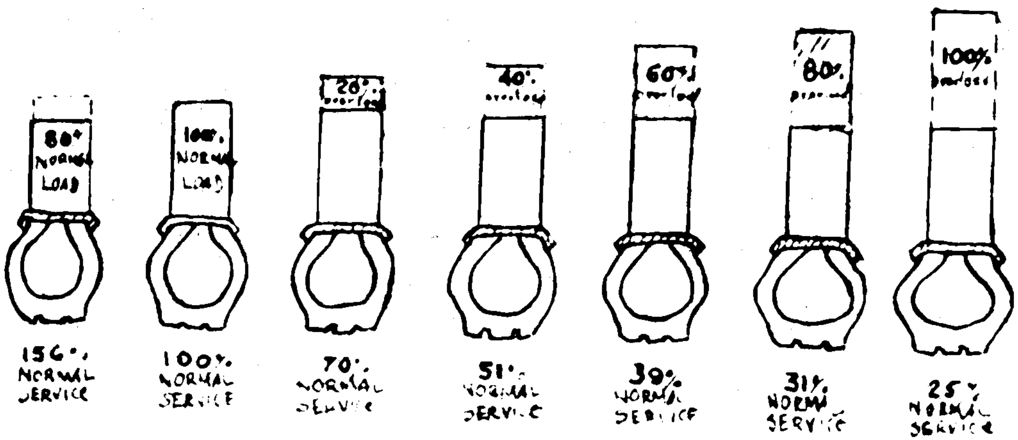


Fig. 23 Cross-section of Tires With Diagramatic Representation of the Effect of Overloading

1. Always install the largest size tires possible on the equipment.
2. Never install mismated tires side by side. Always have the same diameter so that the load will be equally distributed on both tires. Keep the best rubber on the drivers and when they begin to wear transfer them to the trailer.
3. Keep your own shop so that trucks are kept to top-notch condition at all times.
4. In winter, the tires should be inflated more than in hot weather so that blow-outs are kept down.
5. Keep your weight to carrying capacity limit of what the tires are manufactured for and with a margin of capacity left over to care for any super-elevated condition of the road.
6. Air pressure should be checked every other day and any tube that has a tendency to drop in pressure should be replaced and checked for breakage before using again.

Increasing truck capacity. An engineering device employed by some loggers to make the small truck more efficient is done by the installation of auxiliary transmission that would increase the gear ratio of the ordinary truck. (1) The Watson-Brown-Lipe auxiliary transmission provides an underdrive and an over drive to each of the standard truck gears. The gear ratio in compounded low gear of a truck equipped with it is 62.5 to 1 as compared to 42.24 to 1 in the standard trucks. The extra power made by the added gears increases the pulling power of the truck. Another principle used to increase truck capacity is the Timken double reduction axles. Double reduction is made from the drive shaft to the wheel axle.

(1) H. S. Watson, "Selecting proper gear ratio for trucks". The Timberman. Vol. 37, No. 2, Feb. 1936, p.48.

The efficiency of this outfit had been tried in the George Van Vleet (1) operation in Astoria-Seaside Area, Oregon where 18 small trucks provided with double reduction axles have made the VanVleet outfit one of the steadiest truck logging outfits in the Northwest.

A third engineering achievement used to increase capacity of trucks is the installation of two axle drives to take the place of one in the standard truck. Isaacson Iron Works, Seattle, Washington recently announced introduction of their "Thorton Unit". Cronkhite (2) describes the engineering feature "as adding an honestly engineered dual ratio dual drive to the standard little truck with six wheels and two driving axles with an inbuilt under drive available in all transmission speeds". Of course the increase of another driving axle increased the hauling capacity of the truck. The small truck engineered this way is claimed by Mr. Cronkhite to equal the performance of a standard six-wheeled truck which cost 50 to 100 per cent of the engineered truck described.

Six wheeler trucks. The sixwheeler truck is a recent development in automotive engineering. Its advantages are that it increases the capacity of the truck both on

(1) George VanVleet, "Making the most of light trucks". West Coast Lumberman. Vol, 65, No. 6, June 1938, pp. 50-51.
(2) L. J. Cronkhite, "Increasing truck capacity". West Coast Lumberman. Vol. 65, No. 12, Dec. 1938, pp. 46.

private and on public roads, it incurrs less wear on roads, and can have greater load on adverse grades.

LOADING

Loading is an important phase of truck log hauling. It may become a "bottle neck" in the whole logging operation if it is not well synchronized with yarding and hauling. It may delay yarding while a truck is being loaded and may delay hauling for lack of logs caused by intermittent yarding. Therefore, yarding should be handled so that loading may work 100 per cent and hauling efficiently carried with the continuous rolling of the trucks. To attain this end loading should be synchronized with hauling and yarding. In this connection, Baker (1) says:

> "The fluctuation in rate of production of a yarding unit during the course of a days work is usually quite pronounced. This is especially true with high-lead or any other method of direct yarding. On the other hand the trucks usually operate with very little variation in travelling time per trip. Hence it follows that for good correlation of yarding and hauling capacity, we must store up logs at the landing during high production peaks to keep the trucks supplied while the yarder is getting the tough logs."

This calls for the performance of yarding ahead of loading. However, there are certain types of loading devices that may be used in conjunction with yarding without delaying the later.

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(1) Edward Baker, "Loading logging trucks". West Coast Lumberman. Vol. 64, No. 4. April 1937. pp. 18-19.

Types of loading devices.

Loading in truck hauling is more flexible than in railroad logging. The most generally used method in the Douglas fir region is the spreader bar (1) system and the McLean boom system. The spreader bar system is very adaptable to big and long logs and because of the two or more block purchases that could be installed in the rigging that gives mechanical power, it does not require a very powerful machine. A 30-h.p. gasoline engine can load logs 1600 board feet contents. With it logs could be lifted more or less parallel to the road and be brought from one side of the road to the other to be loaded on an empty truck. Loading with proper balance is easy as the truck could easily move back and forth while the loader lifts the log to the proper balance. Another advantage of this system is its adaptability in bringing logs from the cold deck and piling them parallel to the road preparatory to loading while the trucks are away. In this way the loading time is shortened which would otherwise be prolonged due to time lost in shifting logs and sorting them in the landing. The disadvantage of this method is its hardship to rig. Two spar trees are to rigged and they

(1) Edward Baker, "Loading Motor Trucks", West Coast Lumberman. Vol. 64, No. 4, April 1937, pp. 18-19.

are to be located more or less opposite each other on each side of the road.

The rigging of the spreader bar system has many variations.

> "Essentially, the method is to pass the main line (loading line) through the block in the spar tree about 75 to 100 feet above the ground, then through a fall block and then to a tail hold just below the tree block. This gives one block purchase on the main lifting line. From the fall block a spreader bar about 8 or 9 feet in length is suspended by two eight-foot straps. Hooked to this bar are the drop lines with hooks for the loading straps attached, and also the haulback line. The latter is also rigged up with a block purchase, the tailhold being either on another tree or on a special guy line"(1).

Figure 24 shows a typical rigging of the spreader bar system. Figures 25 and 26 are modification riggings of the spreader bar loading system.

The McLean boom "consists primarily of a double boom suspended at right angles to the spar tree, about 30 feet above the ground, with the heel of the boom resting against the spar. One line from the donkey is used to rotate the boom around the spar tree as an axis and the other line depending on the power required. A counter-weight is used to rotate the boom in the opposite direction from the donkey pull". The advantage of this system is: It's ease of operation, steadiness with which logs may be handled, small power on the loader required, and

(1) Edward Baker, Loading Motor Trucks. West Coast Lumberman. Vol. 64, No. 4, April 1937, pp. 18-19.

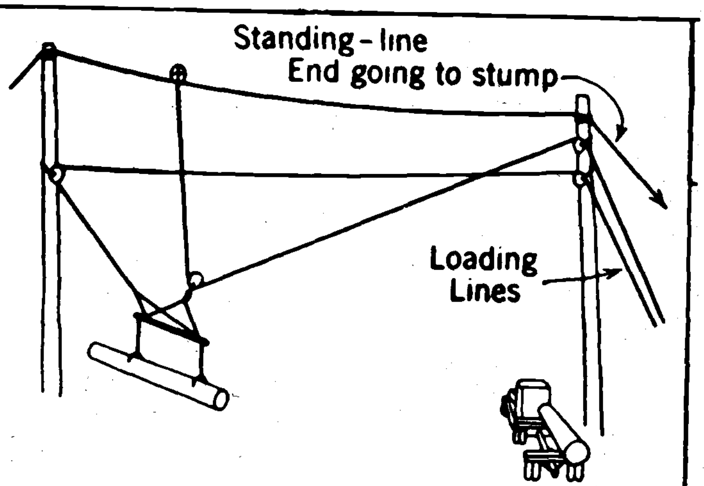

Standing-line
End going to stump
Loading
Lines
B

Fig. 25

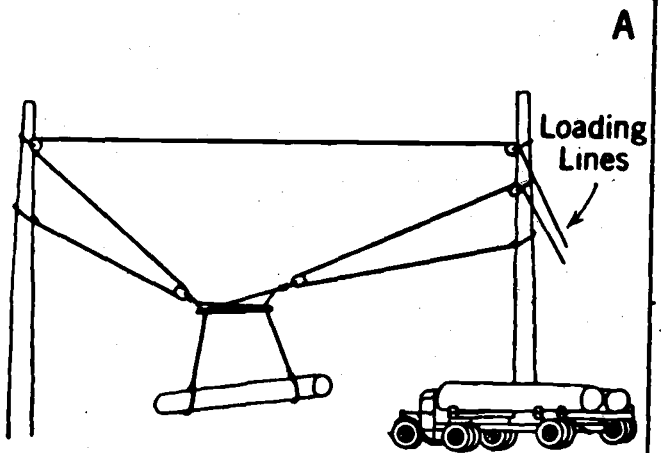

A
Loading
Lines

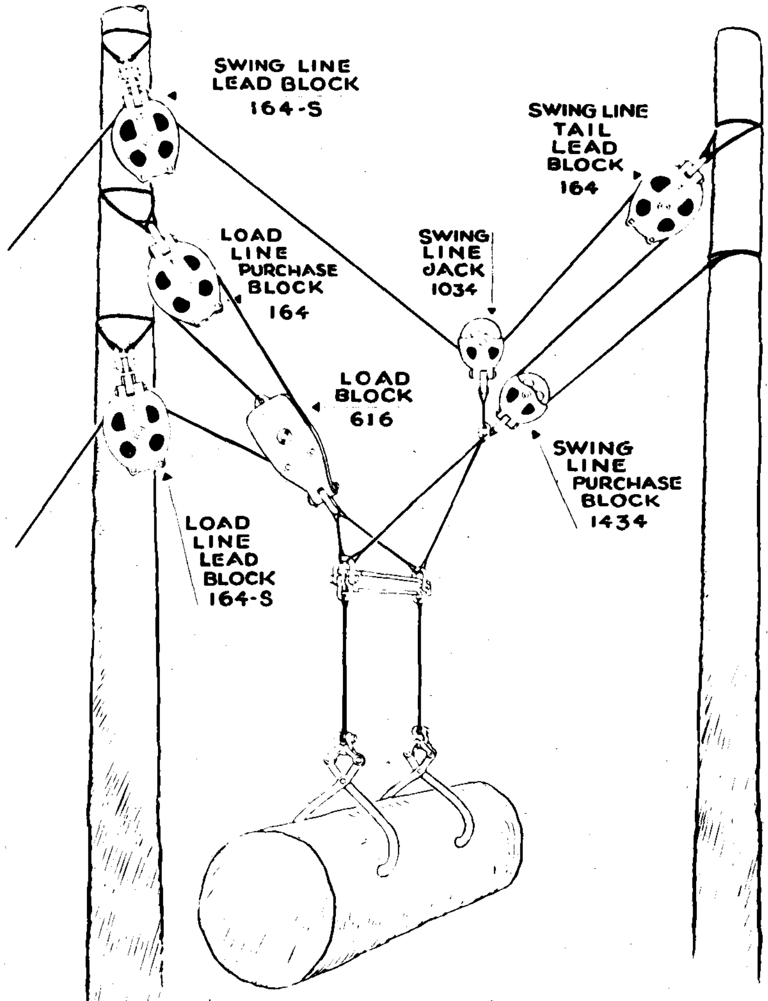
Fig. 24

adaptability for pre-loading logs. The steadiness with which logs are handled by the boom makes pre-loading possible. Its disadvantages are: (1) it takes time to rig which would be of great consideration in sparse stand, (2) slow operation, (3) needs a wide landing near the spar tree where the truck may be backed so that it would not interfere with traffic. This is necessary because this method could not load a truck placed parallel to the road. Figure 27 shows the rigging of the McLean boom system.

For short and small logs and in connection with animal and tractor skidding, skidways made of crib work of logs are employed for loading by hand among small operators. Figure 28 shows a crew of men loading short logs on a truck rolling the logs on the skidway with peavies. The skidways is easy and inexpensive to build. One could be built with logs by the use of three men with the help of a tractor in one-half a day.

Self-propelled loaders are not so widely used in the Douglas fir region as those systems described above because of many reasons: (1) their initial cost is excessive which the average truck logger cannot afford; such units, factory built, could not be obtained for less than $25,000[1]

(1) Baker, *op. cit.*, p. 18-19.




CROTCH LINE LOADING

Fig. 26 Spreader Bar Rigging
(Modification)

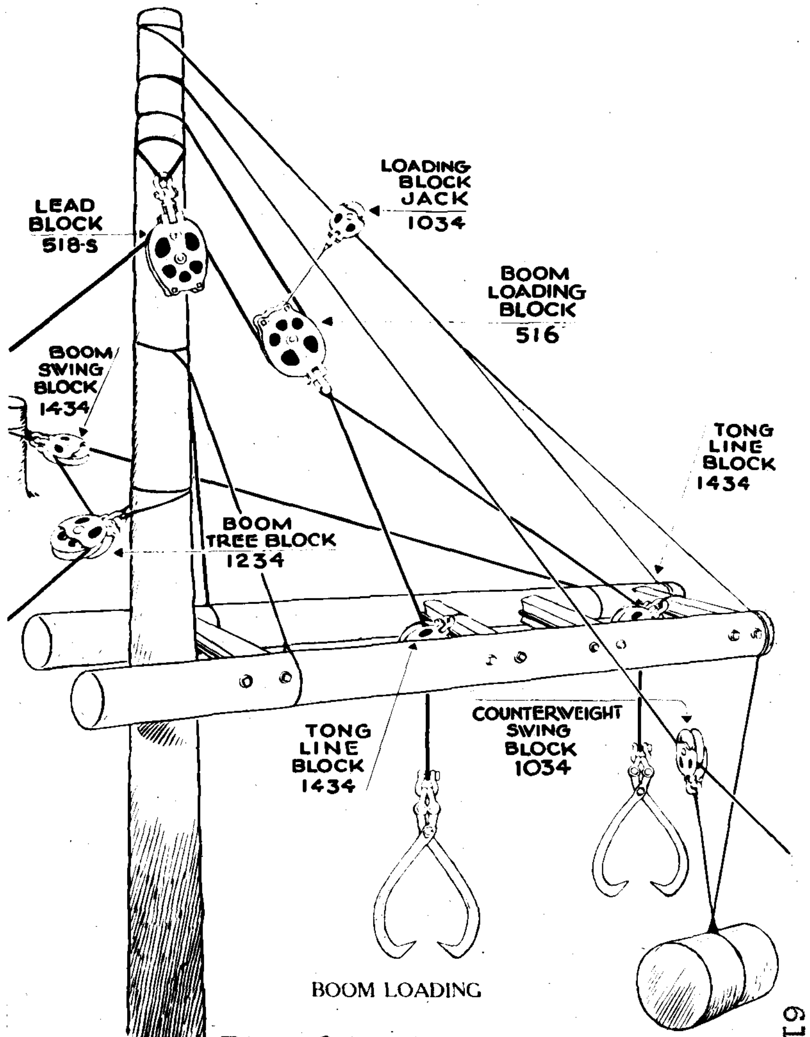



Fig. 27 Rigging-McLean Boom

Fig. 28 Loading Truck from a Skidway.

(2) fir logs are heavy and long and require a strong rig to load it, and (3) topographic conditions are too steep to permit economical use of self-loaders which require a flat country where logs may be brought alongside the road at any point.

The practice of pre-loading is taken advantage of by certain loggers to reduce the loading time. Pre-loading is a great time saver in cases in which the interval between the arrival of empty trucks for loading is long. It is done by placing the logs on two false bunks placed on two parallel logs 40 feet long and spaced so that a truck could be backed between them. The forward end of the load is raised while an empty truck is backed to receive the premade load. Pre-loading also allows the building of a bigger and more balanced load than when ordinarily and hurriedly done.

Cost of loading.

According to studies of Rapraeger, (1) the spreader bar and the McLean boom systems could load from 50,000 to 100,000 board feet a day. With a 30 h.p. gasoline engine of $20.00 machine rate per 8-hour day, (2) loading would cost $ .20 to $ .40 per thousand board feet. There

(1) Rapraeger, op. cit.
(2) Axel J. F. Brandstrom. "Analysis of logging costs and operating methods in the Douglas fir region. " Publication of the Charles Lanthrop Pack Forestry Foundation, June, 1933. pp. 59.

is a big effect of size of logs in the cost of loading. Also, interrupted loading is costly. Higher cost due to longer time consummed in actual loading may be reduced by pre-loading. The following table from Brandstrom (1) which may be applicable in a truck logging operation shows the effect of logs size on the cost of loading and the effect of interrupted loading.

(1) Brandstrom, op. cit. pp. 59.

Table VII

Relation of size of logs to cost of loading and relation of interrupted operation to the cost.

| Volume of logs M. ft. b.m. | 30 h.p. crotch line (operating cost $20 per 8-hour day). Loading independent of yarding. | 10"x12" loading donkey operating cost of $52.50. Loading controls yarding | 10"x12" loading donkey operating cost $52.50 yarding controls loading |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| 100 | $ .67 | 1.31 | 2.57 |
| 200 | .37 | .66 | 1.31 |
| 300 | .26 | .44 | .88 |
| 400 | .22 | .33 | .67 |
| 500 | .19 | .27 | .54 |
| 600 | .17 | .23 | .46 |
| 800 | .14 | .16 | .36 |
| 1000 | .13 | .15 | .29 |
| 1200 | .12 | .13 | .25 |
| 1400 | .11 | .11 | .21 |
| 1600 | .11 | .10 | .19 |
| | | .09 | .17 |
| | | .09 | .16 |

As the volume increases the cost per M in each size class decreases. A large volume in one log is cheaper to handle than the same volume made by many small ones. It is also seen that under column four in the table where the loading was delayed by yarding, the cost is higher than when loading was done uninterrupted under column three.

## HAULING

Hauling deals with the operation of bringing logs to market. The efficient performance of hauling is that condition in which the truck runs continuously. To have this, all the phases of hauling must be considered.

### Determination of the number of trucks to be used in a truck operation.

The amount of timber to be delivered daily, the length of haul, the speed of trucks and the capacity of trucks determine the number of trucks needed in a certain operation. This calls for the examination of road conditions-- grades, surface, width, as well as legal restrictions on hauling if public highways are to be used. A knowledge of this information would allow the amount of timber that could be hauled per trip of the truck. Table VIII on the following page shows the result of studies of Truman Collins (1) which shows speed of trucks of different sizes, load, motor with load and without load on a gravelled road of different grades. From data like this the time it takes a truck to make a round trip could be computed. The round trip time plus time spent for loading and unloading and an allowance for delays make the total time required to deliver a load of logs. The total delivery per day, per month or per year could be computed and given a

(1) Truman Collins, "Light and heavy trucks". The Timberman Vol. 38, No. 12, Sept. 1937, p. 60-61.

Table VIII

Hauling Speed of Loaded and Empty Trucks on Different Grades of a Winding, Gravelled, Good Surfaced Road.

| Grade of Road %. | Chevrolet W/dual axle trailer Motor-206 cubic inches | Mack W/dual axle trailer. Motor-309 cu. in. | Federal W/dual axel trailer Motor-404 cu. in. | Fageol-Diesel W/ dual axle trailer Motor-672 cu. in. |
|---|---|---|---|---|
| | Load : 3200 bd.ft. speed M/hr. | Load:4400 bd.ft. Speed M/hr. | Load:4800 bd.ft. speed M/hr. | Load:9400 bd. ft. speed M/hr. |
| -2 | 23 | 22 | 22 | 22 |
| -4 | 17 | 20 | 20 | 21 |
| -7 | 9 | 11 | 11 | 17 |
| 0 | 11 | 10 | 11 | 13 |
| +3 | 8 | 6 | 7 | 9 |
| -8 | 9 | 10 | 10 | 16 |
| +4 | 7 | 5 | 5 | 5 |
| -8 | 4 | 5 | 6 | 8 |
| | Empty | Empty | Empty | Empty |
| -2 | 25 | 25 | 28 | 26 |
| -4 | 14 | 11 | 17 | 16 |
| -7 | 11 | 8 | 10 | 12 |
| 0 | 23 | 19 | 23 | 22 |
| +3 | 21 | 18 | 22 | 20 |
| -8 | 12 | 8 | 12 | 14 |
| +4 | 22 | 20 | 25 | 20 |
| -8 | 7 | 6 | 7 | 9 |

Note:

- indicates down grade favorable to the load

+ indicates adverse grade against the load certain volume of logs to be delivered a year, the number of trucks required in the operation is obtained. Extra trucks should be provided to be used as alternatives in case other units are to be repaired.

What drivers should know.

Efficiency in driving a logging truck requires that a driver know what precautions to take to avoid accidents and the requirements of his truck as well as truck logging regulations provided for by statutes.

Legal restrictions on log hauling over public highways in Oregon

With the increase of the use of motor trucks as a carrier over public roads, it was necessary for the government to promulgate restrictions for the use of public roads. The Oregon State Highway Commission, which has administrative control over public highways, in defining its policy declared that these restrictive measures are necessary in order to: (1)

> "1. that highways may be rendered safer for the use of the general public.
> 2. that the wear of such highways may be reduced.
> 3. that minimum of inconvenience to other users of the highways may be effected.
> 4. that minimum hindrance and stoppage to other users of the highways compatible with needs of the public for adequate transportation service may be effected.

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(1) Motor Transportation Act. Chapter 429 as ammended 1935, pp. 3.

5. that the highways may be safe guarded from improper and unnecessary usage.
6. that the operation of irresponsible persons or any other operation threatening the safety of the public or detremental to the general welfare be prevented.
7. that the disarimination in rate charged may be eliminated.
8. that conjestion of traffic on the highways may be minimized."

It is necessary that truckloggers know the laws, rules and regulations governning truck log hauling to avoid penalty and delay of operation. The following are pertinent provisions of transportation and vehicle laws of Oregon (1).

1. Log hauling permits are issued by the Public Utilities Commissioner upon recommendations of the State Highway Commission. If the over-all length of the load does not exceed 50 feet, no further permit is required. Otherwise, a permit to run for 30 days for hauling logs maximum length of 110 feet, must be secured from the State Highway Commission, with public liability insurance in the amount of $50,000 to $10,000, property damage insurance in the amount of $10,000 with the State of Oregon and its State Highway Commission, jointly and severally, as parties assured. (2)

2. It shall be unlawful for any person to operate trucks for hauling logs, poles and pilings without first

(1)Earl Snell, "Motor Vehicle Laws of Oregon", Compilation Edition 1937, State Print. Dept. Ore., pp. 16,17,81,103.
(2)Letter of Sec. St. Highway Comm., Ore., May 4, 1939.

applying for and obtaining in addition to the license required by law, a permit. The application should state ownership, equipment to be used, the light and combined weight and character of load to be transported, loading and unloading point and route of travel.

3. The applicant is required also to fill out a form with the Commission a policy of public and property damage issued by an insurance company for such limits of liability, term, condition and provision as the commission may determine to be necessary for the reasonable idenmnification of the patrons of the applicant and of the public against damage and injury for which the applicant may be liable by reason of the operation of any motor vehicle.

4. Financial obligations to be paid.

a. Application $2.50 each vehicle.
b. Yearly registration fees based on light weight of the vehicle. (weight of chassis, cab and body).
    1. weighing not over 2,000 pounds
        $ .30 per 100 lbs or fraction.
    2. weighing 2,000 to 3,000 pounds
        $ .50 per 100 lbs or fraction.
    3. weighing 3,000 to 4,500 pounds
        $ .70 per 100 lbs or fraction.
    4. weighing 4,500 pounds and over
        $ .90 per 100 lbs or fraction.
    5. Diesel truck
        $1.50 per 100 lbs or fraction.

5. Size of vehicle and load
a. no vehicle unladen or with load may exceed a height of 12½ feet.

b. over-all length not to exceed 50 feet.
c. width not to exceed 8 feet.

6. Weight of vehicles and load

a. When total width of tire is less than 30 inches, combined weight of load and vehicle not to exceed 500 multiplied by the sum of the width of the tires.

b. When total width of tire is over 30 inches, the combined weight of the load and vehicle shall not exceed the product of 600 multiplied by the sum of the width of the tires.

c. No motor track is allowed to drive on public highways with more than a maximum individual wheel weight unladen or with load in excess of 8,000 pounds on unpaved roads and 8,500 pounds on paved roads or an axle weight not in excess of 16,000 pounds on unpaved roads and 17,000 pounds on paved roads, with a maximum of vehicle and load not to exceed 54,000 pounds.

However, H. B. 542 passed by the Fortieth Legislative Assembly of Oregon which adjourned on March 15, 1939, allowed 10 per cent tolerance weight to the above load limits making a maximum allowable wheel weight limit (tolerance weight) of 9,000 pounds for unpaved roads, 9,500 pounds for paved roads, a maximum axle weight to be 18,000 pounds and 19,000 pounds for unpaved and paved roads respectively, and a maximum vehicle and load weight not to exceed 59,400 pounds. The intent of this act is that these permissible excess weights shall be deemed tolerance weight and not arbitrary increase in gross weight to those set by statutes under Section 55-

2704, Oregon Code 1935 Supplement (1). However, in a conference held on May 5, 1939 in which legislators, loggers, police forces, the Public Utilities Commissioner and State Highway Commission were present, the basis for arrest would be the tolerance weight, that is 10 per cent increase to those allowed by statutes. The following punishment to violators have been promulgated. (2)

1. First offense--suspension of violator's license for five days.

2. Second offense---suspension of violator's license for 10 days.

3. Third offense---suspension of violator's license for 15 days.

4. If violators refuse to surrender their license, the Public Utilities Commissioner will cancel license automatically.

5. Violators are also liable to fines as the court may prescribe.

The following rules are also issued for compliance of operators. (3)

1. Bunks of truck hauling logs shall be straight or concave upward.
2. Such bunks shall be provided with chock-blocks not less than 8 inches in height when in position holding the load.
3. Loads shall be secured with ties of minimum

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(1) *op. cit.*, p. 105.
(2) Circular issued by Oregon State Highway Commission as a supplement of H. B. 542 passed March 15, 1939.
(3) P.U.C. Oregon Order, No. 3069 as amended by P.U.C. Oregon Order No. 3423.

breaking strength of at least 10,000 pounds, one tie entirely surrounding the load and the rear tie to be fastened to the bunk of the trailer. Short logs not included in these two ties to be tied to the main load.

## Control of hauling

Efficient truck haulers control their hauling through a system of cost recording. Accurate cost data are important for management. From it comparison could be made with different types of equipment, thus enabling the operators to select the most advantageous unit. It also gives enough data for the promotion of contest between drivers in securing the most economical operation.

Examples of an efficient cost recording is that practiced by the Grand Rond Pine Company, Pondosa, Ore. (1) All the operating cost and amount of timber hauled for each truck unit is recorded individually. The foreman approves the time of the drivers, the scalers provide the amount of logs hauled and the truck mechanics look after the repair and consumption of oil, fuel and other supplies. Figure 29a shows the form to be filled for each month for each truck unit to record cost on operating labor, gasoline, and oil consumption, repairs, labor, repair parts, and tires. Figures 29b and c give the history of eabh

(1) Truman Collins, "Forms and records for truck logging". West Coast Lumberman, Vol. 65, No. 4, April 1938, p.23.

Form No. 1

Fig. 29a

Cost Statement TRUCK HAULING

------ ------
(Month) (Year)

Truck No. ---- Driver ----------

| | This Month | This Yr. to Date |
|---|---|---|
| Number of Trips | | |
| Total Footage Hauled | | |
| Average Load Per Trip | | |

Mileage End of Month--
Mileage First of Month--
Mileage for the Month--

| | Notations | This Mo. | Per M. | Last Mo. | Yr. to Date | Per M |
|---|---|---|---|---|---|---|
| Operating Labor | | | | | | |
| Repairs-Labor | | | | | | |
| Repairs-Parts | | | | | | |
| Gas & Oil | | | | | | |
| Sub-Total | | | | | | |
| Tires | | | | | | |
| Grand Total | | | | | | |

Form No. 2

TIRE RECORD Company Fig. 29b

Make -------- Size --------- Ply ------

Serial No. -------- Cost------

| Truck No. | Wheel Position | Beginning Mileage | Date Installed | Ending Mileage | Date Removed | Net Mileage | % Good | Cause of Removal | Repaired By | Cost of Repair |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Cost per Mile- Total Mileage------ Total Cost---------

Make ------------ Serial No. -------------

Form No. 3

LUMBER Co.

TIRE CHANGE SLIP Fig. 29c

Truck No. ---- Date --------

| | TIRE OFF | TIRE ON |
|---|---|---|
| Make | | |
| Size | | |
| Serial No. | | |
| Per Cent Good | | New------Repaired------ |
| Wheel Position | | Tube--New----Used------ |
| Speedometer Reading | | |
| Cause for Removal | | |

Remarks: ____________________

Signed ____________

tire. When kept over a period of one year, the data gives a very accurate basis for the choice of the best tire that should be used. The mechanics and truck driver fill out these forms.

Dispatching trucks: another phase of hauling that needs control is the dispatching of trucks. There should be enough time allowed between trips to allow the loading of each truck and there should also be enough trucks to keep the loader busy. Christensen (1) found that on a 13-mile round-trip haul, their loading could keep four trucks busy all of the time; on a two-mile round trip haul, two trucks are necessary, and on a 25-mile round trip haul 8 to 10 trucks are employed.

Factors affecting cost of hauling.

A. Size of logs. Cost of log hauling decreases with decrease in the sizes of logs hauled. Rapraeger (2) found that with one or two logs comprising the load, an average of 4,454 board feet was realized compared with 3,571 board feet from the same-sized load made up of seven to eight logs. Also, he proves with figures that smaller logs of the same species weigh more per thousand log scale than do the larger ones. For example, he found that Douglas fir logs 16 inches in diameter weigh 7,400 pounds per

(1) L. H. Christensen, "Road building". The Timberman. Vol. XL, No. 5, Dec. 1939, pp. 16,17-20.
(2) Rapraeger, op. cit. Vol. XXXIV No. 12, Oct. 1933, p.18

thousand board feet, Scribner Scale, and large logs, 30 inches in diameter weigh 5,700 pounds per thousand board feet, and consequently with smaller logs;smaller loads could be had at one loading than bigger ones. With less board feet contents in each load as affected by size and weight the cost of hauling per load is more per thousand board feet.

B. Length of haul. This item does not need explanation. Rapraeger (1) found for example that with a 1½ton truck drawing a trailer, it cost 63 cents to have a thousand board feet hauled two miles compared with $5.59 on a 30-mile haul; with a 3-ton truck, 49 cents on a 2-mile haul compared to $4.66 on a 30-mile haul.

C. Truck pulling a semi-trailer vs. truck alone. The average truck motor has power in excess of what is required to haul its rated load. With the use of a semi-trailer its load is increased to two or three times with only about 10 to 20 per cent increase in fuel, oil, and grease consumption. It is, therefore, very evident that truck and trailer combination is very much cheaper.

D. Heavy vs. light trucks. There is no data yet as to the comparative cost between heavy and light trucks. It is established, however, that each has its own field.

(1) Rapraeger, "Motor truck log hauling in Oregon and Washington". The Timberman. Vol. XXXIV, No. 11, Sept. 1933, pp. 18-22.

Heavy trucks give very low cost on hauling done on big timber over private roads. However, small trucks are more profitable in small operations using the public roads.

E. Kind of road---With steep grades, rough surface and sharp curves haulage is decreased with the added disadvantage of increased cost of operation.

F. Delays. Delays are caused by many factors and they increase the hauling cost.

**Method of Computing Hauling Cost**

Rapraeger's Method. (1) His method is shown in the following table.

Table IX

Operating Cost for Motor Truck 1½ ton capacity drawing a trailer (Based on an operating year of 180 eight-hour days).

| | | | |
|---|---|---|---|
| 1. | INVESTMENT | | |
| 2. | Chassis, f.o.b., Portland, Oregon | $745.00 | |
| 3. | Body, cab and special equipment | 146.50 | |
| 4. | Logging trailer with brake equipment | 603.00 | |
| 5. | GROSS INVESTMENT | | $1194.50 |
| 6. | Tire value(subtract) | 347.50 | |
| 7. | NET INVESTMENT | | 1147.00 |
| 8. | FIXED EXPENSES PER YEAR | | |
| 9. | Interest on net investment at 7% | 80.29 | |
| 10. | License and taxes (Oregon rate) | 68.65 | |
| 11. | Insurance: Fire and theft, property damage, public liability | 63.51 | |
| 12. | Storage | 120.00 | |
| 13. | Operating overhead and risk(20% of above items). | 66.49 | |
| 14. | TOTAL FIXED EXPENSES PER YEAR | | 398.02 |
| 15. | FIXED EXPENSES PER DAY(180 operating days a year) | 2.22 | |
| 16. | Driver's wage (8-hour day basis) | 4.00 | |
| 17. | TOTAL FIXED AND DRIVING EXPENSES PER DAY | | 6.22 |
| 18. | RUNNING EXPENSES PER MILE | | |
| 19. | Depreciation of net investment | 0.035 | |
| 20. | Gasoline at 18¢ per gallon | .025 | |
| 21. | Oil at 60¢ per gallon | .002 | |
| 22. | Tires, life expectancy, 10,500 mi. | .033 | |
| 23. | Maintenance and repairs | .016 | |
| 24. | Sundries, greasing, washing, etc. | .010 | |
| 25. | TOTAL RUNNING EXPENSES PER MILE | | 0.121 |

(1) Rapraeger, *op. cit.* pp. 16-24.

Item six, cost of tire, is considered as a running expense and is calculated at 10,500 miles life expectancy, with an expense per mile under item 22 of $0.033. Item 13 is 20% of the sum of items 9 to 12. Item 15 is the result obtained by dividing item 14 by 180 days. Item 19 is obtained by dividing item 7 by 33,000 miles, the life of the truck, depreciated on a mileage basis. It is believed that trucks should be depreciated on the mileage basis because logging trucks become obsolete through service. International Harvester Company, Portland recommends depreciation of logging trucks with the following rates:

For the first year------30 per cent.

For the second year------30 per cent.

For the third year------20 per cent.

For the fourth year------20 per cent.

Item 9, however, seems to be too much as it is based on net investment and not an average annual investment which may be computed by the following formula:

$$\text{Average annual investment} = \frac{(N\ \ 1)}{2N}\ I$$

Where N depreciation period
I initial cost

Considering four years as the depreciation period and $1147.00 as the initial cost, the average annual investment would be $717.87, which when multiplied by 7% would give only $50.18 instead of $80.29.

Knowing the mileage and haulage of timber in one day, cost per thousand board feet could be computed.

Truman Collins' Method.

Rule of thumb for calculating hauling cost:

| | |
|---|---|
| 1. Basic standby charge | $1.00 |
| 2. Add per M per mile | |
| company road unimproved | .17 |
| company road improved | .12 |
| Public road improved | .10 |
| Public road paved | .01 |
| 3. For each 1% adverse grade | .01 |

<u>Unloading</u>

Unloading in truck hauling is not a problem especially for small and short logs. The truck could easily be tilted by elevating one side of the road or by placing wedge-shape blocks of wood on the wheels at one side of the truck. In larger loads composed of larger and longer logs, however, a gin pole is rigged, and with power supplied by a small engine, logs are rolled from the truck. This method reduces damage to the truck. The engine used for unloading is employed to load the tracter on the truck for the return trip.

## MOTOR TRUCKS-NEW ADDITIONS TO LOGGING EQUIPMENT

Today the motor truck is recognized as important addition to logging equipment, probably as important as the locomotive, the donkey engine, and the tractor, and truck transportation had grown as highly economical in its field as are the railroads, the highlead and animal yarding in their own. Among the recognized fields in which trucks are employed in logging today are:

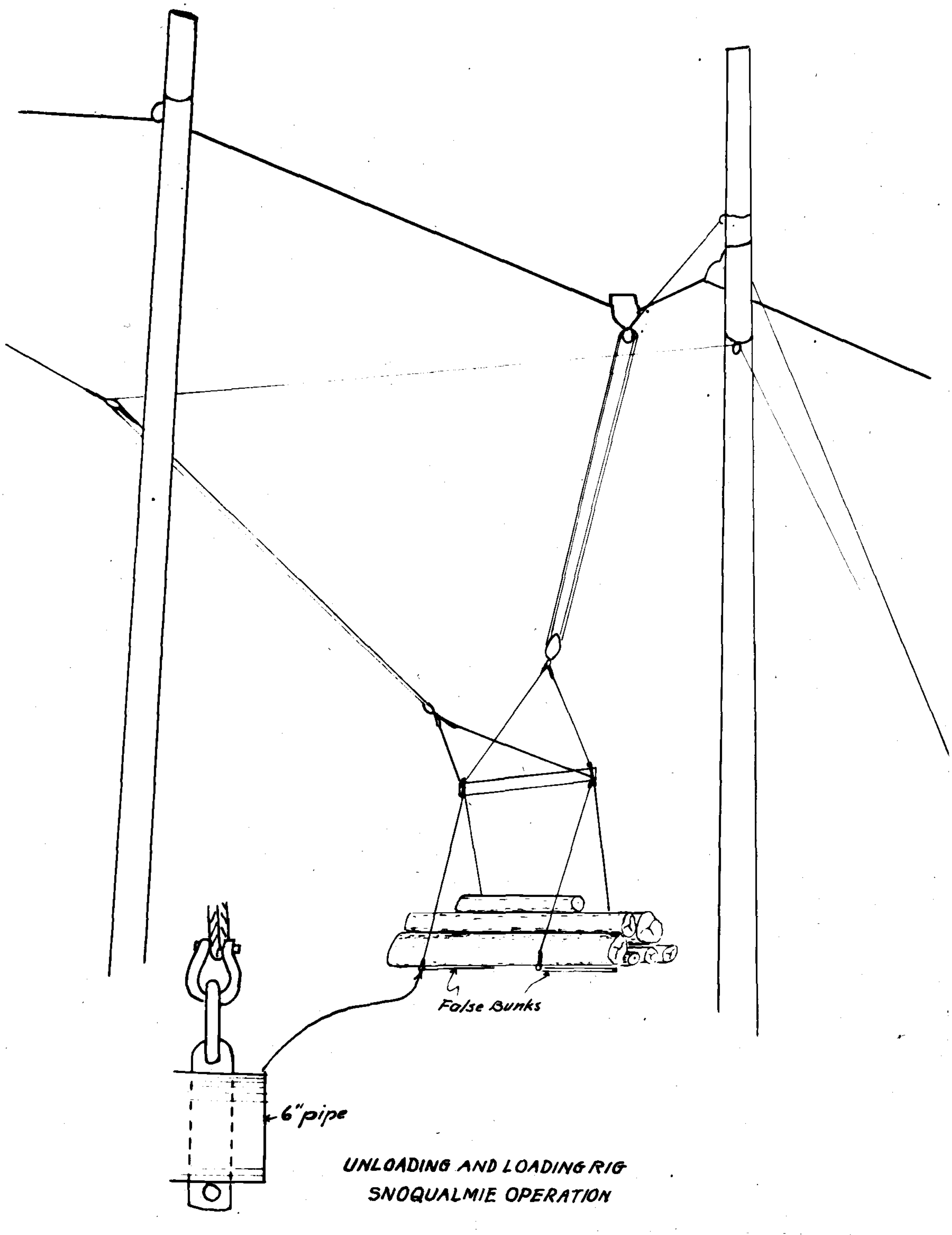
1. Logging with small timber is now a foregone conclusion that truck transportation serves the best means as a primary facility for transporting logs located in scattered small timber located on rough grounds. It is adapted for second growth timber and has been and still is the most economical method of transporting partial removal of the stand in selection forest and in places where damaged timber, due to insect infestation or fire occur. This is the case because of the flexibility of trucks, its low initial cost and its adaptability to hauling on public highways.

2. It has been demonstrated within the last eight years to be economical in logging big timber, the length of haul within certain limits. Trucks are no longer the instrument of "gyppo"loggers and small "strippers". Comox Logging and Railway Company, Ladysmith, B. C.,

Canyon Creek Logging Company, Granite Falls, Washington, Grande Ronde Pine Company, Pondosa, Oregon, and many other outfits have found big truck operations conducted on private roads highly successful with hauls up to twenty miles in length.

3. Of recent development is the use of motor trucks, light and heavy, as feeders of the railroads. Where grades are excessive and construction costs high, truck roads now replace railroad spurs. This brings the truck nearer to the stump reducing the skidding distance considerably. Road construction is easy and inexpensive since most roads that are used are dirt roads with high adverse grades and with sharp curves. "Impossible" areas for railroads are now logged by the use of trucks. The main objection in the truck-railroad combination is the too much delay incurred in unloading the load from the truck and reloading it on the railroad cars. This has been removed and by this time unloading and reloading could be done in two minutes, (1) by the Snoqualmie Falls Lumber Company, Snoqualmie Falls, Washington. Features of the Snoqualmie outfit are: the use of false bunks that lift full truck load to the railroad car, and that each truck load is constructed as one car load. Figure 30 shows the rigging of

(1) Editorial Article, "New Method of Handling Truck Logs", <u>West Coast Lumberman</u>. Vol, 65, No. 12, Dec. 1938, p.11.




(Unloading From Trucks and Loading on Log Cars)
Fig. 30

this outfit. Perhaps the most convincing testimony on the adaptability of trucks as feeders for railroads is that of Jacoby(1), when he said:

> "We loaded two trucks and trailers, one Ford and another light truck on the train and took them to the woods. We took out about six million feet with them. There was a stand of timber we could not get any other way and make money, and it proved to be a good way to bring logs in. It cost no more than swinging, in fact, it cost less".

4. The bringing of small mills, both circular and band, has been made possible by the use of trucks. Such small mills are numerously found on the Willamette Valley of Oregon, and in King, Pierce and Lewis counties of Washington. (2) Trucks bring the logs to the mills and have the sawed lumber sent to maket or to a manufacturing plant. Among the bigger mills operating in this way are, the Alexander Yakey Lumber Company, Prineville, Oregon, The Deer Park Lumber Company, Dear Park, Washington, and the Guistiana Brothers Lumber Company, Eugene, Oregon. These small mills are important factors to be considered in the lumber industry. With the disappearance of the wide solid stand, small mills will probably be the ones most used as is now practiced in the State of New York (3)

(1) Carl C. Jacoby, logging superintendent of C. D. Johnson Lumber Co., Siletz, Ore.
(2) E. J. Rapraeger, "Motor truck log hauling in Oregon and Washington". The Timberman, Vol. XXXIV, No. 12, Oct. 1933, pp. 18-24.
(3) Nelson Courtland ~~and~~ Brown, "The Small Sawmills in New York". Bulletin, No. 50 of the N.Y. St. College of Forestry, Syracuse University, Oct. 18, 1927, p.23-24

where second growth forest are the prevailing ones.

5. Another use of trucks in log hauling is the supplying of logs to big mills whose supply of accessible raw material had already been exhausted. Small timber owners and contractors had made possible the continued operations of these mills by bringing to them logs from different places by motor trucks. The Booth-Kelley Lumber Company, Eugene, Oregon, for example, is supplied by three different entities using motor truck to have logs direct to the mill partly on private roads and partly on the public highway.

The productive utility of trucks had been made possible because of several contributing factors. Good public roads are found everywhere not only on settled agricultural areas but also in timberland regions as well. They serve as main highways to which private roads branch.

The constructions of private roads are not hard. The introduction of tractors, bulldozers, shovels, and stumping dynamite had made road construction inexpensive and fast. Soil conditions---the stony and hard-pan character of the soil make possible the use of dirt roads during the dry season. An all-year-round road is economically possible to construct with planks and gravel which are readily available in most logging shows in the fir region.

The low initial investment needed to start logging with trucks together with the general knowledge of how to operate them had made the truck hauling industry a popular enterprise among the masses.

The engineering of the motor trucks had been developed by expert logging and mechanical engineers whose technique and experience had been spread over the country through the numerous lumber journals and government agencies like the different experimental stations and colleges of logging engineering.

Trucks vs. Railroads

The trucks vs. the railroad controversy is of interest to truck loggers. There are points worth while considering on both sides. One thing on which loggers agree and are sure of, however, is that trucks are undisputedly more economical to use in small, scattered timber located on rough country than railroads. In big amounts of timber, there is the controversy as to which would be better to use. As stated somewhere in this paper, several big logging companies are operating successfully with trucks over private roads with haul as long as 20 miles over rough grounds located on high elevations. In such conditions trucks seem to be favored. The length of haul is within the economical range of trucks with conditions of topography too expensive for railroad construction. The writer found that if, irrespective of topographic conditions, the haul is short, from five to fifteen miles, preference is made by most loggers to use trucks irrespective of the amount of timber to be hauled daily and the length of operation. In this connection, Filberg (1) believes that railroad transportation is less expensive than truck transportation but other factors have to be considered before a comparative merit of the two systems of logging may be fairly considered. He said:

> "Whatever merit there is to truck logging or any type of logging for that matter, must be comparative cost of logging from stump to pond and transportation is not usually the chief cost. If there is merit to truck logging it is in cheaper construction, short yarding and greater mobility than railroad logging. The main advantage of truck logging as I see it is the breaking down of production units from the big expensive sides used in railway logging to more and smaller units in truck logging, thereby permitting a steady and more even production without the peaks and valleys. When big production units goes "hay wire", or a locomotive breaks down or is in the ditch, the delays are fearfully costly because all production is effected. With truck logging and smaller units, one or more trucks can break down and one or more small units can go "haywire" and still sustain nearly normal production. Steeper grades and sharper curves permit cheaper roads than railroads and thereby make yarding possible and long yarding of any kind inexpensive and difficult.
> Trucks are so mobile and flexible that wherever there are logs to be loaded the trucks can be sent quickly and easily. In railway logging, how often do we find one side short of emptys and another side with more than one needed."

(1) Robert Filberg, Manager of Comox Logging and Railway Company, Ladysmith, B. C.

On the side of the railroad, it would be more advantageous to use it when: the haul is long--say 30 to 50 miles; it is used to haul a big body of timber; when a very large volume of logs is to be delivered daily. The big gain in hauling by the use of railroads over the use of trucks is shown by the following studies of Brandstrom. (1)

<u>Relative Costs per M Feet between trucks and railroad.----</u>

| Method of Transportation | Cost for distance as noted in dollars |
|---|---|
| 1. Motor trucks hauling on poor or steep roads--average as to the hauling for a distance of three miles................ | $1.25 |
| 2. Motor trucks hauling on good roads (public highways). Average hauling distance 10 miles................................... | 1.75 |
| 3. Logging railroad spur transportation, average haul three miles................ | .30 |
| 4. Logging main line--average haul 20 miles.. | .80 |

As shown above, railroad transportation is less expensive by one-half to one-fourth that of motor trucks, and the rate of increase in cost with the increase of length of haul is not as big as in the trucks. In the

(1) Brandstrom, <u>op. cit.</u>, pp. 72.

case of trucks using Collins data of $ .10 increase per M per mile for each mile increase in haul, and using the standing charge in (2) above, the total cost per M for 50 miles would be 40 x $ .10 + $1.75 or $5.75 compared to $2.00 in railroad or about three times; or, if we use the per mile cost in (2) as the basis for computing the total cost for a 50 mile haul, it would cost $9.00 per M as compared to $2.00 in the railroad.

It may be said, therefore, that length of haul would be the most important criterion in the consideration of whether trucks or railroads are to be used in a certain operation.

Trucks vs. Tractors

Another controversy is the use of truck or tractors as feeders of railroads. Brandstrom (1) found that tractor could better be used within one mile to feed railroads, but beyond that hauling should be done by trucks. Trucks have the disadvantage in short hauls in road constructions in addition to cost of loading and unloading.

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(1) Brandstrom, *op. cit.*, pp. 72.

## PHILIPPINE CONDITIONS AND TRUCK LOG HAULING

### The Philippine Forest

One of the most valuable natural resources of the Philippines is her vast forests. Fifty-seven per cent of the total land area of the islands, or 45 billion acres, is covered with forest, 97½ per cent belonging to the government. It has an estimated stumpage value of four billion dollars, which, when managed and utilized properly, would support one third of the expenditure of the Philippine government.

The forests are typically tropical, mixed in composition, and belonging to six distinct types. There are about 3,000 species of trees that attain a diameter of one foot, but only about sixty of these are brought to market at the present time. The Dipterocarp family, which produces what is commercially known as "Philippine Mahogany," constitutes 75 per cent of the total stand and 90 per cent of the total volume. This species grows in thick stands making it possibly economical to use modern methods of power logging to exploit it.

The total stand of the Philippine forests is estimated at 465 billion board feet with 8,000 to 85,000 board feet stand per acre in the Dipterocarp forest, averaging 60,000 board feet per acre. The boles of miscellaneous species are short and crooked, but in the Philippine Mahogany group, they are usually long, ranging from 32 feet to 132 feet of clear length, with diameters from 12 inches to six feet; they are usually sound free from too many knots but of considerable weight, ranging from 40 to 75 pounds per cubic foot of green lumber compared to 38 pounds per cubic foot in Douglas fir. Retail price of Philippine Mahogany red, retail price at Corvallis, is $350 per thousand board feet.

Climate

The climate of the Islands is tropical with abundance of rainfall. The Philippine Archipelago may be divided into climatic regions, namely: the seasonal region, non-seasonal region and intermediate. The seasonal region has heavy continuous rain for six months causing the flooding of rivers and streams, with little or no rain in the other half of the year. Logging by trucks during the rainy season is impractical but very profitable when done during the dry months. Average annual rainfall is about 86 inches. In the non-seasonal region, the rain is widely distributed throughout the year, making the ground always wet and muddy. Average annual rainfall is 121 inches. In this place the rivers are always filled with water very adaptable for floating logs. It would be impractical to construct gravel road for truck hauling, but it would be all right to construct plank roads. In the intermediate belts moderate rainfall comes in six months with little rain distributed in the other months. Average annual rainfall is 98 inches. In these places it is possible to operate trucks on gravel roads both in the dry and rainy season and with dirt road in the dry months. The temperatures range from 60° F. to 101° F. with an average for the island of about 75° F. The coldest months are January, February and March which may be comparable to spring in Oregon, with practically all the rest of the year with warm climate. Another characteristic of Philippine climate is the presence of annual typhoons during the months of September, December, January and February. This is an important consideration in the location of shipping points for logs and lumber. Most lumber and logging docks are located in protected harbors. The following places, famous for their logging and lumbering operations, with average annual rainfall and the number of months of dry season obtained from the report of the Weather Bureau, Manila, (1) are given to compare rainfall in different regions:

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(1) Miguel Selga, "Observations of Rainfall in the Philippines", Weather Bureau Report, 1935, Bureau of Printing, Manila. pp. 24, 33, 43, 54, 58, 115, 172, 175, and 241.

TABLE X

| Place | Average Annual Rainfall | No. of dry Months. |
|---|---|---|
| Seasonal region: | | |
| Calapan, Mindoro Is. | 86 inches | 6 |
| Solsona, I. N., Luzon Is. | 86 " | 6 |
| Intermediate: | | |
| Cotabato, Cotabato, Mindanao | 87 " | 5 |
| Cateel, Davao, Mindanao | 169 " | 5 |
| Cagayan, Or. Mis., Mindanao | 64 " | 6 |
| Cadiz, Occ. Neg., Negros | 75 " | 7 |
| Non-seasonal: | | |
| Davao, Davao, Mindanao | 81 " | Practically no dry months. |
| Butuan, Agusan, Mindanao | 92 " | " |
| Ragay, C. S., Luzon | 132 " | " |
| Baler, Tayabas, Luzon | 129 " | " |

Topography and Soil

The Philippines is young geologically with rough topography. The abundant rainfall causes strong currents on streams that erode the land surface cutting numerous deep valleys and sharp ridges that offer problems to engineers in road construction. In general, the slopes are shorter but steeper than those found in the Douglas fir region.

In most timberlands the soil is clay to clay loam reaching a depth of one and one-half feet. The Mahogany group of the Dipterocarp family grows mostly on this kind of soil with the harder species on the rocky areas. Stones are plentiful in stream bottoms. Because of the abundance of rainfall and the loamy condition of the soil, most logging shows are muddy during the rainy season. And in places where the rainfall is widely distributed throughout the year the ground is always wet, making it very hard to truck logs. In seasonal and intermediate zones where there is no rain part of the year, the ground is hard and logging by trucks could be done on earth roads.

Transportation

The Philippines is composed of many islands and inter-island shipping is an important factor in transportation. Native marine companies control local shipping that is maintained regularly on schedules between important ports of the islands. These boats carry inter-island commerce, load products from place to place including logs and lumber. Freight is usually high. It is very hard to transport logs and lumber from place to place especially if the places of operation are in remote places not on the port of call or not connected with road to the port of call. For this reason, the big lumber mills have their own cargo boats to move their lumber, logs and supplies. Land transportation is done by railroads and roads on the islands of Luzon, Cebu and Iloilo, and motor roads in the other islands. The government has been spending big sums of money for the construction of roads especially in Mindanao, second largest island, to reach unpopulated areas. (1) Transportation by airplane is carried from Manila to important points.

## The logging industry

The public forests are not sold but are utilized under a license system. Small licensees operate under a yearly license while big concessioners on a 20-year period renewable for the same time. This system of exploitation gives the lumberman or logger enough chances to make profits. He pays no taxes for stumpage; he is not required to burn the slash; he has low wages for labor; and he does not pay so many taxes. He is, however, required to pay forest charges on all the merchantable trees he cuts, whether he utilizes them or not. A diameter limit is set below which he cannot cut, but the statutes do not forbid him to clearcut, and the diameter limit restriction is not enforced at all. Forest charges are ₱1.25 per cubic meter (424 bd. ft.) for the first group, ₱.75 for second, ₱.50 for third, and ₱.25 for fourth.

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(1) The government spent ₱500,000 in 1937 for road construction of roads in Mindanao alone to reach remote regions. The government also contemplates to spend ₱48,070,650 in a four-year program for public works from 1938 to 1941, according to the annual report of the President as of Dec. 31, 1937, p. 28.

The lumber industry is a big industry in the islands. It ranks fifth in amount of capital invested; fourth in value of production; second in number of employees, and third in monthly wages, compared with other industry. There were 111 sawmills and power logging operations and 1,606 small operators in 1935. Lumber is exported to the United States, Australia, China, United Kingdom, Japan and Europe with most of the logs sent to Japan, Australia and the United States.

Labor is not a big problem in the Philippines. The Filipino labor is easy to direct and learns easily. They work for low wages, as low as $.50 per 8-hour day. Most of the laborers in the lumber industry do not belong to labor unions.

Methods of logging. Methods of logging are still antiquated among small operators. Timbers are still abundant on level places near navigable streams, near the seacoasts, and newly constructed roads and hand rolling and water buffalo sled hauling are used to move logs. In very rough country in the pine region aerial tramways are used. The big mill and logging companies, however, employ power equipment like the railroad, donkey engines, tractors and of very recent introduction--the motor truck, with the railroad and donkey engines still the rule. There are two big companies and some small licensees using trucks for log hauling, but their operations are not managed and conducted on a modern basis. The use of the truck without the trailer is the general practice.

The slow introduction of trucks as additions to modern logging equipment in the Philippines is due to many factors. Engineering the logging truck and truck logging shows is not generally known by local loggers, both big and small operators. The Philippines is not as highly mechanized as the United States, and operating motor trucks is not as easily done as it is here. Dissemination of modern logging methods is slow as Philippine loggers are not organized. They have no congresses, no lumber journals and no experimental stations to help them solve their problems. Of course, American operators and some big Filipino firms take advantage of American journals, but other nationalities do not. And there are local conditions with peculiarities that could only be solved by local study and application. As shown elsewhere in this report conditions of climate, topography, soil, transportation, labor and timber are different from those of the United States, and operating conditions must be different.

The latest development in truck engineering is not available, especially in remote regions. Local truck dealers carry only factory models imported from the United States. Trucks cost more in the Islands than in the United

States by 30 to 40 per cent more because of importing costs.

Excessive rainfall keeps the soil soft all the year around in some places, making it costly to construct roads and operate trucks. Hard and stony dry soil in Oregon and Washington are generally the contrast of most timberland soils and operating trucks have to be done on plank roads or else operation must be done during the dry season.

However, log truck transportation should be popular under many favorable factors. Public roads are found all over the islands and new ones are being constructed to reach remote places making the timber accessible. Trucks could very well serve as secondary transportation on short hauls to bring logs to the coast, navigable rivers and to public roads. Stumpage is not sold, and with a small capital that is needed to buy trucks, the smaller capitalists could easily go into the logging industry. It is a profitable industry. The big logging companies should use trucks to log hard areas. The writer knows operations that have have "impossible" shows with their railroad that could be logged profitably by trucks. Stringent laws and regulations governing log hauling on public roads are not existing and one could use the road as freely as he wants. Fees, licenses and taxes are nominal. No liability and property damage insurance are required. Small mills supply lumber for the local markets and the mining industry would be served best by the use of trucks.

## COMPUTATION OF TRUCKING COST IN THE PHILIPPINES

| | | | |
|---|---|---|---|
| 1. | INVESTMENT | | |
| 2. | Chassis, f.o.b. Davao, P.I. (add 30% to Portland price)..... | $968.50 | |
| 3. | Body, cab and special equipment (add 30% to Portland price)............................ | 190.45 | |
| 4. | Logging trailer with brake equipment(add 30% to Portland price)........................... | 783.90 | |
| 5. | GROSS INVESTMENT...................... | | 1942.85 |
| 6. | Tire value (subtract) (add 30% to Portland price)............... | 451.75 | |
| 7. | NET INVESTMENT (amount to be depreciated)..................... | | 1491.10 |
| 8. | FIXED EXPENSES PER YEAR | | |
| 9. | Interest on net investment per year......................... | 104.38 | |
| 10. | License and taxes (P.I. rate)... | 76.00 | |
| 11. | Insurance: Fire and theft; property damage; and public liability......................... | | |
| 12. | Storage......................... | 50.00 | |
| 13. | Operating overhead and risk (20% of above item).................. | 46.08 | |
| 14. | TOTAL FIXED EXPENSE PER YEAR........ | | 276.46 |
| 15. | FIXED EXPENSE PER DAY (basis of 180 operating days per year)........ | 1.54 | |
| 16. | Driver's wage (8-hr.-day basis.. | .90 | |
| 17. | TOTAL FIXED AND DRIVING EXPENSES PER DAY ($B.22 U.S.)............... | | 2.44 |
| 18. | RUNNING EXPENSES PER MILE | | |
| 19. | Depreciation on net investment.. | .046 | |
| 20. | Gasoline at $ .34 per gallon.... | .047 | |
| 21. | Oil at $ .90 per gallon......... | .005 | |
| 22. | Tires, life expectancy 10,500... | .043 | |
| 23. | Maintenance and repairs......... | .002 | |
| 24. | Sundries, greasing, washing, etc | .005 | |
| 25. | TOTAL RUNNING EXPENSE PER MILE ( $ .121 U.S.)................. | | $ .156 |

<u>Considering a 5-mile haul:</u>

| | Philippines | | U. S. |
|---|---|---|---|
| Truck could make 8 trips a day ($ .156x8) | $ 12.48 | ($ .121 x8) | 9.68 |
| Total fixed and driving expenses per day.................. | 2.44 | | 8.22 |
| Total expenses per day | 14.92 | | 17.90 |
| Amount of timber hauled (P.I. 2.28M per load) | 18.20 | U.S. 3M per load | 24.00 |
| Cost of hauling per M. bd. ft........ | .82 | | .72 |
| Price of lumber per M. bd. ft............ | 350.00 | | 35.00 |

Price of lumber hue is based on Corvallis, Oregon, retail price.

The computations above show a comparison of the hauling cost of 1½ ton logging truck pulling a trailer using "Philippine Mahogany" logs as the basis for computations in the Philippines and Douglas fir in the United States. The total fixed and driving expenses per day for Philippine hauling is very low compared with United States cost, but because of the high price of gasoline and oil and the smaller board feet load of the Philippine truck, it being able to haul only 2,280 board feet per trip as compared to 3,000 board feet United States load, because of weight differential, Philippine log weighing 50 pounds per cubic foot compared to 33 pounds United States, the cost of hauling per M is lower in favor of Douglas fir. Philippine Mahogany, however, costs ten times that of Douglas fir, and, consequently hauling cost for Philippine Mahogany logs is lower in proportion to the price, which, this case should be the ultimate basis of comparison.

## CONCLUSION

The present motor truck has proved very definitely its usefulness in log transportation in the Douglas fir region of the United States and is highly recommended for wide use in the Philippine logging industry. It is a big industry that gives many people employment and brings revenues to the government and should be further developed by the introduction of modern equipment.

The truck unit presently used in the Philippines for logging is not efficient, hence unpopular, because it is not engineered properly. The trailer and other accessories of the logging truck in its latest development in the Douglas fir region must be incorporated in the factory model to fit it for profitable operation. This study recognizes the importance of good roads as a requisite to a successful truck logging operation and better and more adapted roads than those presently used in the Islands should be constructed. The knowledge and technique used in road building in the Douglas fir region is highly developed and should be adopted. Tractors, bulldozers, shovels and stumping dynamite should revolutionize the present slow and antiquated method of road construction by man and animal power. The writer knows of many operators who went into actual logging without planning the operation carefully ahead. It is not because of carelessness or lack of ability, but because of lack of technical guidance. It is urgent that the Bureau of Forestry intensify its drive in securing the approval of the government to establish forest experimental stations to conduct research and studies on forestry problems, including the advancement of the logging industry. No progressive logger in the Pacific Northwest can deny the beneficial results of the information given out by the Forest Experimental Stations obtained from its studies in the advancement of the lumber industry. Furthermore, the government should, in the School of Forestry, University of the Philippines, create a department of lumbering and hire experts to run it for the training of men especially in logging engineering, of which the supply of trained men is badly lacking. As the timber becomes more and more inaccessible, the need for more logging engineers to log it becomes more and more imperative. The logging industry is going to that stage soon, and the government should take it into consideration in the direction of forest education in the school.

The Philippine logging industry has problems that are inherently local that could only be solved by actual trial and study on the premises. It would be very beneficial if the Philippine loggers organize themselves for the purpose of looking into the progress of the industry. The efficiency of present logging methods and equipment of the Pacific Northwest were the results of constant study and application among the loggers themselves through the instrumentality of the Pacific Logging Congress. The present logging truck was developed in a big measure by the Congress. Then, with an association formed, a lumber journal could be published under its auspices for the dissemination of knowledge that would benefit everyone in the industry.

The only factor that may work against the increased use of trucks in the Philippines is the climatic condition. There is too much rain that renders the soil soft and wet, making construction and maintenance of truck roads expensive. Plank roads are found very profitable in the Douglas fir region and would undoubtedly be possible to use in the Islands on wet places. Operation could be suspended during the rainy season and resumed during the dry months.

With the low initial cost of trucks a licensee with a little capital should be able to go into the logging industry and make money. He will not have to buy stumpage and pay taxes on it, he will not have to abide to regulations in using the public roads for hauling, and he will have very low cost of labor. His length of haul will be short, using only very short private roads, because present timber is accessible to many public roads, to navigable rivers, and to the coasts, which would help to bring his logs to market very conveniently.

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