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INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER

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Evaluation of the Tanguay CC-100 Slasher

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FOREWORD

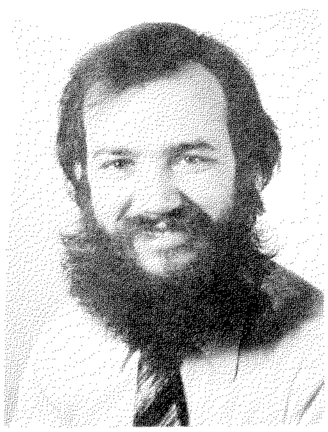
This technical note summarizes the results of a brief study of the Tanguay CC-100 slasher as well as the comments gathered from some of the users of this machine.

The timings, based on two restricted samples present but a limited range from the number of operating conditions which can exist. The results, related to specific cases, are used to indicate the machine potential and should only be applied to other conditions with caution.

In the interests of clarity and brevity, some results and observations are not presented, but may be obtained by communicating with FERIC.

The International System of Units (SI) was used in this report. A conversion table for the Imperial System of Measure (inch, pound) is annexed.

The author expresses his gratitude to the personnel of Neal Forest Products Ltd., of Doaktown, N.B., and Consolidated Bathurst Inc., of Chicoutimi, P.Q., for their cooperation during these observations. Thanks are also extended to Tanguay Industries Limited and Forano Inc.



Pierre Giguère graduated with a B.Sc.A. (génie forestier) from l'Université Laval in June 1978. He was employed by a firm of consulting engineers (Darveau, Grenier, Lussier et Associés) to gather and compute field data to establish production standards for commercial thinning operations in Quebec. He became a member of the Eastern Division of FERIC in November 1978 and is presently occupied with studies evaluating the productivity of logging machines and harvesting systems.

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INTRODUCTION

The Tanguay CC-100 slasher has certain characteristics of interest to loggers. These are mechanical simplicity, a relatively low acquisition cost and the ability to slash trees to various lengths. Furthermore the machine requires only one operator.

The slasher is manufactured by Tanguay Industries Limited of St. Prime and is distributed by Forano Inc. of Plessisville. These two firms are located in Quebec.

A two day study was done on one of these slashers to evaluate productivity under certain conditions. The study took place February 28 and March 1, 1979, at a logging operation of Acadia Forest Products Ltd., located approximately 30 km south-east of Doaktown, N.B. During the study the air temperature was around $3^{o}C$ and the species harvested were mostly balsam fir and black spruce.

The slasher, number 18 of a series of 30 manufactured, belonged to Mr. Robert Neal, a contractor for Acadia Forest Products Ltd. At the time of the study, the slasher had been in use for three (3) months and the operator had three (3) months operating experience.

TECHNICAL INFORMATION AND COSTS*

Figure 1. General view of the Tanguay CC-100 slasher.

BASIC EQUIPMENT

- Caterpillar motor 3304-T, 112 Kw at 2 000 rpm**
- Two (2) speed hydraulic transmission
- Rigid rear axle
- Air brakes
- Four (4) wheels:
  - two (2) rear 17.5 x 25***
  - two (2) front 11.00 x 20***

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* The manufacturer's specifications and costs are as of January 1979 and were converted to the International System of Units (SI).

** The owner of the machine studied estimates fuel consumption at 20ℓ per productive machine hour.

*** Codification used by tire manufacturers.

- Two (2) rear hydraulic stabilizers
- Cab:
    - . windshield wiper
    - . hot water heater
    - . defroster
    - . sliding door
    - . indicators
- Three (3) levers and two (2) pedals to operate the loader and slasher.
- Three (3) hydraulic pumps with total capacity of 6.9 litres per second.
- Operating pressure: 13,790 kPa
- 127-cm diameter saw, 6.4-cm pitch, hydraulically driven
- Reference point for cut of 1.25 m
- Butt plate with 1.25-m travel
- Loader model 4028 with a capacity of 1,800 kg at 8.8-m reach (maximum); "Y" type heel boom and grapple TL-13-1 for handling tree lengths or logs.
- Loader swing: about 320° provided by hydraulic motor driven planetary gear box.
- 1-m turntable with exterior gear.
- 120 V heaters for diesel engine and hydraulic oil resevoir.
- Muffler.

Total............ $77 400.00

<u>OPTIONS</u>

1.	GM. motor	no charge
2.	"Fifth wheel" extension	$ 625.00
3.	Front mechanical stabilizer, pendulum type	300.00
4.	Grapple for holding tree tops	1 800.00
5.	Lights for night operation	575.00
6.	Air conditioning (cold only)	3 000.00
7.	Road lights with flashing indicators	700.00
8.	Mobile butt plate with 2.5-m travel	675.00
9.	137-cm diameter saw, 6.4-cm pitch	450.00
10.	Tilting stop panel for 1.25-m logs	1 600.00
11.	Reference for additional slashing lengths	65.00
12.	Kicker for 2.5-m, 3.7-m, and 5.0-m logs	on request

- The manufacturer reserves the right to change specifications and improve the products without notice or obligation.

CONTEXT OF THE STUDY

The slasher studied was integrated into a system that produced 2.5-m (8 ft) bolts to be used for pulping and 3.7-m and 5.0-m (12 and 16 ft) logs destined for sawmilling. This system comprised a Koehring feller-forwarder model KFF equipped with a felling head incorporating shears and chain saw. Trees having a diameter of less than 23 cm at the stump were destined for pulp and were felled with shears whereas the trees with diameters of 23 cm and more, destined for saw-milling, were felled with the saw. The trees were transported and placed at an angle of about 60^{o} to the road side. Felling was done two shifts per day.

A Koehring delimber, model KBL, delimbed the full trees on a one shift basis. This machine had cradles on each side of the delimbing boom, which permitted the operator to accumulate sawmill tree lengths on one side and pulpwood tree lengths on the other. When these cradles were sufficiently full, the stems were unloaded on one side of the road or the other, depending on their end use. Machines of this type are generally equipped with a topping mechanism, however the one studied did not have one because the topping was done during slashing. This increased the volume of merchantable wood fiber per tree by eliminating the logs shorter then 2.5 m by accepting smaller-diameter top ends to bring the length to 2.5 m.

Finally the Tanguay CC-100 slashers bucked the stems on a one shift per day basis. The tree lengths to be used for pulpwood were slashed into 2.5-m bolts. Those stems destined for sawmilling were slashed into lengths of 3.7 m and/or 5.0 m with the smaller-diameter upper bole going to pulpwood lengths.

Generally the machinery was organized so that one slasher worked continually with sawlogs and the other with pulpwood. However during the study this was not the case as the same slasher was used for both categories of tree lengths.

THE OPERATION

1. PULPWOOD

Moving:

The operator moved the slasher on the road until the loader was facing the tree lengths to be slashed. Before each move, the grapple was clamped to the front of the slasher platform and the stabilizers raised.

Processing: (Fig. 2)

Loading consisted of picking up, with the grapple, a certain number of stems from the pile and placing them on the slasher deck without releasing them.

Subsequently, the butt ends of the stems were aligned by banging them against the butt plate and/or by successive pushes with the plate itself.

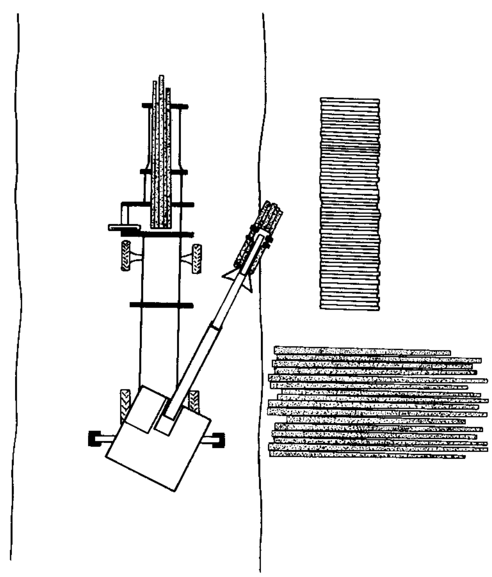

Figure 2. The operating layout used for slashing tree lengths intended for pulpwood.

The operator adjusted the butt plate for a log length of 2.5 m, placed the butts of the tree lengths against the plate, then slashed and unloaded the bolts onto a pile usually adjacent to the tree-length pile. Using the grapple, he then advanced the unslashed portion of the stems against the butt plate and slashed again. When sufficient bolts had been accumulated for a full grapple load, the operator piled them down.

Cleaning:

At the end of each cycle the tree tops were removed from the slasher platform with the grapple.

2. SAWLOGS

Moving:

The slasher was moved as previously described.

Processing: (Fig. 3)

Tree-length loading and alignment of the butts was accomplished using the method described above.

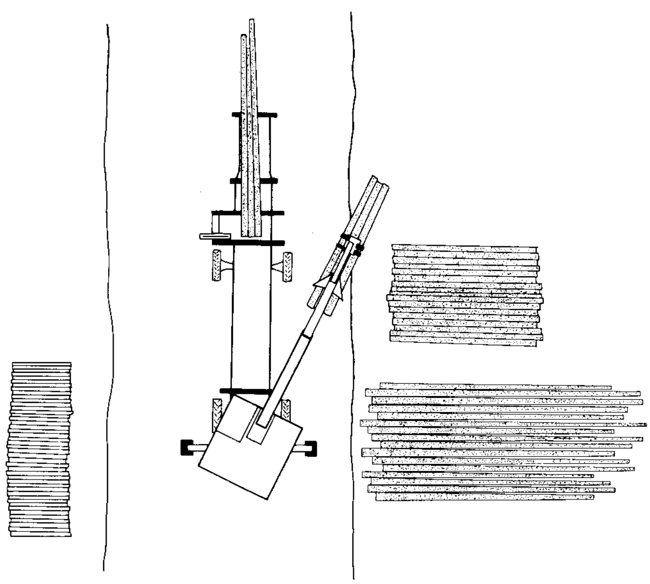

Figure 3: Operating layout used for slashing tree lengths intended for sawmilling.

The operator positioned the butt plate for log lengths of 5.0 or 3.7 m, placed the butts of the stems against the plate and slashed the first length. The sawlogs were placed on a separate pile from the 2.5-m logs. When it was possible to extract additional sawlogs, the operator advanced the unslashed portions of the tree lengths, slashed these logs and unloaded them. However, when this was not possible, he loaded additional tree lengths and repeated the process.

This method resulted in an accumulation on the platform of upper portions too small for sawlog material. When a sufficient number of these had been accumulated, the operator aligned the butts, positioned the butt plate for a length of 2.5 m and slashed them for pulpwood.

Cleaning:

Generally, the operator removed the accumulated tree tops with the grapple once the 2.5-m bolts had been piled.

RESULTS AND DISCUSSION

The total length of the timing was more than 4.5 hours spread over two days of data collection. The operating parameters measured during the timing and the recorded production are described in Table 1. Table 2 contains a summary of the different elements of productive time and of the calculated productivities.

Table 1: Operational Factors and Production

Average Operational Factors	Pulpwood (DSob* <23 cm)		Sawlogs (DSob* ≥23 cm)	
Species	Balsam Fir Black Spruce			
Number of trees (total)	459		101	
Merchantable length per tree (m)	6.5		11.6	
Merchantable volume per tree (m^3)	0.07		0.42	
Number of cycles (total)	43		51	
Number of trees per cycle	10.7		2.0	
Volume per cycle (m^3)	0.79		0.80	
Number of piles (total)	4		3	
Number of trees per pile	115		34	
Volume per pile (m^3)	8.5		13.7	
Distance between piles (m)	20		22	
Production				
Total volume produced (m^3)				
2.5-m		34		12
3.7-m and 5.0-m		0		29
Total	34		41	
Total number of bolts/logs produced				
2.5-m		1223		252
3.7-m and 5.0-m		0		120
Total	1223		372	

* DSob = diameter stump outside bark.

Table 2: Summary of Time Elements and Productivity

	Pulpwood cycles (DSob <23 cm)		Sawlog cycles (DSob ≥23 cm)	
	Average time per cycle (cmin)*	% of productive time	Average time per cycle (cmin)*	% of productive time
Moving between piles	14	4	9	4
Loading tree lengths	60	16	50	22
Slashing 2.5-m	173	47	38	16
3.7-m and 5.0-m	0	0	45	18
Total	173	47	83	34
Unloading	76	20	56	24
Cleaning debris	22	6	5	2
Delays**	27	7	30	13
Total time per cycle	372	100	233	100
Cycles per productive machine hour (PMH)	16.2		25.7	
Trees per cycle	10.7		2.0	
Trees per PMH	173		51	
Volume per cycle (m^3)	0.79		0.80	
Volume per PMH (m^3)	13		21	

* 1 cmin = 1 centiminute = 0.01 minute

** Only delays less than or equal to 10 minutes and more than 5 cmin are included in this category. Delays of 5 cmin or less were included in the work elements, whereas those of more than 10 minutes were considered as unproductive time and thus excluded from the study.

1. PULPWOOD

Moving:

Movement between the tree-length piles took an average time of 148 cmin and occurred every 10.8 cycles for an average time per cycle of 14 cmin or 4% of productive time.

Of the 148 cmin per movement, 60 cmin was time required for setting the grapple on the front of the machine, lifting the rear stabilizers, lowering them on arrival at the new pile of wood and freeing the grapple (i.e. terminal time). The remainder of the moving time represented time spent by the slasher travelling on the road. The 88 cmin corresponded to an average travelling distance of 20 m at a speed of 1.4 km/h.

Interference between the machines in the system, resulting from the very "hot" nature of this operation, forced the slasher to travel up to 60 m at times between set-ups. Under more normal operating conditions, the average distance between piles would have been about 6 m and this would have the time spent in moving reduced appreciably.

Loading:

Loading of the tree lengths took an average of 60 cmin per cycle, or 16% of productive time and represented loading an average of 10.7 tree lengths per cycle.

Considering the slight variation of this work element, loading time was considered constant.

Slashing:

The average slashing time was 173 cmin per cycle, or 47% of productive time.

Of the total slashing time per cycle, 144 cmin, was considered constant and was used to align tree-length butts against the mobile butt plate, slash the first bolt and sort and slash the merchantable part of the tree tops.

For each additional 2.5-m bolt, located between the butt log and the tree top, 25 cmin had to be added to slashing time per cycle. On average, there were 1.2 such intermediate slashes per cycle requiring an additional 29 cmin.

Unloading:

The average unloading time for 2.5-m bolts was 76 cmin per cycle, or 20% of productive time.

Unloading the bolts from the butts and merchantable parts of the tops required 48 cmin.

For each additional unloading, 24 cmin was added per cycle. Since this additional unloading happened 1.2 times per cycle, the unloading of the intermediate bolts took an average time of 28 cmin per cycle.

Cleaning:

The time required to remove the accumulated debris varied very little with each cycle. This operation took an average of 22 cmin per cycle and represented 6% of productive time.

Delays:

Those delays of more than 5 cmin and less than or equal to 10 minutes, considered productive time, resulted from: disentangling stems caught in the tree-length piles, accumulating stems left at the bottom of the piles, unjamming pieces wedged in the saw, rearranging the log piles and talking to the foreman or another operator.

Pro-rating the delays uniformly to each cycle, an average time of 27 cmin per cycle, was obtained or 7% of productive time.

Total:

The average productive time per cycle was 372 cmin, of which 306 were considered constant, 8 were a function of the distance between tree-length piles and 57 were a function of the merchantable tree lengths.

The production per cycle was 0.79 m^3, which gave a productivity of 13 m^3 per productive machine-hour.

2. SAWLOGS

Moving:

Each move between tree-length piles took an average of 152 cmin. Since these moves occurred every 17.0 cycles, the average per cycle was 9 cmin, or 4% of productive time.

Of this time, 74 cmin was a terminal time for setting the grapple on the front of the machine, raising the stabilizers, lowering them at the new pile site and freeing the grapple. The remaining time, 78 cmin, represented travelling time for an average distance of 17 m.

Loading:

The average time required to load the tree lengths was 50 cmin per cycle and represented 22% of productive time, with an average of 2.0 tree lengths per cycle.

During the study, the loading time per cycle did not vary appreciably and this may be considered as constant under these conditions.

Slashing:

Slashing the tree lengths into 3.7-m and/or 5.0-m logs plus removing the pulpwood bolts from the tops, took an average time per cycle of 83 cmin or 34% of productive time.

Of this time, 45 cmin or 18% of productive time was for removing sawlogs, either 3.7 or 5.0 m. On average, there were 1.41 sawlog slashes per cycle at an average of 32 cmin each.

The remaining 38 cmin per cycle or 16% of productive time, was used to slash the upper boles into 2.5-m lengths. In actual fact this slashing occurred every 2.7 cycles and averaged 102 cmin.

Unloading:

The time required to unload the sawlogs and the 2.5 m pulpwood averaged 56 cmin per cycle, or 24% of productive time.

Sawlogs were unloaded in 24 cmin per grapple. At 1.41 unloadings per cycle, the average time per cycle was 32 cmin, or 14% of productive time.

The unloading of 2.5-m pulpwood was done in 65 cmin at every 2.7 cycles. This time, pro-rated to each cycle, gave an average of 24 cmin, or 10% of productive time.

Cleaning:

Cleaning accumulated debris on the platform took 15 cmin and occurred on average every 3 cycles. This gave an average per cycle of 5 cmin, or 2% of productive time.

Delays:

Principal delays were caused by rearranging the log piles, disengaging tree lengths jammed in the loader or the saw, discussing the operation with the foreman and freeing the machine when it became bogged down while moving on a partially thawed road.

Once these delays were pro-rated to each cycle they averaged 30 cmin per cycle, or 13% of productive time.

Total:

The average productive time per cycle was 233 cmin, of which 89 were considered constant, 5 were a function of distance between tree-length piles, 77 were related to production of sawlogs and 62 were related to production of 2.5-m pulpwood. Production per cycle was 0.80 m^3 and corresponded to a productivity of 21 m^3 per productive machine-hour.

LIMITATIONS AND ADVANTAGES

1. LIMITATIONS

Large diameter trees:

As lifting capacity is limited to 1,800 kg at a reach of 8.8 m, the machine has some difficulty when manipulating large trees. Before loading these trees, the operator must drag them as close as possible to the machine to increase the lifting capacity of the boom and to decrease the risk of overloading. The machine may also have lifting problems when the piles are covered with ice or a thick layer of snow.

Distribution of machine weight:

The ground pressure exerted by the machine, calculated with a sinkage of 15% of tire diameter, is 149 kPa at the rear and 139 kPa at the front. These pressures represent 85% to 150% of the pressure caused by a loaded truck.* Such high pressures limit this type of slasher to travel on hard surfaces, such as well drained or frozen roads.

During the study the slasher had to move on a partially frozen road. On the areas where the soil was thawed, the tires broke through the surface and the machine had difficulty freeing itself.

Road traffic:

Slashing should not be done on a road with heavy traffic because the slasher works on the road and blocks nearly all circulation.

Welding:

During discussions with the owner of the slasher, it was claimed that many of the repairs done on the machine were caused by inadequate welding. This did not apply to the loading unit and the manufacturer affirms that this weakness no longer exists.

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* Pressure exerted on the ground by a truck varies as a function of the load on the truck, the number of wheels and the tire dimensions.

2. ADVANTAGES

Adaptability:

The capacity to slash to various log lengths permits the use of this machine in a logging system integrating sawlog and pulpwood production.

The diversity of optional accessories offered permits adapting the slasher to various systems already in use without major modifications to the machine.

Mobility:

With the machine being self-propelled and able to work on forest roads, it is not necessary to haul tree lengths to a central landing for slashing. Thus, trucks haul only merchantable wood, thereby increasing the useful payload.

The machine could climb steep grades without difficulty. According to its technical specifications, the slasher is capable of travelling at a speed of 5 km/h on a hard surface road.

Simplicity:

The mechanical design of the slasher is relatively simple and all controls are manual. This results in high availability and permits the operator to make the majority of repairs with a minimum of mechanical knowledge.

Economy:

The relatively low cost of this machine makes it accessible to small contractors, particularily if one considers that the machine requires only one operator.

CONCLUSION

Productivity obtained with the Tanguay CC-100 slasher was inferior to that which may be expected with a larger slasher requiring 2 to 3 operators. However this lack of productivity is compensated for by the purchase price of the machine and its much lower maintenance and operating costs.

During the study, productivities obtained were 13 m^3 per productive machine-hour for slashing tree lengths destined for pulpwood and 21 m^3 in the case of tree lengths having at least one sawlog. These productivities could be improved if the stems were longer provided the weight was less than the lifting capacity of the loader, and if the tree-length piles were higher and closer one to another. Productivity may also be increased by improving operator work methods. A logging company using this slasher succeeded in producing up to 22 m^3 per productive machine-hour in pulpwood by varying the slashing method and by using the machine in favorable conditions.

However, decreased productivity would likely occur if the slasher was required to sort sawlog and pulpwood stems, during night operation, and when the phases of the logging system were highly interdependent.

In general, the slasher appears promising and the majority of comments obtained from users were favorable.

APPENDIX I

SAFETY AND COMFORT

The slasher, was evaluated* for safety and comfort to the operator. The results are summarized below.

Mounting and alighting from the machine:

Access to the cab was found to be difficult and dangerous and the difficulties are magnified during descent. To gain access to the first step, located 2 m above the ground, the operator must climb onto the slasher platform without aid of steps or handrails. Then he must climb onto the loader's turntable by utilizing the cab's protective grill as a hand hold. From there he can swing to the first step by grasping an awkwardly sized and located hand grip. This procedure is especially dangerous under slippery winter or rain conditions.

Cab:

The cab is sufficiently large and free of objects that might result in injuries to the operator.

Seat:

The seat is very comfortable and easily adjustable to a wide variety of physical shapes. Even the firmness of the cushion is adjustable.

Position of the controls:

The hand levers and pedals used to operate the slasher are located facing the operator's seat and are easily accessible. All machine functions are activated by 2 double levers, 1 single lever and 4 pedals. The double levers on each side of the cab are superimposed and thus very close (Fig. 4). Potentally the lower lever may be triggered when activating the upper one.

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* Evaluation of the machine was done according to: Aminoff, S., Hansson, J.E., and Pettersson, B. Ergonomic checklist for transport and materials handling machinery. Skogsarbeten, Stockholm, 1974, pp. 24.

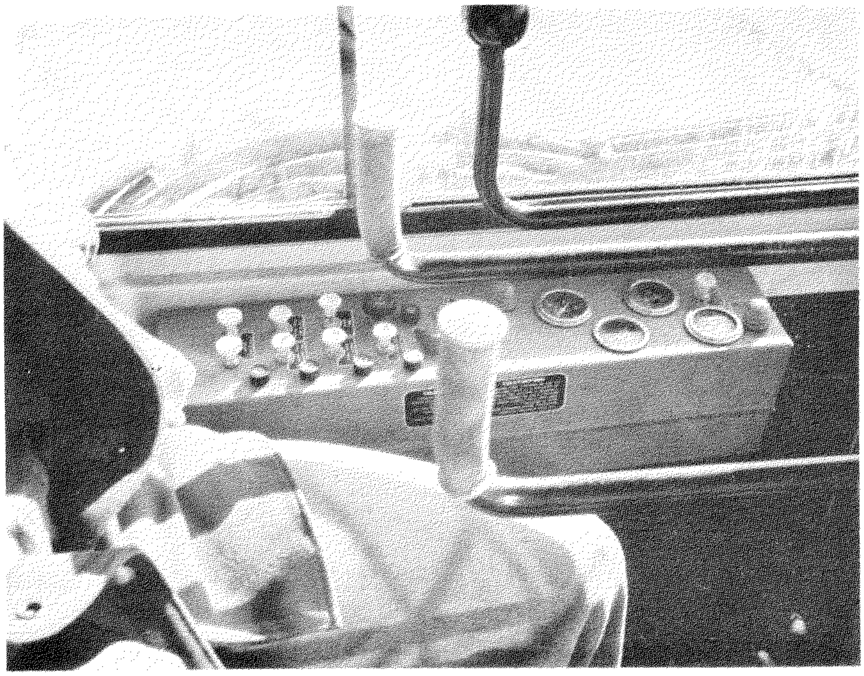

Figure 4: View of hand controls and instruments in the cab.

Instrumentation:

The majority of the instruments supplied are poorly located dials. The difficulties arise because the dials are on the side of the cab (Fig. 4) and a lever obstructs the line of sight. Furthermore it would be advantageous to install, in addition to existing instruments, a fuel gauge as well as a tachometer for the engine.

Visibility:

The visibility from the cab is generally good because of the large windows. However, there are two areas where visibility is reduced. The saw obstructs visibility at the front left hand side of the machine, whereas the motor is a hindrance to visibility to the right rear side of the loader turntable.

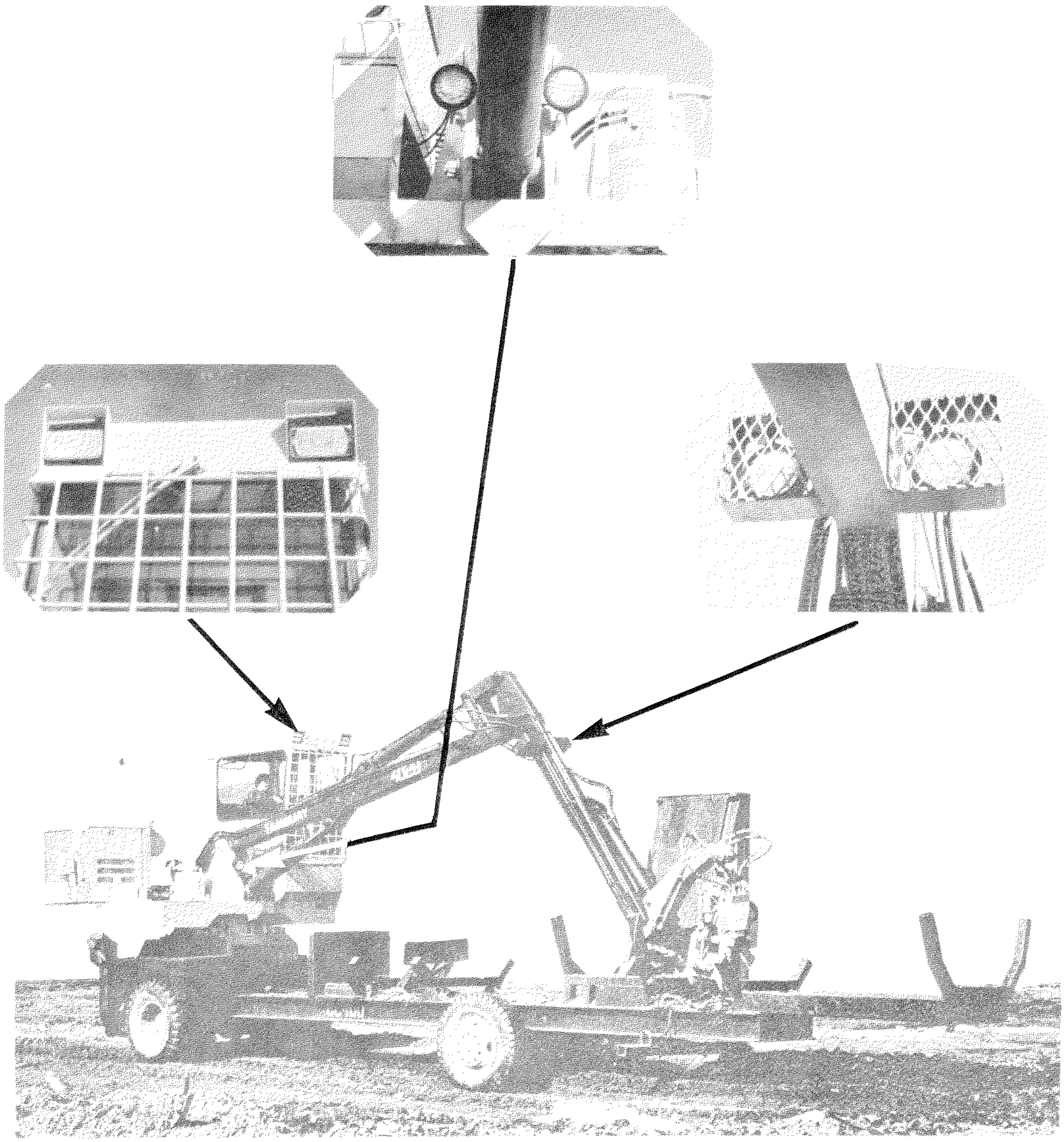

Figure 5: Detailed view of the 6 lights used for night operation and their location on the machine.

Lighting:

Lighting for night operations is insufficient from the point of view of intensity and diffusion. Only a small portion of the area covered by the loader receives the required 30 lux minimum. The machine has six lights (Fig. 5) which are all fixed on the loader and oriented in the same direction as the loading boom. In the immediate surroundings of the machine a series of bright and dim areas succeed one another.

Also no lighting is provided for the rear of the machine, which may make moving dangerous.

Sound:

Readings of acoustic pressure were made in the cab with the door closed and the engine running at normal working rate. In all the octaves, from 31 Hz to 32 kHz, the acoustic pressure was inferior to the allowable maximum for an exposure of 6 hours or less per day. In the A band, which best represents the sensitivity of the human ear, the sound level was also below the permissible threshold.

APPENDIX II

CONVERSION TABLE

1 cm	1 centimetre	: 0.39 inch
1m	1 metre	: 3.28 feet
1 km	1 kilometre	: 0.62 mile
1 m^3	1 cubic metre	: 0.353 cunit
1 ℓ	1 litre	: 0.22 Imperial gallon : 0.26 American gallon
1 ℓ/s	1 litre per second	: 13.20 Imperial gallons per minute : 15.85 American gallons per minute
1 kg	1 kilogram	: 2.20 pounds
1 kW	1 kilowatt	: 1.34 horse-power : 3,425 BTU
1 kPa	1 kilopascal	: 0.145 pounds per square inch
1 lx	1 lux	: 0.093 foot-candle : 0.093 lumen per square foot
^oC	degree Celsius	: $\frac{5}{9}$ (^oF-32)