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05004

United Nations Industrial Development Organization

ORIGINAL: ENGLISH

Technical Meeting on the Selection of Woodworking Machinery

Vienna, 14-23 November 1972

SELECTION OF EQUIPMENT FOR LOG BREAKDOWN: BAND SAWS, FRAME SAWS AND CHIPPER HEADRIGS[1/]

by

Paul Imoery, Project Engineer,
Gebrüder Linck Company, Oberkirch/Baden,
Federal Republic of Germany

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id.72-7189

05004

ID

Distr. LIMITEE

ID/WG.151/28 RESUME
29 octobre 1973

FRANCAIS
Original : ANGLAIS

Organisation des Nations Unies pour le développement industriel

Réunion technique sur le choix des machines dans l'industrie du bois

Vienne, 19-23 novembre 1973

[illegible]

SÉLECTION DE MACHINES POUR LE DÉBITAGE DES GRUMES : SCIES À RUBAN, SCIES ALTERNATIVES ET FRAGMENTEUSES 1/

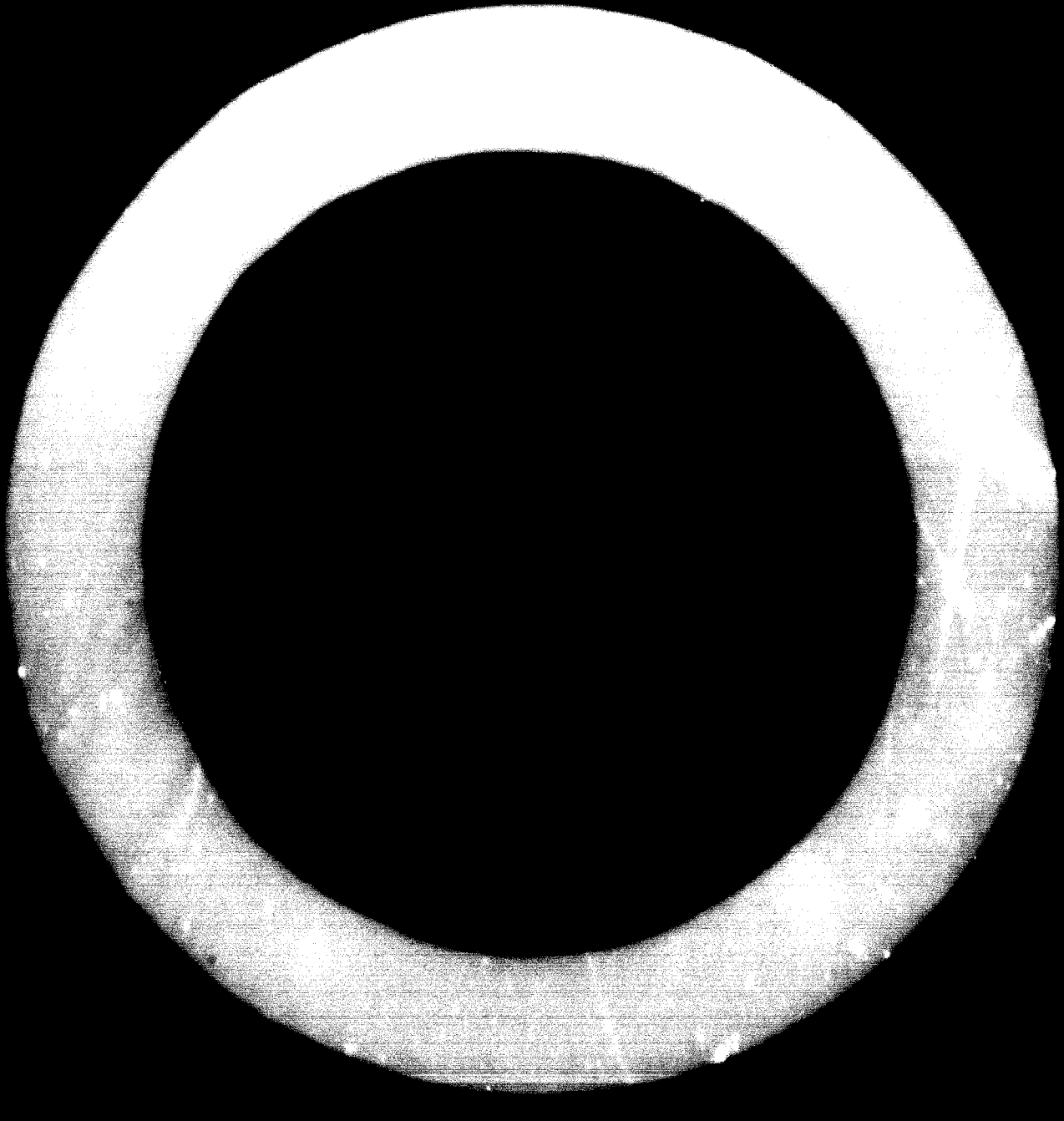
par
Paul Imbery, Ingénieur de projet,
Gebrüder Linck Company
Oberkirch/Baden (République fédérale d'Allemagne)

Au cours des vingt dernières années, le matériel de scierie a connu une évolution rapide. Presque toutes les machines ont été améliorées et la capacité de production s'est accrue. En outre, une toute nouvelle machine a fait son apparition sur le marché : la machine à profiler les grumes.

Ces progrès techniques ont eu pour effet d'accroître le rendement et de modifier la conception technique des scieries, mais aussi de modifier la structure de l'industrie du sciage dans plusieurs pays.

L'auteur de l'étude examine les nombreux facteurs qui sont intervenus dans l'amélioration des machines à débiter les grumes et traite des machines adaptables, à fon

1/ Les opinions exprimées dans le présent document sont celles de l'auteur et ne reflètent pas nécessairement les vues du Secrétariat de l'ONUDI.



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de degré divers, [illegible] en voie de développement.

Il y a lieu de tenir compte des conditions économiques et économiques ainsi que du milieu forestier. [illegible] l'expérience montre que, normale, il semble que l'industrie du sciage ne se développera dans ce pays que si l'on exploite rationnellement les réserves forestières existantes.

Avant d'acheter des machines, il faut, non seulement en étudier les caractéristiques techniques, mais aussi examiner d'autres questions essentielles, d'une importance décisive pour leur bon fonctionnement.

L'auteur décrit les principaux types de scies à grumes et compare leurs caractéristiques techniques et leurs performances. Les machines étudiées sont les suivantes :

- Scie à grumes horizontale à ruban
- Scie à grumes verticale à ruban
- Scie alternative
- Machine à profiler les grumes
- Scie circulaire.

Plusieurs machines peuvent être combinées dans une scierie moderne selon la dimension des grumes, les essences, le rendement et le programme de travail. Les combinaisons les plus courantes sont brièvement décrites.

La bonne utilisation d'une scie à grumes de conception moderne exige la mécanisation des opérations de manutention et d'alimentation de la machine. L'accroissement de la productivité n'est pas le seul avantage de la mécanisation : elle permet aussi un déroulement plus régulier et plus précis des opérations.

L'auteur recommande également la création de scieries mécanisées dans les pays en voie de développement malgré les dépenses d'investissement que leur installation entraîne. Il est vrai que le degré de mécanisation dépendra naturellement du taux des salaires, mais la décision doit en définitive être prise en tenant compte de la nécessité d'assurer la compétitivité des produits de l'entreprise sur les marchés mondiaux.

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05004

Distr.
LIMITED

ID/WG.151/28 Summary
29 October 1973

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SELECTION OF EQUIPMENT FOR LOG BREAKDOWN: BAND SAWS, FRAME SAWS AND CHIPPER HEADRIGS[1/]

by

Paul Imbsy, Project Engineer,
Gebrüder Linck Company, Oberkirch/Baden,
Federal Republic of Germany

SUMMARY

Over the last two decades, a fast progressive development was observed in the field of sawmill machinery construction. Almost all machine types were constructionally improved and capacity increased. Quite a new machine, the double center chipper, appeared on the market.

The result of this technical progress was not only an improvement in output and a change in the technological build-up of a sawmill plant, but also a change in the structure within the sawmilling industry of some countries.

This report explores many factors involved in the constructional improvement of log cutting machinery and deals with machines which are suitable to a greater or lesser degree for employment in developing countries.

Geographical, economic and forestry conditions must be taken into account. The general economic development indicates that the sawmilling industry will expand in these countries if existing timber reserves can be exploited by reasonable forestry measures.

Not only must the technical data of sawmill machinery be considered prior to its purchase, but also some other important features, decisive for the operation of the machine.

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The description of the most important log cutting machinery refer to their constructional composition, t chnical data, working range and to the comparison of features of different types of machines. Those machines discussed are:

Horizontal Log Band Saw
Vertical Log Band Saw
Gang Saw (or Frame Saw)
Double Canter Chipper
Circular Saw

Several types of machinery can be combined in a modern sawmill plant according to log dimension, wood species, output and cutting programme. The common combinations are briefly explained.

Required for the successful operation of a modern log cutting machine is the mechanisation of the material flow and other operations within the sawmill. A capacity increase is not the only advantage of mechanisation; another is more frictionless and faultless operations.

It is also recommended to erect mechanised sawmills in developing countries, in spite of the necessary investment expenditure. The degree of mechanisation is indeed dependent on the wage rate, but must definitely be decided upon in such a way that ensures production within competitive world market prices.

Organización de las Naciones Unidas para el Desarrollo Industrial

ID

[illegible] SUMMARY
[illegible] octubre 1973

ESPAÑOL
Original: INGLES

Reunión técnica sobre selección de maquinaria
para trabajar la madera

Viena, 19 - 23 noviembre 1973

SELECCION DE EQUIPO PARA LA PRIMERA TRANSFORMACION DE TRONCOS: SIERRAS DE CINTA, SIERRAS MULTIPLES Y FRAGMENTADORAS DE COSTEROS[1/]

por

Paul Imbery, Ingeniero de Proyectos de la
Gebrüder Linck, de Oberkirch/Baden
(República Federal de Alemania)

RESUMEN

En los dos últimos decenios, la construcción de maquinaria para aserraderos ha progresado con gran rapidez. Se ha mejorado la construcción y aumentado la capacidad de casi todos los tipos de máquinas. Y ha aparecido en el mercado una máquina totalmente nueva: la fragmentadora de costeros con ataque doble.

El resultado de este progreso técnico ha sido no sólo una mejora de la producción y una modificación de la estructura tecnológica del aserradero, sino también, en algunos países, una reestructuración de la industria de elaboración primaria de la madera.

En el informe aquí resumido se estudian muchos de los factores del perfeccionamiento de la maquinaria para corte de troncos y se consideran máquinas cuyo empleo está indicado, en mayor o menor grado, para los países en desarrollo.

En cada caso, han de tenerse en cuenta las circunstancias geográficas, económicas y forestales. A juzgar por el progreso económico general, es de presumir que, en esos países, la industria de elaboración primaria de la madera ha de ir a más, siempre que, mediante una acertada política de ordenación de bosques, puedan explotarse las reservas de madera en pie existentes.

1/ Las opiniones que el autor expresa en este documento no reflejan necesariamente las de la Secretaría de la ONUDI. La presente versión española es traducción de un texto no revisado.

Antes de comprar una sierra cinta para troncos no sólo los datos técnicos, sino también [illegible] importancia decisiva para el funcionamiento de la máquina.

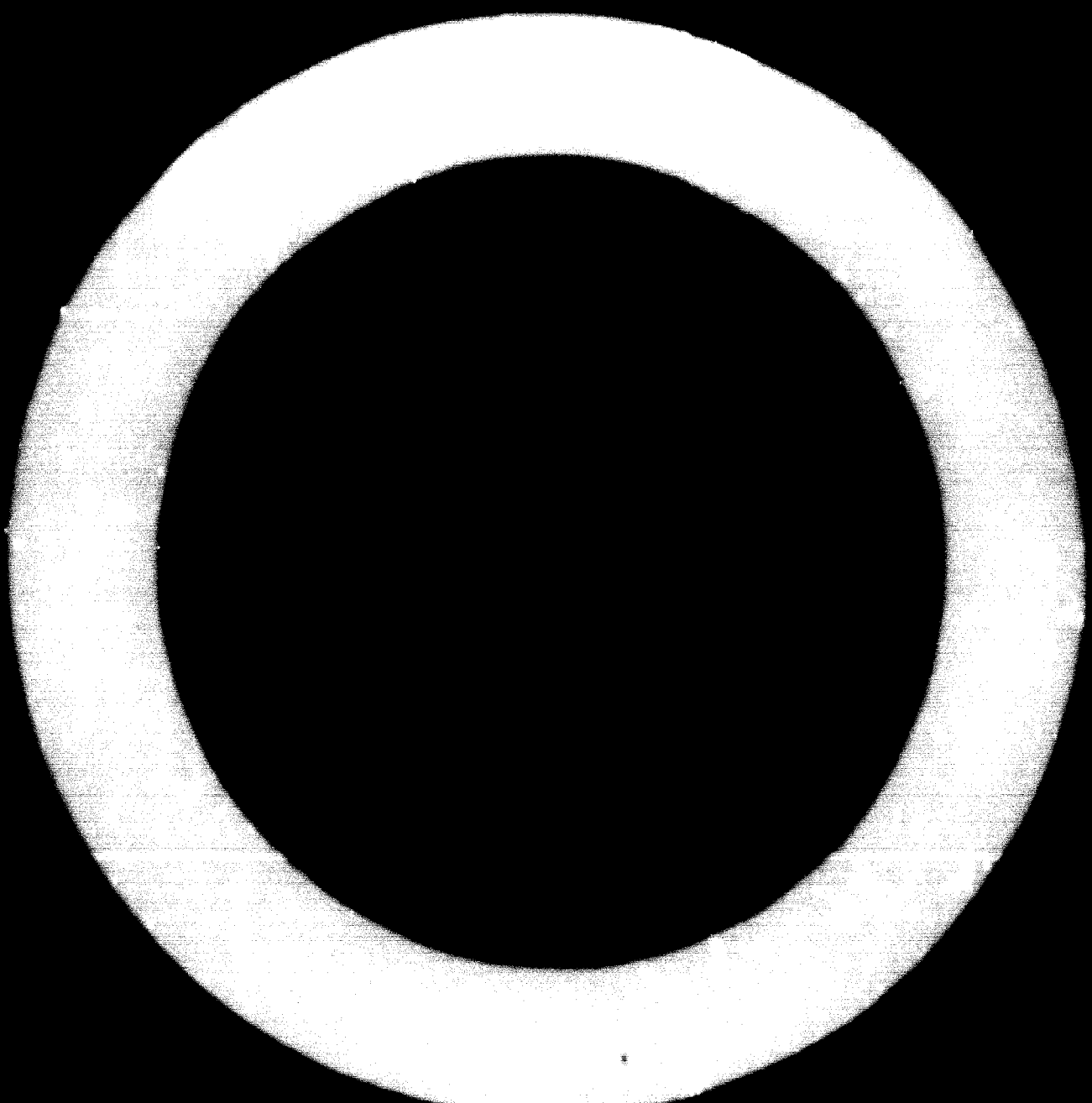
Al describir la maquinaria de corte de troncos más importantes se indican en particular su modalidad de construcción, sus datos técnicos y el campo de dimensiones a que son aplicables, y se comparan entre sí en cuanto a tales características. distintas máquinas. Las que se estudian en el trabajo aquí resumido son las siguientes:

Sierra de cinta para troncos, horizontal
Sierra de cinta para troncos, vertical
Sierra múltiple (o de bastidor)
Fragmentadora de costeros, con ataque doble
Sierra circular

En un aserradero moderno pueden combinarse varios tipos de máquinas, según el tamaño de los troncos, las especies madereras, y el programa de producción y corte. Se explican brevemente las combinaciones usuales.

Para que una máquina moderna de corte de troncos funcione bien, es necesario mecanizar la circulación del material, así como otras operaciones del aserradero. Con esta mecanización se logra no sólo aumentar la capacidad sino también funcionar con menos tropiezos y problemas.

Se recomienda asimismo que en los países en desarrollo se instalen aserraderos mecanizados, a pesar de la inversión que ello supone. Naturalmente, el grado de mecanización dependerá de la cuantía de los salarios, pero, en todo caso, deberá decidirse de modo tal que se asegure la competitividad de la producción en los mercados mundiales.



INTRODUCTION

1. In the last 40 years there has been a considerable development in the field of sawmill machinery construction and technology within the sawmill industry. Conventional machinery was essentially improved, new types of machinery invented and the total mechanization of the work flow and internal material transport were perfected in an effort to achieve greater output with ever smaller costs in wages. Further labour was saved with electronically controlled complete processing lines and automatically functioning electronic measuring and sorting devices, so that modern sawmills set new high records in cutting capacity relative to hourly wage expenditure.

2. Some sawmills now require only 1 wage hour for the processing of 1 m^3 of log volume, and sometimes even less, depending on the cutting programme. It must be added that some working steps on the log which were hitherto done in the forest, such as debarking or measuring, have now been transferred to the sawmill, where they can be handled more rationally with stationary machinery.

3. The result of modernization and mechanization and the investment expenditure connected with them was not only an improvement in output, with respect to a reduction of production costs, but also a change in the structure within the woodworking industry which is still continuing. This is especially apparent in a concentration of the sawmill industry brought about by the slow disappearance of a great number of small mills and by the establishing of an optimum mill size, able to vary according to location and production programme.

4. The optimum size of a sawmill in Central Europe is presently one with an annual cutting of between 20,000 - 30,000 m^3 of log volume. Such a cutting volume is already demanded by the purchase of one barker or one heavy duty gang saw. Small sawmills will not pass away completely but can only find a right to exist by covering locally restricted needs or as branches of a large mill.

5. European conditions [illegible] equipped sawmill without [illegible] treatment average from DM 200 - [illegible] figure not only includes [illegible] equipment, plus buildings [illegible] must be spent for a sawmill with an annual cutting of 20,000 m^3 of log volume.

6. A few countries with similar traditions in Europe and North America were essentially responsible for the technical development in the field of sawmill machinery construction and preparation of suitable technologies. They were of course made to meet the economic conditions and needs of these countries.

7. This report examines the special situations of the developing countries and the machinery and equipment within their sawmills.

I SITUATION AND NEEDS OF THE SAWMILL INDUSTRY IN DEVELOPING COUNTRIES

8. Those nations of Asia, Africa and Latin America defined as Economic Class II by the F.A.O. are classified as developing countries.

9. These countries have, by their geographical location, part of the world's subtropical forest region and therefore almost 80% of their log production consists of tropical or subtropical deciduous trees.

10. The total annual production of the developing countries in saw logs and veneering wood is:

Conifers	25 million m^3 of log volume (4.5% of world production)
Deciduous trees:	78 million m^3 of log volume (39% of world production

11. Of this amount, 1 million m^3 of log volume of conifers and 33 million m^3 of log volume of deciduous trees are presently exported.

12. The total forest area of the developing countries is estimated as being 2,100 million hectares, or about half of the world's entire forest area. The productive forest area is, however, limited to approximately 500 million hectares, of which a large part is only partially used. The regular and permanent cultivated forest area amounts in Asia to 9.4%, in Africa to 2.0% and in Latin America to 0.3% of the total forest area.

13. Most countries make efforts to change their forest regions over into a forestry regulated cultivation and to create the legal basis for it by forest laws. It can be expected, or at least hoped, that these measures will prevent senseless over cutting within a reasonable amount of time, enlarge the productive forest area and essentially and effectively increase in quality and quantity the forestry production. Foreign aid for developing countries has opened fruitful fields of activity.

14. Not only is raw material a part of the build-up of an industry, but so is trained labour - a factor that is often underestimated. An industrial plant only operable with the aid of foreign specialists leads to dependence and to a new type of colonization and thus fails in its original intent.

15. Developing countries with rich wood resources have the possibility of creating a solid basis for any further industrialization with the creation of a sawmilling industry and of educating for themselves a cadre of labour from which specialists for particleboard plants, furniture factories and other wood industrial plants can later be recruited.

16. Some conclusions can be drawn from the above objectives with respect to the erection of sawmill plants and the selection of suitable machinery:

The machinery must fulfil in construction, dimension and capacity the special requirements for the cutting of tropical wood species.

Material used, especially electrical equipment, must take into account the climatic circumstances at the site.

Local labour must be able to do the service and maintenance, including small repairs. Suppliers must be in a position to thoroughly train the personnel operating the machinery prior to its commissioning.

A ready supply of spare parts and tools must be assured on a long term basis. A spare parts assortment to the value of at least 5% of the cost price should also be bought at the same time as the machinery.

on the basis of [illegible] to lower [illegible] developing countries [illegible] and lower prices can be achieved with less investment expenditure and more manual work.

Machinery and plant [illegible] in developing countries should be up to the latest state of the art. Obsolete models or used plants are generally not suitable to enter into successful competition on the export market with [illegible] industrial nations.

Any new project should consider the future economic development of the given country. Indications are that the wood industry of developing countries will experience a fast growth. Flexible plants should therefore be established which can meet changed market conditions in capacity as well as in the cutting programme.

II SAWMILL MACHINERY FOR LOG CUTTING

17. The machinery described in the following chapter for the cutting of logs is usually referred to as the headrig of a sawmill. This machine is mainly responsible for the output of the whole plant. Its technical characteristics must be coordinated to the cutting programme and to the local situation. Great importance must therefore be placed on the selection of the proper machine. Only those machines are mentioned which are of importance for developing countries. Technical data refers to the usual machine size, special constructions are not considered.

A. Horizontal log band saw

Technical data:

pulley diameter (log passage)	-	1200 - 2000 mm
saw blade speed	-	20 - 40 m/sec
feed speed	-	up to 40 m/min
return speed	-	up to 50 m/min
power requirement	-	20 - 50 kW
blade thickness	-	1.0 - 2.0 mm
blade width	-	100 - 190 mm

18. This machine is particularly suitable for the cutting of heavy deciduous logs. Both of its pulleys are fitted onto uprights, which are adjustable in height. The saw blade runs horizontally and cuts with the lower part of the blade. The log carriage with infinitely variable speed moves between the two uprights. Its greatest advantage in comparison with the vertical log band saw is that the logs being cut rest for their full length on the carriage and even extremely twisted log shapes can be [illegible] sawed.

Jaws are [illegible] pneumatically on modern [illegible] irrespective of [illegible] can be placed [illegible]

19. The horizontal [illegible] was essential. [illegible] improved over the last few years [illegible] with respect to auxiliary equipment and operating devices. Modern models have, besides the remote controlled clamping devices, infinitely adjustable cutting speeds in order to best adapt to the different cutting resistance of the species; laterally adjustable blade guides to regul te the free saw length for each cutting width; and a pre-selection of the thickness of cut for the next board.

20. The equipment of the carriage was perfected by so-called alignment devices which are remote-controlled swivel arms with rotating chairs. Light and medium-heavy logs can be conveyed onto the carriage with this device and turned into the desired cutting position.

21. The log turner, mounted onto the carriage, is recommended for heavy logs, such as hardwood. The log is clamped between the two spindle sleeves within this turner, as it is done by a veneer peeling machine, and can be turned to any chosen side.

22. The horizontal log band saw has, of all log cutting machinery, the highest quantitative recovery and he best surface finish. Since lateral play in the carriage trail has no effect on the thickness of cut, the cutting accuracy is greater than with vertical log band saws.

23. The disadvantage in comparison with the vertical model is the lesser capacity. Within a working time of 8 hours, a capacity of 30-40 m^3 of log volume is figured as having an average log diameter of 50cm and a plank thickness of 30mm. The capacity limitation is caused by the high proportion of time needed for preparation (feeding of the machine, turning of the logs, removal of the residual plank). Mechanization of these working steps is very difficult and imperfect, so that manual work cannot be avoided in the handling of logs and sawn lumber.

24. The machine has proven its worth where its employment is limited to the cutting of high-quality hardwood logs requiring an individual cutting pattern. A crane (e.g. bridge crane) with a hydraulic clamping-tong is recommended for feeding to the horizontal log band saw. The removal of the sawn lumber is best done with a vacuum-lifting apparatus of adequate lifting force.

B. Vertical Log Band Saw

Technical data:

pulley diameter	–	1100 – 3000 mm
maximum cutting height	–	1500 – 2500 mm
saw blade speed	–	30 – 50 m/sec
feed speed	–	up to 150 m/min
return speed of carriage	–	up to 200 m/min
power requirement	–	90 – 150 kW
blade thickness	–	1.1 – 2.6 mm
blade width	–	140 – 405 mm

25. This machine, like the horizontal log band saw, has two saw pulleys whose diameter is determined by the size of the model. They are positioned one over the other. The top saw pulley sits on uprights, the more heavy bottom one serves at the same time as flywheel. The saw pulleys must be statically and dynamically balanced and the contact surface hardened and cambered. The saw blade runs vertically from the top to the bottom pulley. The log is clamped onto a carriage and passed by the saw blade is moved closer to the saw blade after each passage by the dimension of the thickness of cut.

26. The vertical log band saw is the most versatile log cutting machine with respect to log dimensions and cutting possibilities. The machine is made in numerous sizes and varieties, which explains the wide range of the above technical data.

27. Modern log band saws have numerous accessories in order to attain a high cutting capacity. They offer, besides the high speed of the carriage and a corresponding saw blade speed, the possibility of cutting on the return stroke of the carriage by using a double-edged saw blade. This results in a capacity increase of about 30% in comparison with a machine with single cut.

28. High feed speed requires an adequate fast adjustment of the cutting thickness. The cutting of the entire log is pre-programmed by an electric control arrangement on the newest models and the machine then works automatically. The carriage normally has hydraulically or pneumatically operating clamping jaws (dogs), individually movable headblocks and a kicker for the residual plank.

29. The removal of logs, the feeding of the carriage and take-off of sawn lumber can be fully mechanized for the vertical model as opposed to the horizontal log band saw. Of course, the degree of mechanization attained by the gang saw or double end or chipper is not achievable; however, the working flow for each cutting process can be arranged in such a way that the complete working flow is controlled by only one man. The capacity of a log band saw corresponds to the numerous sizes and models of this type of machine and cannot be given in a single figure, not to mention that the cutting capacity depends also on species, log dimension and board thickness. The capacity ranges for plain machines without mechanization from about 30-50 m^3 of log volume, and for modern, fully-mechanized heavy-duty machines from 80-120 m^3 of log volume per 8-hour shift provided, however, that a band re-saw works in conjunction with the headsaw.

30. Due to the versatile employment possibility of the vertical log band saw, the question is posed again and again whether this machine should be preferred to the gang saw. Defenders of the log band saw point out above all that a higher quantitative recovery is given, due to the smaller kerf (about 2.2mm in comparison to 3.7mm by the gang saw). However, this additional recovery exists only theoretically; what is confirmed in practice is that the cut by the log band saw is quite often wavy, so that the loss of cut arising by the gang saw is compensated for by more accurate sawing. A wavy cut occurs if the saw blade has not been accurately maintained.

31. The relatively difficult upkeep of the log band saw blades has caused some disappointment in developing countries. It is not feasible unless investment is made in modern and expensive equipment for the saw doctor's room, including automatic sharpening and swaging machines, aligning table, rolling machine and soldering apparatus. The greatest difficulty is to find an experienced specialist for the saw blade treatment. Higher operating costs accrue with the log band saw than with the gang saw due to the expense of procurement and treatment of the saw blade.

32. Investment expenditure is about 30% higher compared with gang saws.

33. The vertical log band saw should be employed wherever use of a gang saw is restricted by the dimension of the log and where individual cutting of valuable logs is important. Logs above a diameter of 50cm, extremely short and heavily twisted logs are usually better cut by a log band saw. Certain special jobs, like the preparation of cleats for veneer manufacture or satisfying a variable production programme can only be done on the log band saw.

C. Gang Saw (or Frame Saw)

Technical data:

sash width	-	[illegible] - 900 mm
passage height	-	[illegible] - 700 mm
stroke		[illegible] - 700 mm
maximum revolution	-	[illegible] rPM (i.e. 340 stroke/min)
feed speed	-	up to 15 m/min
saw blade speed	-	[illegible].0 - 7.0 m/min
power requirement	-	50 - 100 kW
saw blade thickness	-	1.4 - 2.4 mm

34. This report will deal only with the vertical gang saw. Other constructions like side-frame saw or horizontal gang saw play only a minor part in today's sawmill technology.

35. The gang saw is the most commonly used headrig in Europe for the cutting of conifers. Heavy models of this type of machinery are employed with success for the processing of deciduous trees including hardwood. The data given above refers to the usual gang saw size; larger sizes were built on occasion, but are beyond the optimum range of employment of this machinery type.

36. The gang saw consists of a sash moving up and down, supported by two lateral uprights and driven by a crank assembly via flywheel and connecting rods. Depending on the size and desired thickness of boards, up to approximately 30 saw blades can be placed into this sash. Saw blades are tensioned by hand or hydraulically and in the modern heavy-duty machines with a tension of up to 10 tons for each saw blade. A double pair of rollers, positioned in front and to the rear of the sash, provides the feed of the log and holds it tight during the cutting process. Modern gang saws are equipped with hydraulic feedworks and automatic overhang adjustment.

37. Feeding of the gang saw is done by a quick dogging carriage having hydraulic clamping and turning devices which can quickly put even the heaviest logs into the desired cutting position. The machine and the carriage are controlled electrically from the carriage on which the operator rides. Lately, remote-controllable carriages or automatic feeding systems are applied to fully utilize the capacity of a heavy-duty gang saw which can operate at an average feed of 8-12 m/min while cutting conifers.

38. The hydraulic width adjustment serves for the pre-cutting of conifers and especially for the production of structural timber and railroad sleepers, where two banks of saws can be positioned while the machine is running so that the distance between the inner saw blades is changed according to the log diameter.

39. Another special model of the gang saw is used for the simultaneous re-sawing of two cants. For this machine split upper rollers are utilized, and it is mainly employed as a re-saw.

40. The output of the gang saw depends on the log dimension, the species and the cutting programme. It amounts to about 100-150 m^3 of log volume in plain cutting by a heavy-duty machine and within a working time of 8 hours, and is thus higher than that of a vertical log band saw. The capacity is not only due to the fact that the whole log is split up into boards in one pass, but also because the gang saw is outstandingly suitable for mechanization and can be, with adequate expenditure, made fully automatic. The bringing of logs, feeding to the machine, automatic separation of main and side lumber and removal of the sawn lumber can be better accomplished than with a band saw.

41. The employment possibilities of the gang saw are almost as versatile as with the log band saw. Indeed, the diameter of logs to be cut is restricted to the passage dimension of the machine; also required for the safe guidance of the log is a log minimum length of 2.50 meters, with the exception of special models built in particular for the cutting of short logs.

42. The gang saw is the most suitable machine for producing large-volume, standard-sized lumber from both coniferous and deciduous logs with diameters of between 20-50cm. The most common passage size is therefore a sash width of 56 or 71 cm. Employed with success are models with a sash width of 90cm for the processing of large-diameter tropical wood (up to 80cm in diameter) which require no individual cutting.

43. Besides its high cutting capacity, the gang saw has the advantages of sturdy construction, a simple saw blade treatment and relatively low operating costs. The investment expenditure is less than that for a log band saw.

44. A [illegible] which causes considerable [illegible] foundations. [illegible] costs can accumulate therefore [illegible] if there is poor soil.

D. Double Canter Chipper

45. The double canter chipper is a sawmill machine of new conception, developed over the last 10 years almost simultaneously by American, Scandanavian and German machine manufacturers. Pulp chips, particleboard chips and sawn lumber are produced with it in one working step. The following description of the construction characteristics, output and technological utilization refers to a German make, built in two sizes under model designations V25 and V40.

Technical data:	V25	V40	
log diameter, maximum	40	56	cm
log diameter, minimum	8	10	cm
log length, maximum	6 (8)	6 (8)	m
log length, minimum	2.5	1.5	m
feed speed producing pulp chips	45	30, 45, 60	m
feed speed producing board chips	-	22.5	m/min
length of pulp chip	17-30	17-30	mm
length of board chip	-	25	mm
cutting depth per head	100/125	100/150	mm
power requirement up to	2x75	2x110	kW

46. The machine consists essentially of two chipper heads positioned opposite each other at distances to each other which can be adjusted mechanically or hydraulically. The chipper heads are equippped with knives and their number (minimum 2, maximum 12) depends on feed speed, thickness and length of chip. Each chipper head is driven directly by one electric motor. The given feed speeds are invariable. A change in feed would cause a change in the length of chips, which is the function of number of knives, feed speed and rate of revolutions of the chipper head.

47. An important part of the machine is the feeding and centering mechanism at the infeed side since automatic feeding is indispensable with the high feed speeds.

48. Planing heads for obtaining a planed lumber surface can be connected to the outfeed side. A further possibility is given by the attachment of a circular re-saw unit with 3 retractable saw blades cutting the cants coming from the machine up to a cutting depth of 100mm in one working step.

49. The ratio of [illegible] determined by the technical possibilities [illegible] considerations. It is the purpose of the machine to produce [illegible] lumber from small-diameter logs and still obtain pulp or particleboard chips from the lateral sections of [illegible] with a minimum loss.

50. A recovery determination on the V40 double canter chipper had the following result:

Logs ∅ (cm)	11-13	13-15	15-17	19-21
Cants (cm)	8/10	8/12	2 x 6/12	2 x 8/16
	%	%	%	%
Lumber	55.0	56.0	58.0	62.0
Chips	41.0	38.0	36.0	33.0
Sawdust	4.0	6.0	5.5	5.0

51. The important feature of log processing with the double canter chipper is the high feed speed (up to 60 m/min). With this, a machine processing small-diameter logs with a mean diameter of 20cm in a pre- and re-saw mill attain a capacity of about 200 m^3 of log volume in 8 hours. Two men, one as operator of the double canter chipper and one for the re-saw machine (circular or band re-saw) suffice for the handling of this log volume, since the whole processing of slabs is done away with.

52. This gives the prerequisites, that no other machine has, to cut small-diameter logs in an economical way.

53. The economical calculation shows, however, that a double canter chipper with the necessary mechanisation expenditure will only be lucrative if the following conditions are fulfilled:

a) Annual cutting volume must be at least 20,000 m^3 of log volume.

b) Proceeds realised by the sale of pulp or particleboard chips should be so large as to cover at least personnel and operating costs as well as depreciation.

c) Proceeds realised by the sale of pulp or particleboard chips should not be much lower than the proceeds realised by sale of the side slabs and edgings which could be obtained from the same amount of wood, minus the handling costs.

54. Point (c) shows that logs over a diameter of 45cm or 38cm are generally not processed any more on the double canter chipper, since it is more lucrative to saw the lateral sections (slabs) of these logs into boards.

55. Double canter chippers are up to now predominately employed for the cutting of conifers. Cutting trials with tropical deciduous trees and different eucalyptus species have however yielded very good results. If one considers furthermore that plantations with fast-growing conifers, in particular Pinus species, have been started by numerous developing countries which will in a few years produce large amounts of small-diameter logs from thinnings, this will give the prerequisites for a successful employment of double canter chippers in those parts of the world as well.

B. Circular Saw

56. The circular saw was introduced in England in the 18th century as a headrig for log cutting. The machine today still plays a major role in the former British colonies.

57. The simple model of the circular saw has one saw blade. Its saw arbor is driven via a direct drive motor or via V-belts. The log is clamped onto a travelling carriage and is pushed through the circular saw blade manually.

58. Modern types and those for the cutting of large-diameter logs have a clamping carriage with electric drive, hydraulically operated headblocks and preselection of the cutting thickness.

59. The circular saw as headrig in a sawmill will be eliminated within a reasonable amount of time in favour of the gang saw or log band saw. Of all machines, the circular saw yields the smallest recovery of lumber due to its large kerf which, depending on saw blade diameter, amounts to 15-25mm. Circular saws with two saw arbors, working with one top and one bottom saw blade, do not bring any fundamental improvements.

60. In comparable cutting capacity the power consumption of the log circular saw is 2-3 times higher than that of a gang saw or log band saw.

61. Circular saws as headrigs are justified in modern sawmills where they are used as re-saws for the production of railroad sleepers or cants. Lesser cutting depths and saw blades with a maximum diameter of 800mm suffice for this assortment.

62. Double log edgers have two adjustable saw blades positioned next to each other. The infeed has a chain-bed with fixed or insertable dogs.

63. The loss of cut plays a minor part with this machine, since the kerf is only on the outer part of the log and apart from this, only logs of lower quality grades are used.

III SELECTION AND COMBINATION OF LOG CUTTING MACHINERY

64. It appears from the descriptions of these machines that their features of construction are adapted to specific log dimensions, wood species and production programmes, and further that their ranges of utilisation more or less overlap. This last circumstance often gives cause to the issue of what machine type should be preferred. This is then decided in traditional ignorance of other machines in favour of the customary and hitherto commonly used type.

65. Criteria for the proper selection of a machine for the cutting of logs are:

- Log dimensions (minimum - maximum diameter
  minimum - maximum length
  log shape)
- Wood species
- Capacity
- Cutting programme.

66. Other considerations, such as investment costs, power consumption, saw blade maintenance, etc., are of secondary importance for the optimum technical solution.

67. A sawmill will often require a combination of various machines in order to meet the given requirements. The following is a general view of the most frequent sawmill types:

a) Plain Gang Saw Mill

with one or more gang saws, cutting of mass assortments up to a log diameter of about 60cm, conifers or deciduous trees.

b) Combined Gang - Circular Saw Mill

with gang saw as the pre-saw and double log edger as the re-saw machine, sawing of railroad sleepers or structural timber up to about a diameter of 70cm.

c) Plain Band Saw Mill

with horizontal or vertical log band saw as the headrig machine and heavy band re-saw as the re-saw machine; sawing of special assortments, large-diameter logs, also tropical hardwood, up to a log diameter of 150cm.

d) Combined Band - Gang Saw Mill

with vertical log band saw as headrig and gang saw (if occasion makes necessary, with split rollers) as resaw machine; cutting of all marketable assortments up to about a log diameter of 100cm.

e) Chipper Mill

profiling by double canter chipper, resaw on circular resaw or double band saw; sawing of mass assortments of conifers and deciduous logs up to a diameter of 30cm.

IV MECHANIZATION OF SAWMILLS IN DEVELOPING COUNTRIES

68. A few fundamental considerations on the mechanization of sawmills using these machines will follow in order to give a clear picture of the machinery described for the sawing of logs.

69. Mechanization within a sawmill is first of all understood to be the replacement of manual labour for all internal mill material transport by the application of conveyor units, lifting appliances and cranes or a pneumatic conveyor system. Part of it is the feeding of the machinery and material removal from the machines. Numerous other working processes can be mechanized besides pure transport work, such as measuring and sorting logs and sawn lumber with the aid of electronic equipment, automatic separation of main and side products, stacking, packaging, etc.

The fully automatic sawmill functions without any labour force and no longer presents technical problems, but financial investment as against corresponding earning capacity must be considered.

70. It is a widespread, but erroneous, idea that one can abandon mechanisation in the developing countries due to their low rate of wages or be satisfied with a minimum of mechanization.

71. Also, of the machines described, the most economical is always the model with a high or the highest capacity. However, heavy-duty machines do require for their full capacity utilization of unbroken material supply and fast removal of material, which is not achievable using a large working force but only by adequate electrically driven conveyor units. This is true in particular for tropical hardwood sawmills where logs of large dimensions and heavy weight must be handled.

72. The method of operation takes its course in a well run sawmill from beginning to end of each shift in a pre-determined steady pace. The output of each machine is coordinated with each other. Human muscle power depends too much on the working willingness of the individual and other imponderables for them to carry out in the long run, the required optimum working tempo.

73. Another aspect is the quality of the work performed; in mechanised plants it is often estimated to be higher, but in all cases more uniform, than when using manual labour. For instance, no mistakes can be made with an automatic lumber sorting unit due to inattention or fatigue of the operator. Likewise, less mistakes are possible on an automatic sharpening or swaging machine than on a hand operated one.

74. Additional investment expenditure for the mechanization of sawmills in developing countries should in principle be answered in the affirmative. No all-encompassing answer can be given to the degree of mechanisation; it not only depends on the production programme and investment means available, but also on local conditions.

75. A characteristic factor for the degree of mechanisation is the hourly wage costs per m^3 of log volume.

76. Fully mechanized sawmills in Europe achieve productivity figures of 1.0 - 2.5 hours/m^3 of log volume. Included in this figure is all work done in the log yard, mill building, saw doctor's room and lumber yard, including loading. Whilst the portion of wage costs in Europe reaches 65-70% of the total sawing costs, in most of the developing countries it should be at about 40% of the sawing costs. From this it can be concluded that an economically viable operation can still be attained in these countries with an hourly wage expenditure of from 3.0 - 6.0 hours/m^3 of log volume and still produce at competitive rates.

CONCLUSION

77. In summary, it can be said that a considerable boom in the economic development within developing countries can be expected for the wood industry. A series of efficient machinery for the sawing of logs is available for equipping sawmills. The economic success of a mill will depend, among other things, on the selection of the proper machinery and the knowledge of their technical features and their employment possibilities. Mechanization of the main operations is recommended in principle, in spite of the small wage rates in developing countries.

78. The technical equipment of sawmills in developing countries must meet international standards and at the same time be coordinated with the special requirements of these countries.

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