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Technical Meeting on the Selection
of Woodworking Machinery

Vienna, 19 - 23 November 1973

THE SELECTION OF MAINTENANCE EQUIPMENT FOR WOODWORKING PLANTS 1/

by

Ahti Akkanen
Lahden Rautateollisuus Oy
Lahti, Finland

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SUMMARY

The amount of work devoted to maintenance in woodworking industries has increased continually in the last few years. Industrial managers have learned that an idle machine and losses due to that will cost much more than the money spent on reasonable provisions against undue standstills, in other words: on effective maintenance techniqes . Minor and medium establishments in general still take a sceptical attitude towards preventive maintenance, but I am convinced of its justifiability under all circumstances, provided that the program is planned reasonably considering the local conditions and facilities. Overmeasures as well as overhasty steps should of course be avoided.

In my personal opinion the importance of preventive maintenance is ever-increasing, among other things due to following facts:

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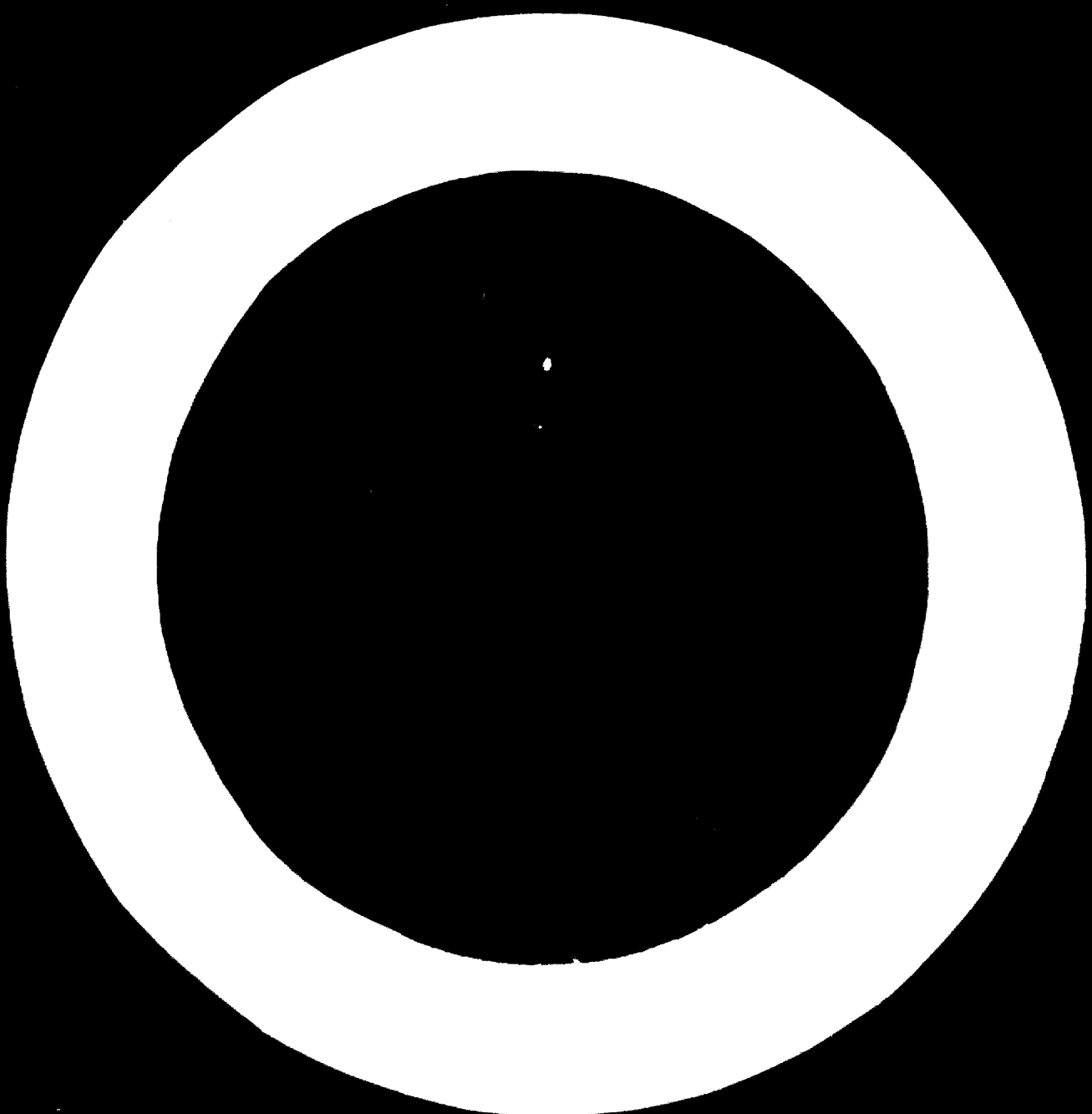

1. The continual progress of rationalization, mechanization and automation in all lines of industrial activity will reduce the actual productive labour intensely even in the future.

2. Simultaneously the equipment grows rapidly and becomes more and more complicated.

3. In consequence of the development, even a standstill of the most trifling part of the process equipment, in all probability would stop the entire production. By that means, one operation trouble trivial as such would bring about enormous monetary losses, if the fault could not be repaired in a very short time.

4. The immense growth of industrial investments inevitably requires that the production be kept running uninterruptedly day and night, in 3 or at least 2 shifts.

5. The revolution rates, temperatures, pressures, electric capacities, etc. have increased, and cause faster wearing down.

6. Better accuracy of machines and higher quality of products is made a necessary condition for succesful competition on the world market.

7. It must be possible to move machines and equipment without delay.

8. Safety, industrial hygiene, noise abatement, pollution abatement and waste problems charge the maintenance technique with new obligations.

Establishments working under the difficult conditions of developing countries, far away from manufacturers of machines, have to choose between two alternatives: either to train skilled maintenance men, fitters and mechanics, or to try to solve the maintenance problems by replacement technique. The latter alternative means spare parts, spare equipment, and even spare machineries ready to be mounted in place of the damaged ones. Faulty equipment, if still good for repair, is shipped to a qualified repair shop for overhaul. Nevertheless, a trained maintenance crew is avoidable as are repair facilities, implements, etc., or otherwise even the smallest troubles would stop the production at short intervals. Therefore, the machine manufacturers should be demanded to organize the necessary training, either in their own or in the purchaser's country.

The manufacturers should provide all possible information concerning the maintenance of every machine, as well as adequate implements and spare parts to that purpose. They also should identify earlier users of similar machines, which could give advice from experience.

Because it would not be justified to keep specially skilled workmen for jobs needed only a few times in a year in small establishments, e.g. in a saw mill, it is plausible that certain maintenance works will be given to specialised subcontractors. E.g. a repair shop of adequate size, specialized in machines as well as in electric and electronic equipment, could undertake the more complex maintenance jobs for a fairly large region. And that should particularly include preventive maintenance.

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Vienne, 19-23 novembre 1973

RESUME

LE CHOIX DU MATERIEL D'ENTRETIEN POUR L'INDUSTRIE DU BOIS[1/]

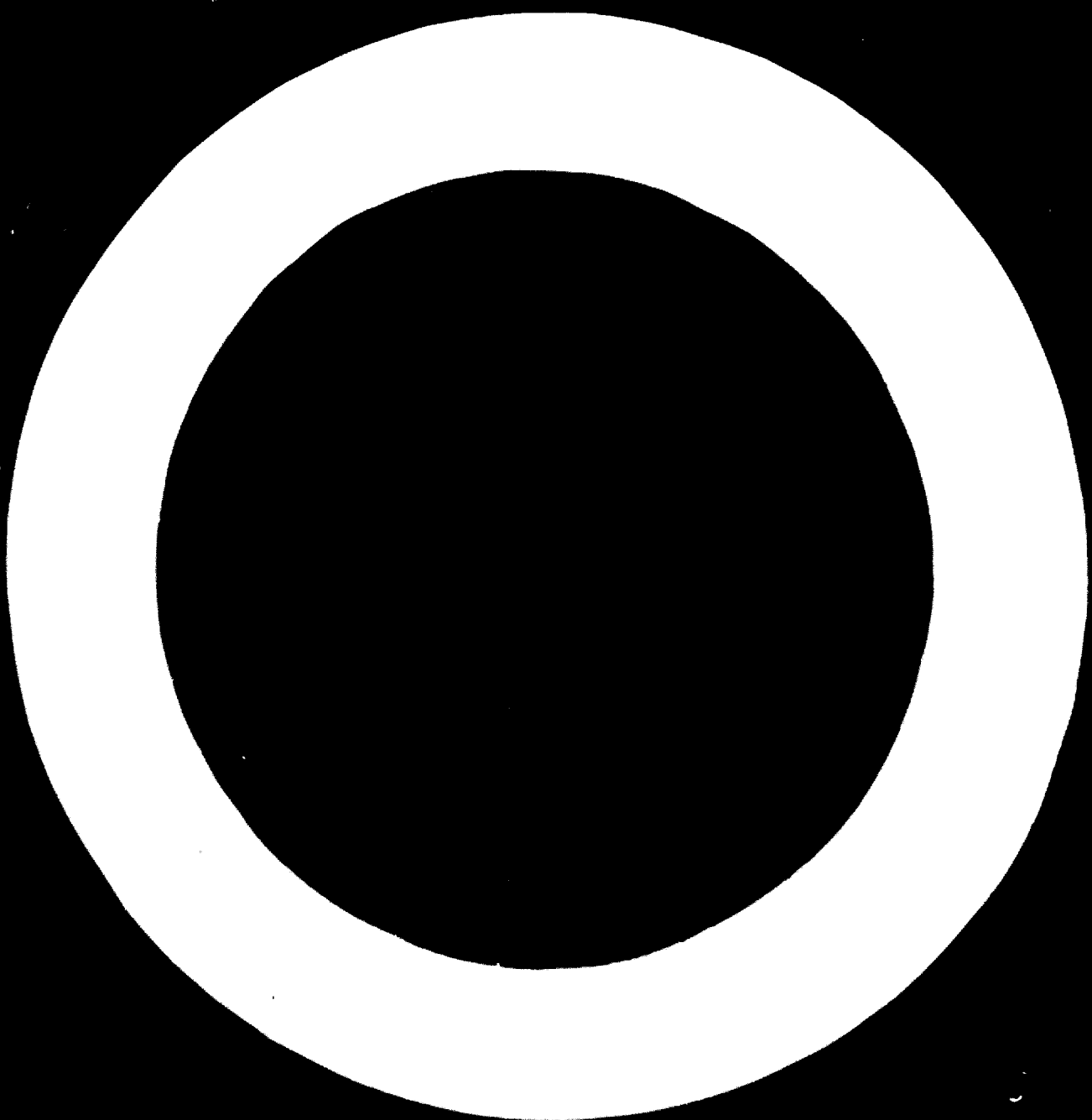
par
Ahti Akkanen
Lahden Rautateollisuus Oy
Lahti (Finlande)

On consacre depuis quelques années de plus en plus de temps à l'entretien du matériel dans l'industrie du bois. Les industriels ont constaté que la défaillance d'une machine et les pertes qui en résultent coûtent beaucoup plus cher que les précautions raisonnables prises pour s'en prémunir, et qu'elles sont en fin de compte bien plus onéreuses qu'un entretien efficace. Les petites et moyennes entreprises font encore preuve de scepticisme à l'égard de l'entretien préventif. Il ne s'en justifie pas moins quelles que soient les circonstances, pourvu que le programme soit établi avec discernement et en tenant compte des conditions et des possibilités locales. Tout excès et toute précipitation sont bien entendu à éviter.

L'entretien préventif revêt de plus en plus d'importance, notamment, pour les raisons suivantes :

1. Les effectifs de la main-d'oeuvre employée directement à la production continueront de diminuer du fait des progrès constants de la rationalisation, de la mécanisation et de l'automation dans tous les domaines de l'activité industrielle ;

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.



2. Le nombre et la complexité des machines ne cessent de croître.

3. En raison de cette évolution, la moindre défaillance du matériel risque fort de provoquer l'arrêt total de la production et, partant, de lourdes pertes d'argent si la défaillance ne peut être réparée rapidement

4. La croissance considérable des investissements industriels exige que la production soit assurée sans interruption, de jour comme de nuit, par trois ou tout au moins deux équipes travaillant par roulement.

5. L'accroissement des vitesses de rotation, des températures, des pressions, des puissances électriques, etc., accélère l'usure du matériel;

6. Une plus grande précision des machines et une qualité supérieure des produits sont des conditions nécessaires pour affronter avec succès la concurrence sur les marchés mondiaux.

7. Les machines et le matériel doivent pouvoir être déplacés rapidement;

8. Les exigences en matière de sécurité, d'hygiène industrielle, de réduction du bruit, de protection de l'environnement et d'évacuation des déchets imposent des nouvelles obligations aux services d'entretien.

Les entreprises des pays en voie de développement, qui connaissent des conditions d'exploitation difficiles et sont éloignées des centres de production de machines, ont le choix entre deux solutions : soit former du personnel d'entretien qualifié tels que graisseurs et mécaniciens, soit s'efforcer de résoudre les problèmes d'entretien en remplaçant les pièces défaillantes. La dernière solution exige le stockage de pièces détachées, d'éléments d'équipement et même de machines entières prêtes à être installées à la place de celles qui sont en panne. S'il est réparable, le matériel défaillant est confié à un atelier de réparation pour être remis en état. En tout état de cause, il est nécessaire de former du personnel d'entretien et de disposer d'installations de réparation, d'outillage, etc., pour éviter que la production ne soit arrêtée fréquemment, à la moindre défaillance. Par conséquent, les fabricants de machines devraient être invités à dispenser la formation nécessaire, soit dans leur pays, soit dans le pays du client, afin de permettre à ce dernier d'assurer l'entretien de son matériel.

Les fabricants devraient mettre à la disposition de leur clientèle tous les renseignements, l'outillage et les pièces détachées nécessaires à l'entretien de chaque machine. Ils devraient également s'efforcer de rechercher les utilisateurs de leur matériel susceptibles de faire profiter de leur expérience les acheteurs de modèles analogues.

Comme il ne serait pas rentable pour une petite entreprise - une scierie, par exemple - de maintenir du personnel qualifié auquel on ne ferait que rarement appel, certains travaux d'entretien pourraient être confiés à des firmes spécialisées. C'est ainsi qu'un atelier de réparation suffisamment important, équipé pour effectuer des travaux de mécanique et réparer les équipements électriques et électroniques, pourrait entreprendre les travaux d'entretien les plus délicats pour toute une région et plus particulièrement s'occuper de l'entretien préventif.

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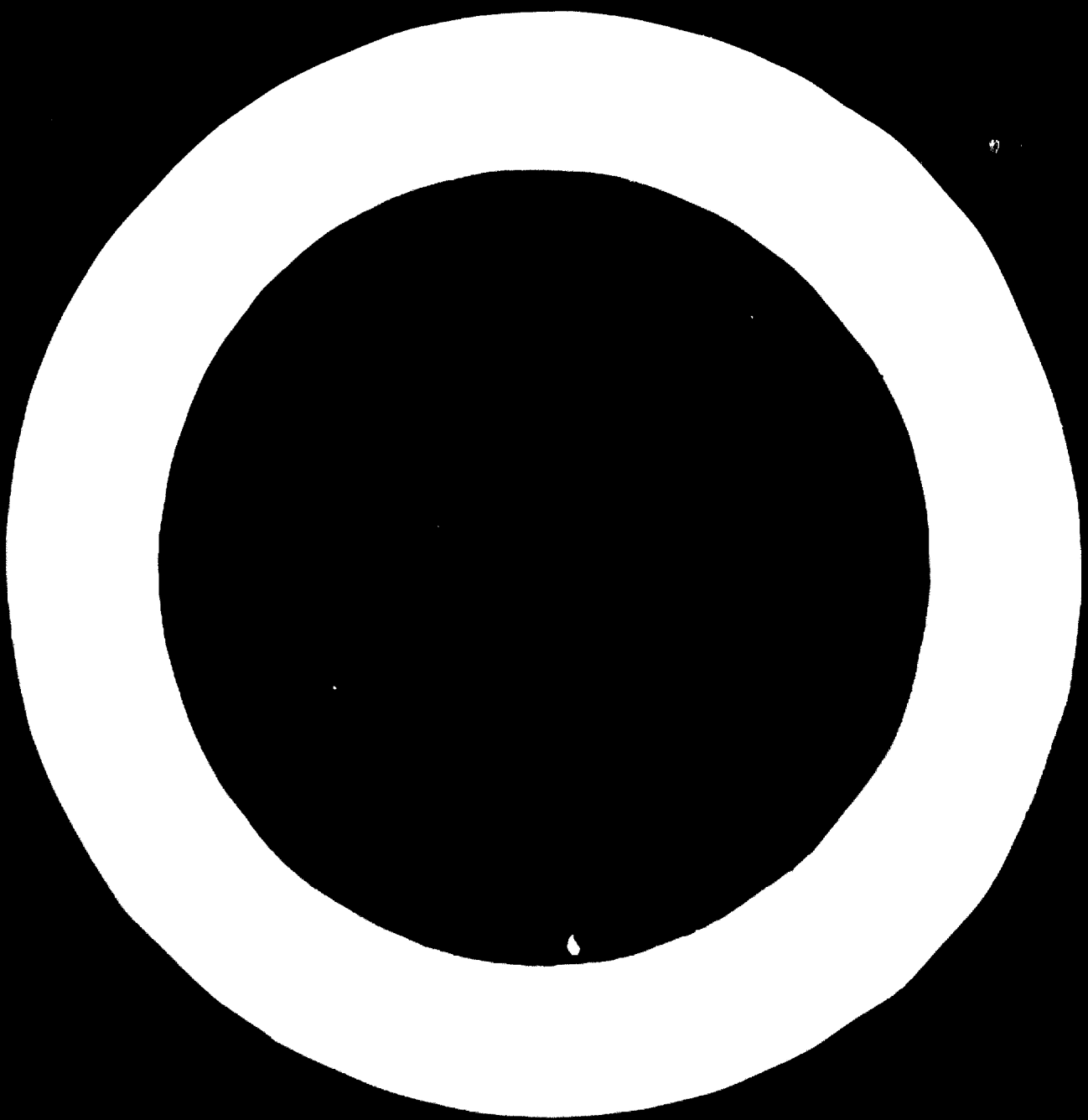
PREFACE

1. This paper should be of greatest benefit to the large woodworking enterprises which represent large investments and require a sophisticated approach to maintenance and, although not yet common in developing countries they are more and more being considered as necessary to meet competition on world markets. It is, therefore, more comprehensive than had it been aimed at the small and medium-scale operations.

2. The lists of maintenance tools and equipment, machine cards and inspection systems must all be considered in this light, also remembering that a certain generality is necessary in any treatment with as broad a scope as this one.

3. The diagnostic and problem-detecting recommendations should, however, be of particular interest to small and medium-sized enterprises as is the short list of inspection implements (sections VIII and VI).

4. It is hoped, therefore, that the advice and recommendations of the author will be interpreted with this in mind and that the paper will be of use to woodworking firms of all sizes.



I INTRODUCTION

The present-day maintenance and recondition/ing of machines and equipment is no more plain repairing damaged equipment and replacing broken or worn-out machine parts, not even in the woodworking industries, but/the following/of a systematic maintenance program, and the continual observing of the machines in operation, in order to prevent interruptions and losses caused by damages as well as premature wear.

Unfortunately, the attitude in small and medium establishments generally is such that repairs are undertaken only in case of breakdown. In that event, the repair forces are alarmed like/a fire brigade. The broken equipment is repaired in anxious haste, trying to put things right at all costs. Other parts, and possibly implements also, may be broken in that hurry, but nobody troubles himself about such trifling matters, if only the evil is removed as soon as possible, and the production can be started again.

Such attention is excused by the argument that it would not be payable to sustain a well-organized but expensive maintenance system for more incidental breakdowns. In reality, such/an approach becomes considerably more expensive in the long run than an effective and versatile maintenance crew with necessary repairing facilities, whose principal task is preventive maintenance. Yet the elderly industrial managers do not understand such kind of "wasting money". An absolute change of attitude is inevitable in this respect, and a maintenance engineer needs a good deal of diplomacy as well as thorough professional skill, and clear-cut calculations to be able to convince his conservative principals of the matter. Figures possibly adapted to the actual conditions of production activity are the very best arguments when trying to get the rigid maintenance organization of an old plant

II PREVENTIVE MAINTENANCE

What is to be understood by the term Preventive Maintenance? It, as the maintenance on a whole, includes every machine and machine part exposed to wear and tear due to motion and/or to corrosion. In a wider sense, the preventive maintenance also includes the electric distribution gear, pipe lines, buildings, roadways, etc., i.e. all facilities providing for trouble-free continuation of production on the whole.

The preventive maintenance is performed by observing the machinery and equipment in operation as well as during stoppages by regular inspections and by lubrication according to the instructions, considering the modifications due to the local conditions. In the critical points of production, where a standstill would stop the entire plant or a part of it, the wearing parts of machines and equipment should be replaced at regular intervals, even though not completely worn out or otherwise damaged. Such preventive measures provide against unexpected breakdowns and standstills. These replacements are made during normal idle times, i.e. when the plant or a part of it is stopped over night or weekends. The frequency of replacements is determined by long experience. A necessary condition for working out an appropriate time-table is through maintenance bookkeeping that includes the critical points. In case of new machines, where conclusions cannot be drawn from one's own experience, valuable information could possibly be obtained from other establishments using identical or similar machines. It is true that such experiences can rarely be adapted and used as such, due to varying working conditions, but they provide a basis for planning the maintenance. The machine manufacturers of course provide the purchaser with basic instructions for maintenance.

In all cases the Finnish manufacturers give realistic data on expected life of equipment, machines and machine parts, based on experiences drawn from users during a long period.

The spare parts recommendations given by the manufacturers are to be followed with good reason, but not blindly, because own experiences derived from the actual working conditions are decisive, as is the careful maintenance.

This kind of active maintenance work planned and prepared in detail, in order to prevent losses caused by undue standstills and perform the repairs during normal idle times, may be new and possibly even utopistic in many cases, but I dare say that the smaller the plant the more important is the effort to minimize the losses of time, since only in that way it will be possible to keep the prices low, and stand the hard international competition.

The preventive maintenance is by no means a new idea in our society. Certain machines and equipment, such as aircrafts, ships railway engines and vehicles, lifts, pressure vessels, etc. have been regularly inspected and repaired during several decades, and even automobiles are tested ordinarily once a year.

The aim of preventive maintenance is to keep pace with the course of development, in order to make the necessary repairs in advance, before the wear, corrosion or other faults cause a breakdown and a standstill if not greater damage. It is of vital importance that

a) replacements or repairs are made early enough to prevent actual breakdowns,

b) the course of action is carefully planned and prepared in advance,

c) measures are taken opportunely with regard to normal idle times, so that the production is hampered as little as possible.

III PREPARATION OF MAINTENANCE PROCEDURES

As mentioned before, an unexpected operation trouble or breakdown gives rise to anxious repair measures with all possible forces available, and in feverish haste. It often happens that the work must be done with inadequate implements and materials, maybe provisionally and even carelessly. Though the machine or manufacturing line is idle, there is neither time nor facilities to interfere in other points requiring maintenance or repair, even when identified. The repair calls for overtime work, work on Sunday, emergency work, and it is not unusual that the repair forces must be alarmed at midnight. Such haste and lack of planning becomes very expensive.

If, on the contrary, the management as well as the maintenance crew are aware of the stoppages and the repair work in advance, it is possible to work on all objects requiring recondition. Necessary implements, spare parts, materials, transport and hoisting equipment as well as drawings are provided to the site. The men are selected and got to do their tasks according to individual skills and the working procedure is planned carefully. Everything is carried through quickly and according to plan. The results are worth the trouble.

Presently, the trend of preventive maintenance consists of a fairly wide field of activities including among other things:

- inspections and tests of different machines and equipment
- small repairs, settings, adjustments, cleaning, etc. during the inspections
- planned repairs according to the inspection findings
- overhauls and thorough repairs planned in advance, and regular repairs during normal stoppages
- regular lubrication according to time-tables
- investigations and corrections of raw materials and constructions

- resharpening of tools
- comparative investigations of dissimilar safety arrangements, and possible recommendations on the basis of results.

Preventive maintenance is not free of charge but costly, since it involves the following costs:

- Numerous working hours for inspection, taking apart, cleaning, fitting, readjusting, etc.

- Machine parts must be replaced long before they are really worn out. That results in a large supply of half-worn parts unfit for use.

- Machines must be stopped for inspection and repairs because all maintenance work cannot be done during stoppages due to high overtime wages.

- The inspectors need expensive precision instruments.

- The maintenance system makes necessary a certain amount of increased bureaucracy, forms to be filled, files, etc.

The amount of work - and resulting costs depend to a great extent on the length of intervals between the inspections. Therefore, the real need of inspection should be weighed carefully for every object separately, in that way the inspection period can be justified by accurate calculations as well as by experience in the long run. The following questions can be put in order to make the planning feasible:

- Is the machine or device in question of vital importance for the production?

- Would an unexpected breakdown really cause a serious situation?

- Is it or is it not possible to purchase a reserve device?

- Is it possible to prove that the preventive maintenance will be less expensive than the losses caused by a possible stoppage.

- Is it sure that the machine or device does not wear for an unnecessarily long time, due to preventive maintenance, i.e. longer than would be economically payable?

- Would it cause disadvantage to the production, the labour, the quality of product, safety, etc., if the machine or device would be excluded from the preventive maintenance schedule?

In spite of all the expenditure involved in preventive maintenance, it should be regarded as a paying investment, since it causes savings e.g. in the following ways:

- It provides against unexpected stoppages, or at least reduces the number of such incidents.

- It reduces direct maintenance costs by cutting down the number of overtime, Sunday and emergency working hours as well as reduces the need of alarming the personnel from home.

- It reduces the need of purchasing new machines, equipment and parts, etc.

- It renders possible to plan and make preparations for effective maintenance

- It improves working safety and fire prevention, and has a positive effect upon the motivation and attitudes of labour, etc.

The principles and the trend of prospective activity should

be explained to everyone concerned in any way. It is of course most important to gain unreserved support from the management in its entirety. The management usually is accustomed to think about and appraise things converted into money. As a matter of fact, preventive maintenance is nothing but an investment from their point of view - fully comparable with the purchase of a new machine - and the management is entitled to insist upon some plausible argument for the profitableness of that investment.

It is quite natural that the economic importance of preventive maintenance cannot be evaluated precisely. However, certain ways of appraisal are at hand:

a. Statistics on stoppages in the last few years are worked out, endeavouring to make all the resulting costs and losses clear (unproductive and additional wages, repair costs, damaged products, losses of time, losses of output, wasted overhead, restarting, etc.). Effort is made to calculate the price of each particular stoppage.

b. The expenses of preventive repairs are evaluated, provided that those would have been carried out early enough and carefully prepared in advance, according to information received from the preventive maintenance inspectors.

c. The difference in costs between items 1. and 2. can be invested in preventive maintenance with good reason.

d. It also may be possible to refer to experiences from other establishments - in particular from those in the same line of business - articles in professional journals or specialist literature, etc.

An exellent means of "selling" the idea could be a permanent exhibiton of preventive maintenance. The exhibits would include broken parts of different machines and equipment, with reports on the causes of breakdown, and suggestions

for preventive measures to provide against such breakdowns. Such a collection would most effectively teach by object-lessons, and I don't believe that one would meet any difficulties to find suitable "educational supplies" in any industrial establishment. It must be admitted that it is really very difficult to prove the profitableness of preventive maintenance in a continuous process industry, where the production line should be stopped voluntarily for overhaul at certain intervals. Nevertheless, the preventive maintenance is extremely important in such industries, and the program should be put into practice in spite of all reservations. Empirically, a very succesful method for fixing the moment of stoppages for overhaul is a so-called elastic program in which the production management is asked for a stoppage to begin within a certain period (e.g. in the course of next 20 days). It can be arranged in due time with regard to the requirements of production by that unit. Of course, the machinery should be observed carefully in operation for all possible points requiring closer inspection and/or repair. Adequate preparations should be made for best possible efficiency of repairs during the stoppage.

It should be made clear from the very beginning that the results of preventive maintenance cannot reasonably be anticipated immediately after the program is started. Several years may elapse until concrete results can be demonstrated. Keeping that aspect in mind, it would be useful to begin with a limited object and preferably with one which in all probability would bring perceptible results within a reasonable time. Proceeding in that way, the maintenance engineer is able quite soon to give evidence of savings, even if modest ones, and the continuation will be easier. For instance, such a very limited object can be the connecting rod on a gangsaw - or any other movable machine part exposed to heavy strain - whose condition can be checked by ultrasonic measurements.

It is not absolutely necessary that the personnel for preventive maintenance is employed in a special department, even though such a department is often formed. The crew can well be charged with ordinary repair jobs besides the periodically repeated preventive maintenance tasks. It is, however, important that the manager of preventive maintenance is as qualified for his post as possible. In addition, he must be free from other duties, because the setting-out, planning and development of suitable preventive maintenance technique cannot be performed as a side-line. I will not maintain that the present maintenance management would be incompetent for managing the preventive maintenance, but it has no time left for that purpose. That is why the executive as well as the working crew should be free from the daily routine. In all events, a maintenance foreman should be named. He should be a trained machine technician well at home in repair work, and acquainted with the local working conditions, machinery, etc. He should be allowed to participate in the planning of the preventive maintenance system from the very beginning, and charged with obtaining information about the need of maintenance, making up card files, etc. As a rule, it is estimated that a maintenance department including about 100 workmen at least requires an educated engineer for organizing and leading the preventive maintenance.

IV SETTING OUT A PREVENTIVE MAINTENANCE PROGRAM

Before putting into practice a true preventive maintenance system a great deal of preliminary work must be accomplished, and that may require months and even years. Therefore the work should be set out without delay. The only way to make rapid progress is to detach labour for that purpose exclusively and not to charge them with other tasks - even when that would be tempting. Necessary preliminary work includes e.g.:

a. Providing the machines and equipment items with identification numbers, and working out reponsive card files. The card index must not be made up head over heels, but only after thorough consideration. The purpose the index is to serve must be defined, and what kind of information really is worth writing down, should the cards be written by hand or typed (spacing of lines decided upon), where will the files be kept, who is responsible for them, etc.

b. The machine documents, such as instructions for application, maintenance manuals, instructions for lubrication, spare parts lists, technical descriptions, information about ancillary devices, correspondance concerning the purchase, etc., make an essential resource for deliberating suitable measures of preventive maintenance. A lot of people need these papers, and it is due to that they are very liable to vanish now and then, and even to be lost for ever. It is advisable to file them in suspension cases in a locked room, providing each case with the machine identification number. A record-keeper is made responsible for the files, and he has to make a note of every lending in the lending list preferably attached to the suspension case. It at least will be possible to find whoever happens to keep the papers in possession. It is of course essential that the documents be duly translated into the users' native language.

3. The drawings [illegible] reasons of [illegible] machines, [illegible], involve a great number of drawings: foundation and erection drawings, part and spare part drawings made by the manufacturer or by the user, modification drawings (e.g. a slide bearing replaced by a roller bearing), [illegible] electrical drawings, wiring diagrams, etc. Antiquated and otherwise useless drawings should be destroyed when putting [illegible]. All essential drawings should be kept in duplicates to be on the safe side, e.g. the original and a reproduction. These should be stored separately to provide against destruction by fire, etc., although the most safe way is to photograph such drawings on microfilm, and keep the films in a fireproof safe-deposit. It is often advisable to keep one set of assemblage and spare part drawings in the spares store room, where they can be used for acceptance inspections of coming goods, for checking the fitness of parts, as instruction drawings in emergencies, etc. The spares store room possibly is the suitable place for entering modifications on the drawings and undertaking to keep contact between the repair shop and the designers.

4. Statistics [illegible] should bring information about the causes of troubles, and the resulting costs should be recorded. The stoppages of single machines should be distinguished from those of the entire production process. The latter must of course be recorded in detail, but the stoppages of single machines should be noted as well.

5. Detailed information of repairs accomplished should be recorded continually. The most simple way - if not always very effective - is to attach a card to every machine, and oblige the repair man to enter all repairs accomplished on it. A more frequent practice is the use of work dispatches, including a great deal of useful information. Sometimes the repairs are written down in a repair book or only the reports written on the time-cards are transcribed.

The main point is that as complete information as possible about all repairs is recorded - usually on machine cards or on separate repair cards - and that the information is analysed, weighed and made use of. It is by no means possible to eliminate the proven high repair costs each time, only by intensifying the preventive maintenance efforts. Very often conditions are encountered, under which it must be recommended to scrap the machine in question urgently and replace it with a new one. It is not unusual that a revision of cards reveals, for instance, that 25.000 marks were spent for repair of an electric motor in the current year, while the purchasing price of that machine is only 15.000 marks. To prevent returns of such circumstances, it must be made completely clear which kind of repair is payable, and which is not.

6. Circuit diagrams of all essential supply lines (water, electric current, pressurized air, gas, steam, fire sprinkling system, etc.) as well as of ventilation, dust removal and sewer systems are an important resource for the planning of preventive maintenance technique. Many establishments still live in days gone by, and have confidence in tradition and recollection of some veterans, but in plants growing up there must be some facts put on paper also, like the approximate courses of circuits, dimensions and capacities, materials, valves, cocks and switches, connections and couplings, etc. Working out the circuit diagrams no doubt is hard work, but it usually will pay almost immediately, because it reveals a great number of ancient blunders, planning errors, inconsistencies, inadequately dimensioned mains, faulty connections, useless valves but also lack of valves where they would be needed, leakages, and even risk of fire due to poor insulation, etc. It will not be easy to find "missing" pipings and cables hidden in concrete or in the soil outdoors. Special metal detectors, so-called "mine rakes", have been used succesfully to that end, without calling for vast excavations. In all events, it would not be desirable for a main water pipe to be broken or an electric cable of 6 kW torn off by a shovel dredger

when digging foundations for a new building - which has really happened.

7. Reliable supply facilities for spare parts are an essential condition for systematic preventive maintenance, and they must be arranged from the very beginning.

8. The maintenance crew should be motivated properly, and inspired by the idea. A great deal of money and time can be saved by that means. Versatility, intelligence, judgement, alertness, diligence, and many other qualifications - I would like to say - seldom encountered are called for.

It is a fairly common illusion that the essential condition for succesful preventive maintenance is a well-organized "paper war", properly filled forms, records and files, in short: the bureaucracy. It is true that the forms must be designed in a matter-of-fact way, and that records should be kept carefully, but the preventive maintenance technique can be developed to a fairly advanced stage almost without printed resources. In fact, it is often recommended that the activity should be started quite informally, being contented at first with the requirements of cleanliness and good order. The machines should be observed seemingly without regular plan or schedule. It also is advisable not to imitate forms used in another establishment without more ado, because the circumstances are very seldom quite identical.

The lubrication service, a separate but closely related activity to preventive maintenance is very well suited to be the first object of improvement. If the lubrication service crew (lubrication mechanics) consists of high-standard skilled workmen, it is possible to take advantage of their observations for preventive maintenance purposes.

As mentioned before, it is essential to be able to choose the right starting point for actual preventive maintenance

efforts. It is advisable to begin with such a key point, where unexpected standstills have caused a lot of trouble. If, on the other hand, for instance pumps or electric motors have been the sources of most troubles, the attention can be directed towards that category of machines in its entirety.

INSPECTION TECHNIQUE OF PREVENTIVE MAINTENANCE

The inspection activity can be divided in two different fields:

- routine inspections and maintenance, and
- observation and inspections of certain machines and manufacturing lines according to schedules.

The first category of objects could include:

- electric motors, their switches, safety fuses, etc.
- power transmission arrangements
- pipings, valves and pumps
- transport equipment, lifts
- air-conditioning and dust removal equipment
- illumination installations
- typewriters, calculating machines, etc.
- instruments and automatic controls
- buildings and constructions

Certain categories of equipment, such as lifts, instruments, office machines, etc., require a great deal of special skill, and it is normally not justified to employ specialists for such very limited fields of activity. It is known from experience that there must be, for instance, about one hundred pumps to care for before the employment of one specialist pump fitter becomes justified. In most events, it is advisable to subcontract the inspection and maintenance of such equipment. However, the maintenance organization may include detached work teams (servicemen) specialized in the maintenance of pipings, valves, pumps, power transmission arrangements, electric motors and installations, etc.

After the objects of preventive maintenance have been made clear, it should be determined which particular points of each object must be inspected, and what should be the

inspection frequency. Unfortunately, both of these essential problems are dependent on local conditions to the extent that it is not possible to give any directions of general application. As an example, the general inspection and maintenance schedule fixed by an industrial establishment is related below.
It is followed, if not otherwise called for, for certain cases.

a) Once a week:
- weighing machines
- cooling installation
- photocells
- tools provided with electric motors

b) Every other week:
- belts
- switches, starters
- electric motors
- instruments, electric controls
- air compressors
- pumps
- air conditioning system

c) Every month:
- blowers
- belt conveyors
- pneumatic and hydraulic conveyors
- water treatment arrangements
- hoisting equipment, lifts

d) Once a quarter:
- battery charging outfit
- boilers
- illumination
- welding machines and transformers
- electric hoists, overhead railways

d) Once a half year:
- fire fighting equipment
- water tanks with fittings

- heat exchangers
- pipings, power lines
- heating equipment
- roofs

f) Once a year:
- small electric blowers
- ball bearings in normal use
- buildings and constructions.

The above schedule really is a general one only, because single devices may be inspected and maintained according to special instructions, for instance cleaned daily, readjusted once a week, checked for operation every month, and overhauled once a year. As a matter of fact, appropriate planning and scheduling of inspection frequencies makes the fundamental condition for a succesful preventive maintenance program. Too frequently repeated inspections are a waste of money and labour, whereas a practice of too few inspections may be hazardous considering the useful life of machines. It should be tried and yet the possibility should also exist to alter the schedules as occasion requires. The length of time before next inspection/service should be reconsidered each time the machine or device is inspected and/or repaired. A new machine must be inspected more often than normally at first, but the inspections should be reduced in number gradually. Many industrial establishments insist that the inspector writes down on the report his opinion of the adequacy of the inspection period.

Whoever is observing the inspection reports is able to estimate the adequacy of inspection and/or maintenance frequency, by checking the observations and the nature of repairs. If actual repairs have not been needed, this may reveal that the preventive maintenance is unreasonably effective - and apparently too expensive. Although such exaggregation would not be very serious, it should be kept in mind that too rigid a scheduling has always nearly been the cause of failure in a preventive maintenance program,

because it usually - and often [illegible] - regarded as waste of money. One illustrative example of circumstances, where a total preventive maintenance program has not proved paying, is that of taxi cabs. Presently, only the parts involving [illegible] are subject to regular inspections and maintenance, while e.g. the motor is left without maintenance as long as it runs, and is replaced with a new one in due time. Often the same practice is applied to machine tools driven by electric motors - at least if the motors cannot be reconditioned as fill-in work.

The command for action is received either
- from the card index, the maintenance schedule or programme
- from the indication of an operation time recorder or a revolution counter, or
- as an actual order based on the observations made by the production personnel or the maintenance crew (e.g. a lubrication mechanic).

The inspections are performed in two ways:

a) Machines being in operation are checked for abnormal noise and vibration, wear, faulty lubrication (e.g. oil leakages), running hot, poorly secured parts, play of shafts, poor cleanliness, risky working conditions, etc.

b) When the machines are idle, the inspector is able to make observations far more closely, and at least every third inspection should be made in that way. It is possible, in that event, to inspect and measure the axles, bearings, gears, slide surfaces, belts and belt tensions, flanges, screw joints, etc.

Especially machines producing shavings, chips or saw dust should be inspected closely during stoppages, because parts normally not visible can be observed in that way. At the same time such machines should be checked for fire-safety,

and - especially in tropical climatic conditions - for adequate grease lubrication and its protective effect.

The inspectors often make use of special check lists which facilitate checking of all parts and make it possible to ascertain that the inspection was duly performed. As a rule, the inspector lists the faults other observations, and his recommendations for repair measures. That card related to a machine can also be used for preliminary planning of work, e.g. by applying it to a pigeon-hole scheduling table. It is moved after the inspection to that point on the week/ly schedule, at which the next inspection is considered necessary. The need and number of check lists is dependent on the complexity of the machinery in the establishment in question. As automation advances the check cards become more and more indispensable. They are still seldom used in small and medium woodworking plants

An inspector must not be contented with checking the points specified on the list only, but he has to keep his eyes open, and pay attention to every detail possibly deviating from normal conditions.

There are special instruction manuals for preventive maintenance measures - as for the maintenance on the whole. These maintenance manuals provide more information than the check lists, and give detailed instructions for the technique, such as what must be inspected, in what way, on which conditions, which implements and/or precision instruments should be used, which precautionary measures are necessary, etc.

Certain inspection and maintenance activities can be subcontracted. Such objects are lifts, weighing machines, office machines, etc. It also is often advisable to ask for specialist help from the equipment manufacturers, when large or complicated equipment is overhauled and/or thoroughly repaired.

Utilization of suitable instruments facilitates the work of inspectors considerably. It is possible to fit machines with permanent operation time recorders, revolution counters, ammeters, etc. It also may be necessary to make certain modifications on the machines in order to make the inspection work feasible. Such measures can be e.g. making the guards easier to remove, providing the working site with permanent hoisting facilities, fitting necessary cocks, valves or electric switches etc.

The machine inspectors for preventive maintenance should be highly skilled workmen able to make smaller repairs also, according to their own judgement, though it is not advisable to use those specialists for time-consuming routine jobs; these should take about 50 per cent of their total working time at most. Too "refined" people are not suited for the task, because they may be too careful not to get their hands dirty.

Under certain circumstances suitable work teams have proved appropriate. Such team may include a filer, an electric fitter, or the like. Machine attendants and other production personnel, too, can be charged with certain inspection duties with good reason. That is very much to the purpose during the evening and night shifts, and reduces the number of maintenance crew as also the costs by that means. It also has proved appropriate to change the activity areas of machine inspectors now and then, since that contributes to the versatility of these people.

VI INSPECTION IMPLEMENTS

Although the maintenance equipment until quite recently has been fairly rudimentary it does not consist of an oil can only. Presently, there is on the market a great number of specially designed implements and instruments to that purpose.

One of the most useful inspection practices at the present time is the ultrasonic measurement, by which it is tried to discover the weakening of metals, applying short wave transmitters and receivers. That weakening begins with hairline cracks, and widens sometimes fast sometimes slower until the part in question breaks. Such incidents often leading to severe damages can be prevented, because it is possible to discover the weakening at an early stage.

In the sawmill industry the ultrasonic measurements usually are made on the connecting rods of gang saws that rotates heavy masses - the sashes - and, when it breaks damages without exception the adjacent parts, and possibly breaks down the machine in its entirety. Such accidents in turn stop the production for a long time, as the main machine must be thoroughly repaired or even replaced.

Similar practice also is advisable for testing cutting disks of wood hogs (chipping machines), in particular if the machine is large and expensive. On the whole, it pays to apply ultrasonic tests to all machine parts exposed to heavy strain and/or torsion, such as crankshafts and side posts of gang saws, band wheels of hand saws, large diameter circular saw blades, etc.

The following equipment should be available in maintenance departments of large and possibly medium-sized plants.

Measuring instruments 1/

* - setting gauge, micrometer, measuring rods and metal tape of 1, 2 and 10 m
* - caliber gauge e.g. for measuring the air gap of electric motors
* - revolution counter (tachometer) with various heads

1/ The ones considered most essential are marked with an asterisk.

- light hardness drop tester
- stroboscope with revolution rate, stop, retardation, timing
* - surface thermometer, thermochalks and -colours for observation of surface temperatures
- needle pressure gauge for measuring pressures directly through rubber hoses
* - stop watch
* - ammeter with shear-type or screw base, for e.g. observation of loads on electric motors
- insulation tester, voltmeter - also for static electricity - etc.
- leakage tester, e.g. listening apparatus
- thickness gauge for magnetic paint layer or the like
- illuminatometer (lux)
- ultrasonic, radioactive and X-ray apparatuses for testing material strengths and faults
- magnetic or ultrasonic apparatus for testing surface faults
- pocket microscope, magnifying glass with electric light
- second stop watch
- piece counter
- inclinometer
* - stetoscope for detecting bearing faults.

2. Other implements

* - monkey wrenches and other spanners, tongs, pliers, screw drivers, etc. as necessary
* - electric torch, extension bracket lamp with magnetic holder
* - "oil pen", i.e. a pocket size oil gun
* - cleaning material, solvent, rust preventer, possibly in spray cans
* - suitable self-sealing films and tapes ("scotch tapes")
* - cleaning brushes, clean soft rags.

VII WARNING SIGNALS AND MACHINE CARDS

Operation troubles and possible evil-boding faults can be controlled by means of various light or sound signal systems. Such signal systems, however, are applicable in the first place, to actual process industries such as pulp and paper mills, but less often to sawmilling or woodworking plants. Nevertheless the Finnish machine manufacturers provide their saw timber and veneer dryers with alarm systems revealing e.g. a stop of blower fan, overheating or cooling of heating medium, etc. An automatic veneer guiding system in turn reveals operation troubles or breaks of the wire-cloth conveyor belts, failures in the guiding system, feed jams, etc., by light or sound signals. By that means, it is possible to become aware of troubles in points not visible to the machine attendant except by stopping the machine. Automatic boiler arrangements (control of oil or water quantities) as well as particleboard and fibreboard plants (e.g. dosing of glue) also can be provided with light or sound control systems for trouble control.

The maintenance technique related above for the most part emphasized the importance of preventive maintenance. Such techniques have as yet only been put in practice in large scale plants but have proved useful from experiences in smaller establishments, too, provided that the scope and the objects of control are chosen appropriately. Such kinds of precautions are justified in particular when the suppliers of machines as well as repair shops capable of complex repairs are far away. A special preventive maintenance department or group is necessary for every establishment, but it is indispensable in every plant where the number of maintenance crew goes beyond 40 persons.

Different kinds of cards and card indexes have been frequently mentioned before, and it may be justified to look at that paper work more closely, because even a machine card may act as warning signal, if it allows space enough to

reports on earlier inspections. The machine manufacturers deliver with every machine due instructions for installation and maintenance in the desired language, and a so-called machine passport that should inform the user of

- the date of purchase
- the original order, the purpose and type of machine
- the spare parts
- the implements
- the criteria of performance, capacities
- the instructions for lubrication
- operating instructions
- the safety rules
- the schedules for cleaning and maintenance.

Immediately after the receipt of a new machine a so-called machine card is prepared for it. The card should include the essential data affecting the erection, operation and maintenance of that machine. An example of a machine card suited for the woodworking industry is shown below.

Name					Manufacturer		Type		No
Foreign name					Manufacture No		Normal capacity		Manufacture year
Motor No	kW	Revs. per min.	Type		Ordered		Locat. pc.	Spare parts	Type
					Arrived				
					Taken in operation				
Drawings		Purchase price							
		Additional devices			Suction				
		Motor			Water				
		Costs			Pressure air				
		Mounting			Steam				
					Hydr.				
		Purchase value							
Comments					Equipment				
					Lubrication		Guarantee		
Supplier					Weight Total m^2 Length		Original Insured Value		
							Width	Height	Capacity kW

Year	Operation time		Depreciated amount in bookkeeping			Depreciated amount in calculation			Interest	Maintenance		Energy		Machine hour
	h	%	%	Value	Bookk. value	Present value	%	Value	Value	Mat.	Wages	kW		Hours

Comments

TABLE I: An index card that in addition serves as an information source for fire insurance, depreciation, etc.

VIII SELECTION OF MAINTENANCE AND REPAIR EQUIPMENT

In bandsaw mills, as well as in other types of saw mills the essential object of maintenance activity consists of the conveyors and the transport equipment, such as the stacking and other trucks on the timber yard. It is true the most important and most expensive field of maintenance work in the main machines of a band mill, the band saws, is the resharpening and replacement of tools. In spite of that I do not deal with it in detail, since the matter already was discussed here in other connection. For the rest, a band saw as well as a gang saw does not require very much maintenance. In addition to normal lubrication, the drive arrangement, as the electric equipment on the whole, requires continual observation, because the safety relays and fuses for overload must be replaced fairly often, due to the fluctuations of load - sometimes the nominal capacity is exceeded considerably. Such measures can be reduced notably by appropriate maintenance of tools, i.e. by keeping the tools always sharpened and tensioned and suited to the particular species of wood to be sawn.

The following relation deals in short with the circumstances of A. a Band Saw Mill, B. a Gang Saw Mill, and C. Manufacturing Plant for Flooring, Doors and Windows.
Following items will be treated:

1. The main machine
2. Typical faults and their characteristics
3. Warning signals and systems
4. Testing after repairs and/or maintenance
5. Maintenance and reconditioning implements for the above machines and for the repair shop of a minor woodworking plant.

A. Typical Band-Saw Mill for hardwood conversion; annual output 10.000 cu.m.

A 1. Machine list,

1.1. Barking machine
1.2. Log sorter and metal detector
1.3. Log conveyor and feed table
1.4. Feed conveyor
1.5. Log trimming band saw
1.6. Delivery conveyors
1.7. Feed conveyor
1.8. Top action band saw (band saw for slabs)
1.9. Double edger
1.10. Discharge conveyors for sawn timber
1.11. Core line band saw (line-bar resaw)
1.12. Double band saw
1.13. Loading and sorting table
1.14. Waste conveyors
1.15. Wood hog
1.16. Tool grinding and reconditioning machines

A 2. Identification of main types of faults

2.1. Barking machine

I deal hereby with the so-called rotor/(or ring)type barking machines mainly used in saw mill and plywood industries because of their high output and low maintenance costs.

The machine attendant usually becomes aware of a trouble either by an unusual noise of the machine or by unsatisfactory barking

Possible difficulties during barking:

Fault	Reason
A. Bark rings left on logs at regular intervals	1. Blade spring(s) broken
	2. Blade bearing house(s) loose
	3. Blade(s) not correctly fastened
	4. Blade rising angle incorrect
	5. Infeed speed too high
B. Bark rings left on	1. Rotor V-belts slipping

logs at irregular intervals	2. Jerky infeed 2.1 Loose power transmission chains 2.2 Loose sprockets 2.3 Loose joint shafts or safety pins
C. Bark rings left at both ends of logs	1. Log rotates or swings on entering rotor or on leaving feed rolls 1.1 Feed roll springs without suffient compression 1.2 Guide roll springs without sufficient compression 2. Guide rolls aren't centering logs correctly 3. Fastening of the intermediate bar (to pre-open guide rolls) faulty
D. One side of log ends remains unbarked	1. Machine and conveyors are not in line 2. Infeed or outfeed conveyor (resp. outfeed table) do not provide adequate support to the logs. 2.1 Cradle or roll too high 2.2 Cradle or roll too low - springs dead - spring tension too weak
E. Logs of small diameter remain unbarked at one side of the circumference	1. Feed rolls have moved from the feed line 1.1 Sector locking key has moved 2. Rotor has moved from the feed line
F. Bark remains on log	1. Cutting edges of blade(s) are worn 2. Inadequate "clearance angle(s)" 3. Inadequate "cutting angle(s)"

G. Rotor filled with bark	1. Blade cutting edges are worn and will not cut the bark 2. The bark is already removed at the infeed rolls (this can be prevented by using special bark clearing device, mounted to the rotor).
H. Rotor gets overheated	1. Rotor bearing is short of oil 2. Fastening of the lower part of the rotor loose; thus the rotor frame has been deformed. 3. Profiled gasket rings have been renewed and left too high, which causes too large touching surfaces.

2.2. Log sorter and metal detector

The type of log sorter treated here is one provided with so-called mechanical coil memory; it is fairly inexpensive to purchase, and reliable due to its low degree of automation.

The maximum sorting speed mounted to 10 logs per minute

The only points liable to troubles are the electric equipment; the overturn magnets on the conveyor and the micro-switches. Electric troubles can be identified by the fact that any one of sorting compartments does not take in a log directed there. These parts should be kept in reserve; they are cheap and readily replaceable. Faults on other moving parts always originate in mechanical wear, which is easily perceptible during daily lubrication and provisions against troubles can be made in advance by that means.

The faults of metal detectors, if one is necessary, are found on the sensitive electric devices. They often originate in short circuits due to moisture and poor insulation, or in shaking due to inadequate rigidity of the foundation. The shaking causes loosening of contacts, / electric troubles.

/leading to

The necessity of a metal detector becomes evident as soon as there are reasons to believe that the logs may include nails or fragments of iron or other metals, because they almost without exception cause a breakdown of the saw blade. Such an incident is the cause of considerable losses of time and money, due to the need for a new expensive blade and a long stoppage.

2.3. Log conveyor and feed table
Troubles can originate in the limit switches or mechanical wear Possible causes for troubles usually are easily found in advance by regular inspections or lubrication

2.4. Feed conveyors as in item 2.3.

2.7. Feed conveyor as in item 2.3.

2.10. Discharge conveyors for sawn timber as in item 2.3.

2.5. Log trimming band saw
2.8. Top action band saw
2.11. Core line band saw

2.12. Double band saw
The most usual faults on band saws are breaks of saw bands. If the bands break very frequently, it is evident that the cause must be found elsewhere on the machine. Such incidents reveal that a thorough overhaul of the machine is necessary. The most frequent causes are a faulty bearing or axle journal. Sometimes the play or lack of balance of a band wheel may be the origin of trouble. The bearing and the axle are readily inspected and replaced when necessary, but faults in band wheels are not often found easily without special implements and a skilled specialist fitter. Such faults usually make it necessary to ask for a fitter from the manufacturers or their authorized maintenance firm

without delay. Fortunately, faults of band wheels are fairly seldom met with and in most cases "the third problems" troubling new plants in the early days of operation. Normally the finish grinding of band wheels is made only after the machine is erected on the site. Possible play is rectified by an accurately supported grinding machine, since the play gives rise to jerky running of the saw blade. Alternating stretch and slack causes untimely breaking of the blade.

The finish grinding after the erection belongs to the obligations of manufacturers as well as the measurements and possible balancing measures. In the event there would appear any fault on the band wheels later on, maintenance fitters trained by the manufacturers must be charged with the necessary repair job, and there will be no need for expensive implements and measuring instruments.

2.9. Double edger

The most plain and common faults are poorly sharpened set circular saw blades, which result in inaccurately sawn timber. The double edgers provided with mechanical working width adjustment are simple and easy to maintain, whereas those equipped with hydraulic adjustment - which is a common feature of modern trim saws - require more maintenance and checking measures. The packings of hydraulic cylinders and valves are exposed to wear causing leakages and operation troubles. However, a leakage is easy to identify in time while undertaking regular lubrication

It is essential to prevent air, water or dirt from getting in to the piping when installing the hydraulic system or replacing the packings. If that accidentally happens, the live saw blade will move unexpectedly - the machine becomes mad. Other possible faults originate in mechanical wear and tear. Parts exposed to wear are saw blade guiding pins and rules, chains and bearings, those of the live saw blade in particular. The machine attendant becomes quite soon aware of such fault that reveals itself

by an unusual noise, not to mention, that the bearing runs hot, of course.

2.13. Loading and sorting table

2.14. Waste conveyors

These conveyors usually run rather slowly, and the only faults are caused by the wearing of chains, bearings end belts. The faults are apparent during inspections and even in operation.

2.15. Wood hog

The hog is one of the most strained machines - and it is important, too, because it makes "money" of the waste, provided that a use is found for the wood chips.

Particular attention should be paid to the maintenance of the hog. The points liable to cause troubles are the chains and rollers on the feed arrangement as well as the bearings of feed arrangement and cutter wheel. Proper lubrication of the wood hog is essential, as is strict cleanliness of working site: free from edgings and chips. The bearings should be inspected regularly, regardless of the absence of alarming signs. The belt pulleys must be well balanced, since they are heavy and designed for high operating speeds. If the pulleys lack balance, whether they are for V- or flat belts, the bearings of cutter arbor or motor will be damaged sooner or later. The cutters should be kept always in good repair. They must not only be sharp but also sharpened correctly to ensure long useful life of the machine.

2.16. Tool sharpening and reconditioning machines

The tool shop of band mills usually is larger and equipped with more versatile machinery than that of gang saw mills. A medium band saw mill requires adequate facilities providing continual supply of sharp tools by its own resources. That equipment includes the following machines and implements: saw band jointing machine, band shearer, band welding machine (inert gas welding machine), saw band grinding machine, grinding machine for circular saw blades, setting machine, micrometer setting gauge, tooth cutting machine, rule,

anvil and at alternating intervals. These machines are supposed to be maintained by their operators and under continual control by their means. A proper toolman takes care of his machine like a nurse of a baby.

A 3. Warning signals, identification of faults

Warning and alarm systems were already dealt with. As stated the saw mills usually are not provided with light or sound signal arrangements installed on the machines, in order to reveal parts or devices out of order. But the sawmilling industry needs not such signal systems as much as for instance the cellulose and paper industry, where the raw material for a long processing chain gets wasted if the production, due to some trouble in operation, has to be stopped. Further, the cellulose and paper factories run continuously in 3 shifts, but at saw mills the faults discovered or suspected during the day can be repaired by night.

It is possible to fit an alarm signal system for instance to the following machines:
3.1. barking machine, 3.5. log trimming band saw, 3.8. top action band saw, 3.9. double edger, 3.11. core line band saw, 3.12. double band saw, as well as to controlling apparatus for lubrication systems and for hydraulics, especially if the clamping of band saw blades takes place hydraulically.

The metal detectors mounted to the feed table of the barking machine or the log sorter (3.3) and to the feed table of wood hog (3.15) are an exception. The metal detector itself gives a warning signal for metal fragments involving the risk of tool breakdowns.

A 4. Testing after repair
4.1. Barking machine

A test run must be arranged after every maintenance turn. Before that it must be made sure, that:

- the machine was lubricated according to the instructions,
- the oil tank or oil cup lubricating the rotor bearings is filled with oil, in order to ensure adequate lubrication of the rotor, i.e. 10 to 15 drops p.min,
- the cutter springs are in good repair and duly stretched; the tension is tested by pulling, at which it is inspected by the eye that the cutters are sharp and reliably secured,
- the rotor revolves freely when moved by hand,
- the drive chain is stretched adequately,
- the spring load of feed rollers works correctly.

After that the rotor is first started, ... next the feed rollers, and finally the conveyors. The first log is fed through the machine, and the barking result is tested. If satisfactory, the work can proceed.

4.2. Log sorter and metal detector.

After its recondition the sorting conveyor is operated idle some time. Then the compartment that was repaired is switched on. Several logs are guided to it, and if the machine works normally, the sorting operation can proceed.

Logs with nails on different sides are fed through the metal detector. If the device produces an alarm each time, it proves reliable, and the production can be continued.

The conveyors, items 3, 4, 7, 10, 13 and 14, are tested in the same way as the log sorting conveyor. After an idle run the conveyors are operated with load some time. The bearings and the drive are checked for possible hot running.

4.5. Log trimming band saw
4.8. Top action band saw (for slabs)
4.11. Core line band saw (line-bar resaw)
4.12. Double band saw

The machines are checked and lubricated overall according to the instructions. The band saws are operated slowly after every maintenance job, if possible, at which the run

of saw band on the wheels is watched closely. Then the full speed is switched on after [illegible].

The machine is stopped again, and the saw band tension is checked by gauges. It is rectified by means of adjusting valves. After a new start at low speed, the machine is operated at full speed. If the saw band runs without vibration and the bearings do not run hot, the machine is ready for normal operation.

4.15. Wood hog

The machine is checked for adequate lubrication, correct function of electric devices, and good repair of cutters. The cutter spindle is operated idle at first. Then, a full charge of waste wood is led in. Such a situation appears often, and the machine must be able to stand it, because it usually stops during the production and causes a jam on the feed table, which must be cleared up.

4.16. Tool grinding and reconditioning machines

These machines are tested in the same way as the others: the tool is fastened after a short idle run.

A 5. Typical maintenance implements

Barking area, special implements for the barking machine:

- hydraulic hand pump for adjusting the cutter pressure
- valve key
- cutter spanner
- cutter dismounting wrench
- cutter spring adjusting key
- cutter setting gauge
- feed roller setting implements: coarse and fine adjuster
- adjuster for feed conveyor spring
- male hexagonal spanner, series from 6 to 16 mm (or inch equival

Band saws:

- band tension gauge

- valve key
- extractors, diameters 150, 250 and 500 mm
- heavy spanner wrenches, 32 mm and more

Wood hog:
- heavy spanner wrenches
- knife setting gauge

Implements for repair shop and maintenance crew:
- hand grinding, i.e. angle grinding machine
- sets of box spanners: 6 to 32 mm and 32 to 60 mm (or inch equivalents)
- heavy monkey wrenches: 8, 10, 12, 18 inches
- male hexagonal spanners: 3 to 20 mm
- pliers and side-cutting pliers: 2 + 2 pcs.
- screw drivers and cross bits: 2 + 2 pcs.
- plate shears
- screw plugs: (hand taps and dies) /3 to 25 mm (or inch equivalent)
- extractors 5 pcs.
- screw presses: 4 pcs.
- calipers: 3 pcs.
- metal saws: 3 pcs.
- pipe spanners: 4 pcs.
- smith's and riveting hammers: 3 + 3 pcs.
- straightening hammers: 2 pcs.
- anvils: 2 pcs.
- table vices: 2 pcs.
- blocks and tackles: 400, 1000 and 5000 kg
- lubricating cans, grease gun etc.: 3 to 4 pcs. each
- iron bars, nail drawers, shovels, axes: 4 pcs. each

Machines and equipment for repair shop:
- post drill
- welding generator
- gas welding equipment: 2 sets
- table grinding machines: 2 pcs.
- metal lathe: centre height 300 mm (12 inches) / centre distance 2500 mm (100 inch) /
- metal milling machine
- rack-jacks: 6 and 12 t.
- belt jointing press (e.g. TIP-TOP cold vulcanization press)

B. Typical Gang Saw Mill for conversion of plantation grown coniferous wood, annual output 10.000 cu.m.per annum

B.1. Machine list

1.1. Barking machine

1.2. Log sorter and metal

1.3. Log conveyor and feed table

1.4. Log carriage

1.5. Log trimming gang saw

1.6. Conveyors for trimmed logs

1.7. Cleaving gang saw

1.8. Conveyors for sawn timber

1.9. Double edger

1.10. Equalizing and loading table

1.11. Waste conveyors

1.12. Waste hog

B.2. Identification of main types of faults

2.1. Barking machine

2.2. Log sorter

2.3. Log conveyor

These three were treated in connection with the band saw-mill.

2.4. Log carriage

The only parts of log carriage exposed to damage are the pulling chains and carriage wheels, and also the gripping jaws operated hydraulically. The main problem thus is the mechanical wear normally discovered in time during lubrication or the yearly overhaul.

2.5. Log trimming gang saw

On so-called low-base gang saws normally used in saw mills of this size the most critical parts are the sawblade buckles. Usually the fault is difficult to observe in advance. The upper buckles are more liable to break than the lower ones, and they usually break at an angle. Immediately before a break the cut becomes uneven, and it is possible that the

sawyer or the trimmer becomes aware of it at the last moment, though not very often.

The best precaution measure is to inspect the buckles thoroughly each time the saw blades are changed. Different kinds of metal alloys should be experimented with in order to find the most suitable material for buckles for the particular species to be sawn. Every saw mill provided with adequate repair shop facilities is able to make buckles by own resources as the occasion arises.

A very critical point is the connecting rod. Even though it does not break very often, it is treacherous because of the weakening of the iron under heavy strain, and in case of a break it would cause great damage and even danger to life. Therefore it should be inspected very carefully at intervals of some months, at which ultrasonic tests are used to find possible hair line cracks. Both the small and big end bearings are exposed to heavy strain and wear. They usually cannot be thoroughly inspected or replaced, except during the annual overhauls.

The essential aspect of preventive maintenance is adequate lubrication. The sawyer as well as the maintenance men have to make sure that the automatic lubrication system works blamelessly each time, and provides due lubrication for bearings and other moving parts. Provided that the instructions given for installation, maintenance and lubrication are followed conscientiously, the gang saw is one of the most reliable woodworking machines. Strict attention also should be paid to the use of appropriate lubricants, and to the manual lubrication points for which the grease gun is used.

2.6. Conveyors for trimmed logs
2.8. Conveyors for sawn timber
2.10. Equalizing and loading table
2.11. Waste conveyors
2.12. Waste hog

The fault finding and preventive maintenance measures concerning the above equipment were already dealt with in connection with the band saw mill.

2.13. Tool grinding and reconditioning equipment
Although the repair shop equipment and the implements of the maintenance crew of a gang saw mill differ somewhat from those in a band mill, their essential features are similar, as is also their maintenance. The users are charged with the preventive maintenance as well as necessary repairs concerning that equipment.

B.3. Warning signals, identification of faults

As mentioned in connection with the band saw mill, actual warning signals or alarm systems are seldom met with in saw mills. The main machines, gang saws items 3.5. and 3.7, however, with good reason can be provided with a sound alarm revealing a trouble in the oil circulation system. In the event the wooden contact surfaces of sash are provided with a cooling system, that can be secured by a sound signal or signal lamp for trouble alarm. As a rule, a sound signal is used for warning of danger when the operation is started, but that precaution in the first place serves the safety purposes already dealt with in another connection.

B.4. Testing after repair

Other equipment except the gang saws were treated in connection with the band saw mill.

4.5. and 4.7. gang saws
In the same way as during the first test run after the erection, the machine is operated idle for a short time after a repair. This is to test the temperature of bearings in the first place. During the idle run the machine is listened for possible unusual noise from the gearbox, etc. If the bearings do not run hot, and the machine seems to be in order, the cutting operation can be started. Even after

that the temperature of bearings should be checked repeatedly, in particular if any one of the bearings or the connecting rod was replaced.

B.5. Typical maintenance equipment

The equipment of repair shop in a gang saw mill is fairly similar to that of a band saw mill, with the exception that certain special wrenches, lubrication devices and other implements are delivered with the gang saws, together with instructions pertinent to the matter. For more extensive repairs, e.g. for replacement of bearings, the following implements are required:

- moulds for bronze and white bronze: 3 pcs.
- caliber gauge
- lead mallet
- water level and rules (the last-mentioned for erection of a new machine or of an old one that has been moved).

C. Typical manufacturing plant for flooring, doors and windows

A plant such as would have a machine list as below is not ideal, but would be suitable for conditions where the production program includes very different kinds of doors and windows in small series production. In case it is possible to rationalize the production to a few types only, the plant can reach equally high output by a smaller number of machines. In addition to that the manufacturing lines can be automated. An automatic plant requires less space and labour, whereas the need of preventive maintenance and the number of maintenance crew increase. Consequently, the plant discussed can be placed somewhere halfway between a handicraft workshop and a modern industrial plant.

C.1. Machine list

1.1. Drying kiln

1.2. Cross-cut saws

1.3. Dovetailing equipment
1.4. Five-cutter moulding machine
1.5. Planing and thicknessing machine
1.6. Single end tenoners
1.7. Chisel mortiser (Chain mortiser)
1.8. Band saw
1.9. Spindle shaper
1.10. Frame press
1.11. Sander
1.12. Door press
1.13. Double end tenoners
1.14. Trimsaw
1.15. Wide belt sander
1.16. Patching machines
1.17. Assembling presses
1.18. Single end tenoners
1.19. Frame assembling press
1.20. Window furnishing equipment
1.21. Pane setting area
1.22. Frame assembling area
1.23. Dust removal system

C.2. Identification of main types of faults

The main repair objects in a joinery plant are bearings and electric equipment. Therefore cleanliness is an essential aspect of maintenance in such plants, which especially means effective and continuous removal of saw dust and wood waste resulting from the work. The dust removal suction system must have an adequate capacity to ensure complete removal of saw dust, chips, shavings and other waste. Electric motors and connection boxes left under heaps of waste do not cool sufficiently, and become heated; insulations get damaged, and may give rise to short circuits and danger of fire.

Sawdust coated bearings readily run hot, and may even be left without regular lubrication. They will wear down prematurely.

Woodworking machines such as cross-cut saws 2.2, a part of dovetailing equipment 2.3, moulding machines 2.4, [illegible] 2.6. and 2.13, planing and thicknessing machines 2.5, mortisers 2.7, shapers 2.9. and crimsaws 2.14. are also subject to above-mentioned maintenance technique. They are highly dependent on the effectiveness of the dust removal system, and overall cleanliness.

2.1. Drying kilns are usually inspected and maintained thoroughly during the annual overhaul. In particular, all bearings, valves, radiators, pumps as well as the automatic temperature regulating system are checked carefully for possible faults. If that practice is followed, usually no other faults than those in bearings, for the most part due to running hot. Bearings of fans will appear during the intervening time and can be replaced even during the drying. The dryer is switched off to that end, and the doors are opened in order to prevent the moist timber from getting damaged. The procedure will last about 2 hours. Four to five sets of bearings should be kept in reserve for each fan.

Other possible operation troubles affecting the drying kiln originate in the electric equipment, in particular on the temperature regulating system. Radiator leakages may appear in old kilns also. In the event such leakages occur repeatedly, the radiators should be replaced at earliest opportunity.

2.11. and 2.15. Sanding machines

Rollers and bearings are the parts of sanders which are mostly exposed to wear and damage. An adequate supply of them should be kept permanently in reserve. Inspections become necessary more often than in connection with the annual overhaul. In case a faultless sand paper produces poorly smoothened surfaces, the fault is found in rollers or bearings almost without exception.

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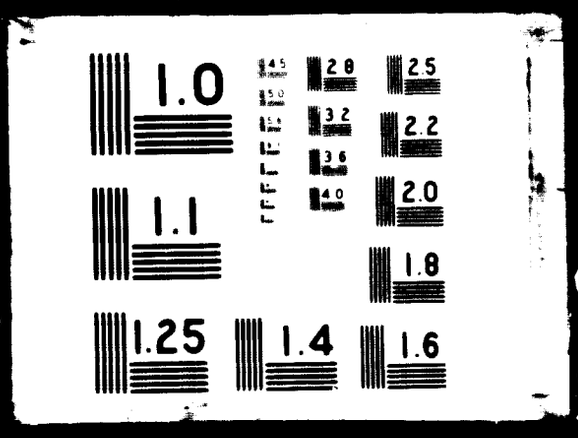

2.10, 2.12, 2.17, 2.19, and 2.22. Presses
The operation troubles mostly originate in failure of the hydraulic system, caused by dirty piping or leakages on valves or cylinders. The packings should be inspected once a year at least, at which hardened or otherwise ineffective ones must be replaced. Valves and cocks should be checked for possible clogging, etc.

C.3. Warning signals, identification of faults

Actual alarm systems are not usually applied to joinery plants, with the exception of automatic establishments where the production is carried through in continuous process, or the work at least is performed on several automatic manufacturing lines. Such plants, like other process industries, must be provided with complete alarm systems giving light and/or sound signals if a conveyor stops, the lubrication system gets out of order, a press becomes overheated or cooled, a paint dryer fails, etc. The plant used here as an example is not automatized but simply a fairly old-fashioned establishment for versatile small-scale production, where the possibilities for utilization of such precautions are very limited.

Nevertheless, there are points where certain alarm arrangements are justified and even needed. Thus, failures of heat supply and/or ventilation in the drying kiln would result in considerable losses due to damaged timber. A signal lamp and/or a sound signal warns of a stopped fan, and another of too high temperature, etc. Such warning signals are all the more useful because such troubles are very likely to occur at night when in all probability only one night-watchman is present.

Troubles in the operation of a drying kiln are usually caused by electric failures or faults in the power transmission system. A broken bearing, on the other hand, is so noisy that special signal arrangements are needless.

C.4. Testing after repair

A test run becomes necessary after a repair; that is arranged on every machine by operating it without load at first - so-called idle run - in order to check the bearings for possible running hot, to reveal possible hydraulic leakages, etc. However, for test runs of a press such press charges should be chosen which require as long pressing time as possible, because leakages usually can be found only in that way. In the plant discussed - as also in minor joinery plants in general - occasional repairs and test runs on single machines do not hamper the work on the others, because the working steps are performed independent of each other, which is not the case in saw mills.

C.5. Typical repair shop equipment and maintenance implements

The usual repair and maintenance equipment are similar to those of saw mills. It is quite natural that opinions e.g. on the number and types of implements may differ. As a rule the machine manufacturers deliver with the machine all wrenches and other implements needed for maintenance of that particular machine. If not so, the purchaser should by all means try to get them included in the delivery, even, if necessary, at additional cost. In all events, the tool kit of every maintenance man should include at least following implements:

- ratchet spanner: series 17 to 41 mm (or inch equivalents)
- wrench spanner: series 8 to 24 mm (or inch equivalents)
- monkey wrench: 8, 10 and 18 inch.
- measuring rule (and tape)
- caliper
- sheath knife
- different kinds of screw drivers
- pliers
- side cutting pliers
- metal saw with spare blades

The following special implements for more complex repairs on the presses are worth mentioning: different kinds of implements for fitting packings and gaskets, stretchers and measuring instruments such as caliper gauges, dial gauge and precision water levels.

The reflections about maintenance proposed above for discussion have applied to the importance of preventive maintenance in the first place. In developing countries, far away from the machine manufacturers as well as from outlets for service and sales of spare parts, this aspect is essential. I once more would like to lay stress on the importance of cleanliness, not only on that of machines and equipment but also of the working site. Every machine, conveyor, etc., should be cleaned from sawdust, chips, shavings and other kind of rubbish each time the working day comes to an end, and every machine attendant should be proud of his clean and well-maintained machine.

IX TO PURCHASE OR TO MANUFACTURE SPARES - THAT IS THE QUESTION! 1/

The solution of this problem requires close and [illegible] co-operation between the maintenance and purchasing departments. The question whether certain spare parts and/or ancillary devices should be made by the company's own resources or purchased, must be answered separately in every special case. However, some directions of general application can be given.

The spare parts should always be made locally in those circumstances, where it is not be justified to wait for original spares due to long deliveries, in view of the importance of the part or device in question.

Special equipment requiring specially skilled fitters as well as special implements and precision instruments not available in the own repair shop should always be sub-contracted.

Likewise, all such maintenance and repair jobs, which sub-contractors are ready and able to discharge at lower prices than the own repair shop, should be left to such specialist establishments (such as winding of electric motors, cylinder borings, etc.).

In addition to that, it should be kept in mind that the maintenance crew should always include persons able to carry out emergency repairs. That personnel should be provided with other jobs at intervening times. Nevertheless, the number of maintenance crew must not be increased unjustifiedly to that end, though it is of course essential to keep skilled workmen in service. Even large establishments - and those in particular - avail themselves of other firms as subcontractors of spare parts as well as of maintenance and repair services. It often can be perceived that a new subcontractor candidate offers his services at very favourable prices, in order to gain a foothold with an impatient purchaser that will be in need of such services in the

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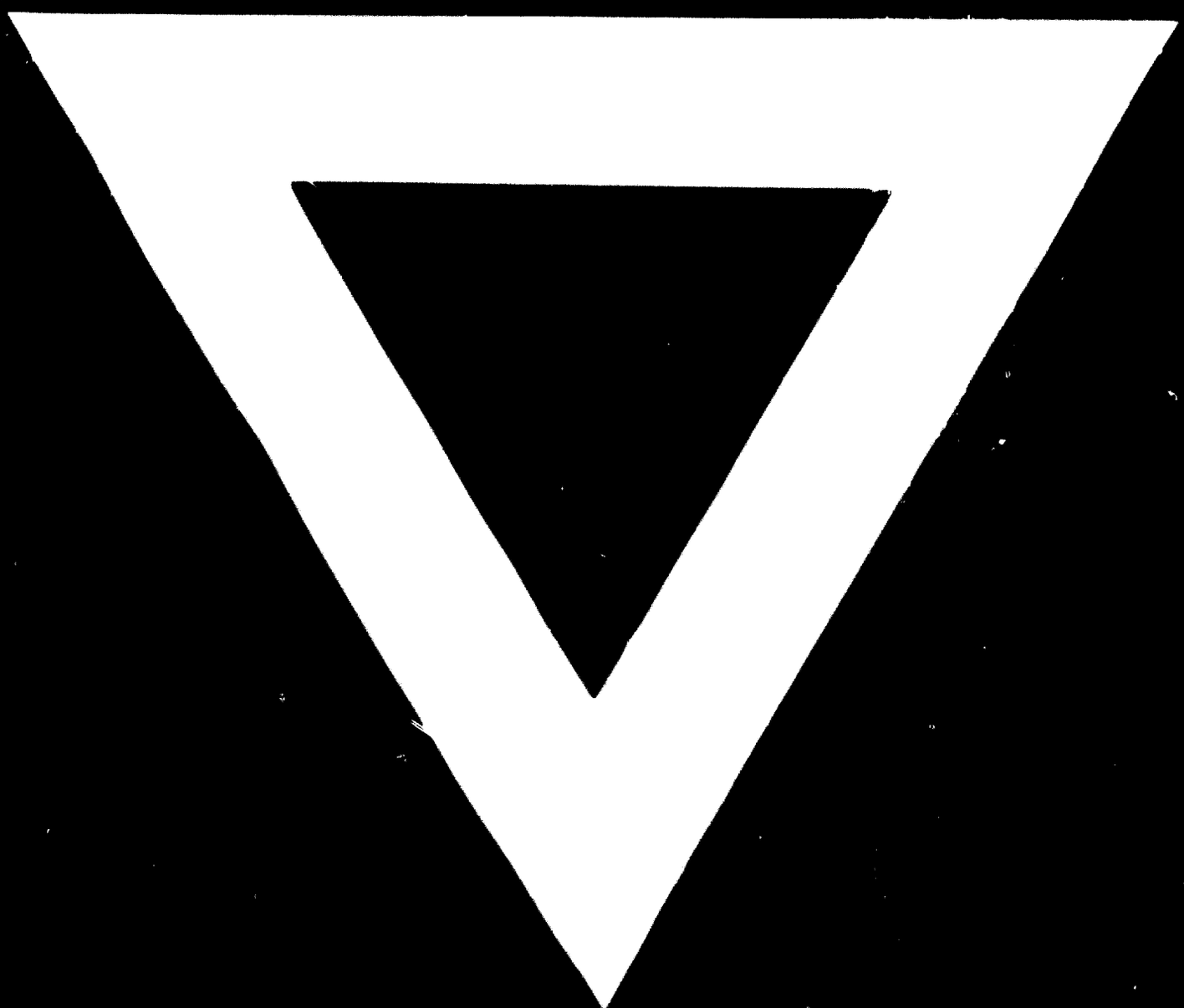
1/ This quotation is reproduced since the topic is just as important as to be or not to be!

future also. Fairly often such suppliers have in mind to raise their prices as soon as they consider themselves to be in a secure position. To provide against such tendency, it is advisable to invite tenders from all major wood engineering works as well as from smaller ones at times.

The maintenance department has a key position considering the offer invitation to that extent that the description of work enclosed in the tender is as detailed and thorough as possible. That is an absolutely necessary condition for comparative evaluation of the offers. Of tenders of equal value preference should be given to those repair shops which are nearest to the plant, because time and money can be saved in that way, and if the subcontractor is in the immediate vicinity it may be possible to supervise the execution of the order.

There are, of course, certain repairs that should be entrusted to the machine manufacturers because some setting and special techniques, such as temper hardenings, etc., often can only be controlled by the manufacturers.

Central repair shops provided with effective and modern machines, as well as with precision measuring instruments, would be useful for certain woodworking centres. Such repair shops could be founded either by joint venture of interested woodworking industries or by private enterprise; in the latter event the repair shop should be assured adequate work from a certain region. It is quite natural that the activity of a such repair shop should not be limited solely to the repairs of woodworking plants but small plants of other lines would share its services as well.



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