SAFETY DEVICES
FOR
WOOD-WORKING MACHINERY
GREAT BRITAIN AND SWITZERLAND

GENEVA
1925
PREFATORY NOTE

Accident prevention is an essential feature in the protection of the worker, yet it is almost more difficult to secure precise information on this subject than on any other. Progress in industrial safety depends entirely on technical research and practical experience, but little general idea of either can be gained from the infrequent publications which too often treat the subject in a fragmentary fashion. Hence there is a danger that valuable experiments for the prevention of a given industrial risk may be carried on simultaneously in several countries, each investigator being cut off from the results of the research of others, and from the possibility of modifying or improving his own work in the light of these, simply by the lack of information.

Realising these facts, the International Labour Office has initiated a new type of work which is represented by the present volume. It was felt that one of the prime duties of the Industrial Safety Service of the Office should be to make a comparative study, or at least a general survey, of the efforts made in each country to remove the causes of any given class of industrial accident. It is only too clear that this is an arduous task. Frequently the protective devices used and the results achieved can only be fully grasped if the student examines them on the spot and requests competent experts to check the results of such first-hand observation. This is a safe method of procedure, though slow and costly. It is nevertheless hoped by this means to prepare and issue a series of monographs giving an objective survey of experiments and safety measures in the various countries.

The present volume represents the first step along these lines. It describes safety devices for woodworking machinery used in Great Britain and Switzerland, but for the present no attempt has been made to deduce any conclusions of an international character. The selection of these two countries naturally does not imply that they are alone in considering the problem. It is in fact a matter of concern to all industrial countries, every one of which is making continual efforts to solve it. In Great Britain and Switzerland, however, reports on the present state of
progress in the matter have been prepared and issued, and the International Labour Office therefore thought it desirable to publish the information which it has thus received.

It must again be emphasised that this is merely a tentative effort. It is hoped that manufacturers, workers, and technical staff, for whose benefit this report is published, will forward to the Office any comment they may have to make and suggestions for increasing the value of future publications. On the reception which they accord to this volume depends the progress of the new type of work which the Office has undertaken.

1 Thanks are due to the British and Swiss authorities which have made this publication possible by supplying material and authorising the reproduction of illustrations. The blocks for all the illustrations in the first part of this report have been kindly lent by the Controller, H. M. Stationery Office, London.
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GREAT BRITAIN

Under Section 79 of the Factory and Workshop Act, 1901, the Home Secretary is empowered to issue special regulations for the protection of workers employed in dangerous trades. That woodworking falls into this category is proved by the number of recorded accidents, which totalled 2,424 in 1921, including 7 fatal, 2,604 in 1922 (6 fatal), and 3,187 (8 fatal) in 1923. The authorities consider these figures high, but a considerable improvement in the situation should result from the issue of special Regulations, drawn up in 1922 and brought into force on 1 January 1923. The new code describes in detail the respective duties of occupiers of undertakings and their workers. The former, besides being required to adopt certain general safety measures, are under an obligation to provide specific types of guard for certain machines; circular saws, plain band saws, planing machines, vertical spindle moulding machines, and chain mortising machines. The workers on their side must use the guards thus provided, in so far as the nature of their work allows.

Well-devised regulations are clearly the first step to be taken to raise the standard of industrial safety, but if they involve the use of technical appliances the persons concerned must be given expert assistance if they are to carry out the regulations properly. Not infrequently employers are willing to comply with regulations

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2 These include all accidents resulting in incapacity for work lasting one day or more.


In 1923 the distribution of the accidents according to the machine involved was as follows: circular saws, 1,714 (4 fatal); spindle moulders, 289 (1 fatal); planers, 555 (1 fatal); other machines, 629 (2 fatal).


5 Under Section 85 of the Factory Act any worker contravening any regulation under the said Act is liable to a fine. The employer is also liable to a fine unless he can prove that he has done all in his power to prevent the worker committing the breach of the regulations.
but lack the necessary knowledge; this applies particularly to small employers using wood-working machinery. The Home Office has therefore issued a pamphlet entitled *Fencing and Other Safety Precautions for Wood-Working Machinery*. This publication, which was prepared by the factory inspectorate, is in some measure a technical commentary on the new Regulations. It contains practical information on the best means of complying with the regulations for guarding machinery and suggestions as to the methods of working most likely to reduce risks. In an appendix is given the text of the 1922 Regulations and of an Order of 8 November 1918 regarding ambulance and first-aid arrangements at saw mills and factories in which articles of wood are manufactured.

**GENERAL SAFETY PRECAUTIONS**

The first part of the pamphlet deals with general precautions in such matters as workshop equipment and factory organisation which fall under the first nine regulations. Most of them are standard safety rules which have long been accepted but which need constant repetition.

Under the first clause of the regulations every machine must be provided with an efficient stopping and starting appliance, in such a position that it can be conveniently operated, and fitted with a locking device to keep it in position either for working or at rest. The guide gives illustrations of suitable devices which can easily be fitted. The absence of such appliances has led to many accidents through the machinery being unexpectedly set in motion by a belt “creeping” from the loose to the fast pulley.

Any appliance by which a wood-working machine is set in motion, such as shafts, pulleys, belts, etc., must be properly installed and securely fenced (clause 2). In up-to-date factories shafting and pulleys are placed in trenches in the ground covered by movable plates or boards. This prevents the accumulation of sawdust in the machinery and facilitates inspection and oiling. The latter operation is made still easier by running oil-pipes from the bearings up to the floor level, a labour-saving and safety device which has not yet become as popular as it deserves to be.

Sufficient clear space must be maintained round every machine (clause 3). The condition of the floor is of great importance, especially with large circular saws and planing machines, where the operative works in a position in which he
may easily over-balance. The floor must therefore not be slippery and must be kept free from chips or other wood waste (clause 4).

Where such dangerous machines as wood-working tools are insufficiently illuminated the risk of accident is greatly increased. In deciding where machinery is to be fixed, prime consideration should be given to lighting. Clauses 5 and 6 deal with the question of natural and artificial light; under clause 7 the Chief Inspector of Factories may prohibit the use of wood-working machines in underground rooms which are inadequately lit or ventilated, or unsuitable in any other respect. The natural illumination of a machine may sometimes be very much improved by such simple means as whitewashing walls and ceilings. Artificial illuminants must be so installed as to prevent glare; the best combination is that of lamps at a certain height for general illumination with other well-shaded lamps by which a sufficiently strong light can be directed to the point where it is required.

Clause 8 lays down that the temperature in any part of a room in which a wood-working machine is employed must at no time fall below 50° Fahrenheit.

Important though such material precautions may be, the human factor must not be neglected. Thus clause 9 of the Regulations provides that any person required to operate a wood-working machine must be fully and carefully instructed as to the dangers arising in connection with the machine and the precautions to be observed. No person may be employed at such a machine unless he has been sufficiently trained or works under adequate supervision. The guide further reminds employers that the installation of safeguards will not by itself infallibly prevent every accident, and that the personal factor is important. Workers to be employed at the machines should be carefully selected; slow or reckless men or young inexperienced workers should not be chosen. A foreman endowed with caution and an intelligent regard for accident prevention may do much to promote safety.

The upkeep of tools is also of importance; if they are kept in good condition and well sharpened they are both safer and more efficient.


2 American experts attach the greatest importance to this in circular saws. Cf. National Safety News, July 1921, p. 15.

See also A. PALLET: Les scies circulaires à bois; a practical treatise on sharpening, setting, and hammering. Editions de l'Usine, Paris, 1924.
Special attention should be paid to the correct mounting and proper maintenance of safeguards. All adjustable parts of the guards should be provided with fastenings, such as butterfly nuts or handwheels, which can be manipulated without the use of a tool. If there is unnecessary difficulty in working the guards, it is to be feared that the workers will not trouble to adjust them properly for each operation.

In conclusion it is recommended that notices should be affixed to each machine stating, for instance, that the safeguards must be used, that if they are unsuitable for any particular operation the foreman must be notified, that persons disregarding the instructions are liable to dismissal.

Circular Saws

A considerable amount of space is devoted to circular saws. A large variety of these are in use in industry and they differ very much both in size and methods of working. They have given rise to so many accidents that their dangerous nature is well-known. There is no single device applicable to all the many varieties of this machine, but there is no sawing operation for which it is not possible to secure adequate protection by providing safeguards or adopting certain methods of working. Nevertheless, the pamphlet strongly recommends that whenever possible circular saws should be replaced by band saws, which are much more easily guarded.

The worker at a circular saw may be injured by contact with some part of the blade either above or below the bench or by objects being thrown back. A piece of wood may be caught in the teeth, or, what is much more serious, the halfcut timber may close in and catch on the saw, and be flung back. The "projection" of timber is one of the risks of ripsawing, i.e. sawing along the grain of the wood. The movement is very violent, and is the usual cause of fatal accidents. The riving knife, described below, may prevent this type of accident, and fortunately it is always possible to fit it.

Many injuries arise at the front of the saw, which is frequently left unguarded. Although this part cannot be as simply guarded as the back is protected by the riving knife, there are many devices which can be used.

Before discussing safeguards properly so called, the pamphlet enumerates the most usual types of circular saws. Ripsaws work in a bench, whether fixed, adjustable, capable of inclination, or
in a rack; the last-named are often used for the first sawing of tree trunks. In certain trades saws of small diameter, though they may be very thick, are used for making grooves (rebating) or for cutting tenons. Special mention is made of a new type of saw in which, contrary to current usage, the spindle of the saw is above the table, and the wood is pushed towards the saw from the side opposite to the usual one. Machines intended for cross-cutting, i.e. for cutting across the grain, are usually fitted with a sliding table or "chariot" to hold the wood and move it towards the blade. This chariot may pivot about an axis instead of having a sliding motion. In so-called pendulum or swing saws, the blade itself is supported by a rocking arm.

Clauses 10 and 11 of the Regulations enumerate the various safeguards which are compulsory for circular saws. They apply only to saws working in a bench or a rack bench, whether for ripsawing or cross-cutting, to the exclusion of swing saws or other saws which are moved towards the wood. Presumably the authorities think it hardly possible to enumerate in precise regulations all the safeguards which may be needed for the latter machines, since they vary considerably in construction; such saws are therefore subject to the general provisions of Section 10 of the Factory Act. In this connection the pamphlet makes suggestions, to be discussed later, in accordance with the recommendations of factory inspectors. Information is also given on the other safeguards which under clause 22 of the Regulations may be substituted for the standard guards in certain special cases, provided that they render the machine equally safe. If provision had not thus been made for the most frequent kinds of special work the value of the Regulations would have been greatly restricted by the phrase requiring that the guards indicated in the Regulations must be used "except when, owing to the nature of the work being done, the use of the guards or appliances is

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1 Excerpt from Section 10:

With respect to the fencing of machinery in a factory, the following provisions shall have effect:

(c) All dangerous parts of the machinery and every part of the mill gearing must either be securely fenced, or be in such position or of such construction as to be equally safe to every person employed or working in the factory as it would be if it were securely fenced; and

(d) All fencing must be constantly maintained in an efficient state while the parts required to be fenced are in motion or use, except where they are under repair or under examination in connection with repair, or are necessarily exposed for the purpose of cleaning or lubricating or for altering the gearing or arrangement of the parts of the machine.
rendered impracticable”. But now that the information given in
the pamphlet is available, this exempting phrase can no longer
be cited except for special types of work, which obviously cannot
be enumerated, and for the manufacture of patterns. It should
be noted here that in the opinion of the factory inspectorate the
proportion of circular saw operations in a pattern making shop
which do not admit of the use of safeguards is less than ten per
cent.

Methods of Guarding Circular Saws

Experience has shown that the part of the saw blade below
the bench should be completely protected so as to prevent any
accidental contact, as for instance when removing sawdust. If an
exhaust system is used for removing chips, the hood of the
collector may easily be arranged to provide such protection. In
other cases it may be secured by metal plates or other rigid
material placed on either side of the saw. Under clause 10 of
the Regulations, the distance between the two plates must not
be more than six inches, and the plates must extend to a distance
of not less than two inches beyond the teeth of the largest saw
used. The thickness of the plates is also fixed by the Regulations
and depends on whether they are beaded or not. The practice
of fitting the framework of the bench with movable panels is
unsatisfactory, for the panels are frequently not in position or are
only found on the side nearest the worker, leaving dangerous gaps
on the other three sides.

The normal guard for the part of the blade above the bench
consists of (1) a riving knife, (2) some sort of hood or cover
over the “crown” of the saw, i.e. the top part of the blade, about
one-sixth of its total circumference, (3) a cover protecting the
front of the blade which can be easily and rapidly adjusted to the
thickness of the blade. The use of these guards is enforced by
clause 10 (b) and (c) of the Regulations.

A riving knife is a steel blade placed at the back of the saw
and in careful alignment with it. Its chief function is to keep the
saw-cut open and prevent the wood being projected backwards.
At the same time, if properly adjusted, it prevents the hand of
the worker from coming into accidental contact with the back
of the saw. The riving knife must be strong, rigid, and smooth.
It need not have a cutting edge in the ordinary sense, but should
be wedge-shaped in section, its greatest thickness being slightly,
say 10 per cent., more than that of the saw teeth. It is essential
that the riving knife should be curved so as to fit close to the saw, as is provided in clause 10 (b) (i) of the Regulations: "The edge of the knife nearer the saw should form an arc of a circle having a radius not exceeding the radius of the largest saw used on the bench." By this means it is possible to keep the knife very close to the saw blade, the maximum distance between them being fixed at half an inch.

It must be possible to adjust the knife in such a manner that it extends upwards from the bench to within one inch of the top of the saw for saws with a diameter of less than 24 inches, or to a height of at least 9 inches for saws of larger dimensions. The principle of the riving knife is quite simple, but it is important in practice to have it properly fitted. The British experts
consider that riving knives should be fixed by fasteners both above and below the bench. These fasteners should be designed to allow of accurate and rapid adjustment of the knife, which is necessary both for following up the wear of the blade and in using a series of blades of different sizes. In most cases adjustment is effected by some sort of slot. The use of a screw engaging in one of a series of holes placed at regular intervals is not to be recommended, for it does not allow of sufficiently exact adjustment. Satisfactory methods of fastening riving knives are illustrated in figures 1 to 4.

For the crown of the saw there are a large number of hoods and covers, many of which are unnecessarily cumbersome. Such appliances are inconvenient in every respect and create prejudice against the use of guards; types which have not been properly tried should not be used. The best kind of guard is an inverted U, suitably curved, with sides deep enough to cover the teeth of the top of the saw. The cover should not be too deep, or it will prevent the sawing of thick pieces of wood. It may be supported in various ways, the usual method being to fasten it to the table by means of a vertical pillar fitted with a horizontal arm which can be adjusted both horizontally and vertically. In certain cases it can be held in position by a kind of bracket placed on the wall or suspended from a beam. These various types of support are illustrated in figure 5. It is desirable that the guard support should be fitted with some device for swinging it clear of the whole machine without disturbing its adjustments, so that the saw is accessible for such operations as sharpening or changing the blade. Preference is given to the type of guard illustrated in figure 6, which also shows how the crown cover is supplemented by the cover for the front of the blade. This part of the saw is protected by a cover of the same shape as that for the crown, but it slides in a slot so that it may be easily adjusted to the thickness of the work. The authors of the pamphlet consider it necessary that provision should be made for getting a view of the saw, which is done by cutting a long narrow slot in the guard. A system by which the guard is adjusted by a

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1 Some objections may be made to the use of butterfly nuts for fastening the riving knife by hand, as owing to the vibration of the machine and possible strain on the knife it might be feared that a fastening of this kind would not be strong enough and would tend to come loose if the knife were not also fixed to the end of the hood.

2 Sighting slots up to a full half-inch in width are sanctioned by the factory inspectorate.
Fig. 5.

Guard supports (circular saws).
hand-gripped screw to the thickness of the wood, from the thinnest board to a block almost as thick as the height of the saw above the table, is preferred to devices which rise automa-

tically as the piece of wood advances. Although these provide the necessary protection, they are usually too complicated and interfere with the work.

Figures 7 to 8a illustrate some of the guards which have been constructed on the above-mentioned principles and are cited as models. To a certain extent they seem capable of adjustment to blades varying between somewhat narrow limits of size, but they then have the disadvantage of requiring complete re-adjust-
Fig. 7.

Fig. 8.

Fig. 8a

Circular saw guards
ment. It will be noted that in each case the riving knife is fixed to the end of the guard: thus the various parts can be tightened up to form a solid whole.

Even where satisfactory guards are provided, a certain danger arises when the end of the timber is being cut. In order that the worker should keep his hands far enough away from the blade, he must use a push-stick, which should always be kept handy. A better system would be a sort of sliding cleat (Fig. 9; for the sake of clearness the ordinary guard is not shown).

Fig. 9. Sliding pusher for circular saw.
There are certain other devices for preventing wood from being thrown back from a circular saw, for instance that illustrated in figure 10. In view of the violence of the strain to which they are exposed, it may be questioned whether these devices are sufficiently strong; they should in no case take the place of the riving knife, but may be used as a supplementary guard. Figure 11 shows a guard which may be used for very small saws with a diameter of not more than six inches, where the ordinary type of guard would be too cumbersome. Small saws are sometimes used for rebating or tenon cutting, and the very simple guards
Angle-piece guards on circular saws used for rebating and tenon cutting.
Fig. 14.
Circular saw with automatic feed.

Fig. 15.
Method of protection for multiple circular saw.
Fig. 18. Multiple saw, with guards.
illustrated in figures 12 and 13 provide all the protection required for these operations. From the point of view of safety, circular saws with automatic feeds, in which the wood is moved mechanically, are excellent (Fig. 14), but their use is naturally limited, as they are suited chiefly for repetition work.

Multiple saws may be protected under one hood, as shown in figure 15, if the blades are sufficiently near each other, but they must also be fitted with a device for preventing the wood from being thrown back. If the distances between the blades can be varied, each blade must be protected in the usual way (Fig. 16).

Yet another type of machine for ripsawing is the rack saw. A guard of the kind illustrated in figure 17 is considered sufficient when cutting logs, provided that it is of generous dimensions, and at least as wide as the travelling table. Since the blades of rack saws are often entirely buried in the timber, the ordinary riving knife would often have to be removed. This may be obviated by using a shorter riving knife, provided that it is also wider, so as to provide the necessary rigidity.
Circular saws are also used for cross-cutting, i.e. cutting across the grain. If this operation is effected by a saw which can also be used for ripsawing, all the guards described above must be retained. If, on the other hand, the machine is used
only for cross-cutting, it is sufficient to fit an adjustable hood and a sloping piece, where the riving knife is usually fixed to prevent pieces of wood from being thrown back by the back of the blade. As a rule, the pieces are fed to the saw by means of some sort of chariot. This is the standard design of so-called "fire-wood" saws (Fig. 18).

Yet another kind of cross-cutting saw is the pendulum saw. There is no difficulty in guarding the blade, which may be done as shown in figure 19, but it is important to guard the shafting and belting properly and to limit the swing of the arm of the pendulum.
From the technical point of view the protection of band saws is very simple compared with that of circular saws. The Regulations (Clause 12) require that both sides of the bottom pulley and the front of the top pulley shall be completely covered, as well as the whole of the blade, except, of course, the actual cutting part situated between the bench table and the guide. In the absence of such precautions accidents might result if the blade were to break or the operator came in contact with the spokes of the wheels or with the teeth of the saw.

It is recommended that the covers for the pulleys should be made of wire netting or perforated sheeting. It is better not to
use solid sheet fencing, which is necessarily opaque, at least for the top pulley, since it would interfere with illumination and sight. The covers should be hinged or otherwise rapidly detachable for convenience in changing the blade. Figure 20 gives a very good idea of the manner in which a band saw should be protected. The part of the blade between the bench table and the lower pulley should also be covered, especially as the working lever is placed under the table and the worker in feeling for it might touch the blade by mistake and injure himself seriously.

Fig. 21.
Light guard attached to band saw guide.

A very light and simple device may be attached to the guide to protect the part of the blade above the table (Fig. 21). Its adjustment to the thickness of the work is automatic, since it is effected at the same time as that of the guide.

In addition to the ordinary band saws there are some very large models in which the danger of contact with the cutting part of the blade is reduced by an automatic system of feeding. The guards for other parts of the blade must be very strong to prevent the serious consequences of a breakage. Finally, the feed rolls should be guarded in the same way as for planing machines, discussed below.
Fig. 22.
Cutter blocks, square and circular.

Fig. 23.

Fig. 24.

Fig. 25.
Three types of circular cutter block.
Planing Machines and Thicknessers

In using a planing machine the operative must press very heavily on the work to bring it against the cutter while keeping it on the bench. If there should be a knot or other irregularity in the wood, it is apt to be drawn backward out of the grip of the operative, whose hand then falls on the cutter. Such accidents are very serious if the machine is fitted with one of the old-type square cutter blocks: they usually involve the loss of the fingers. With the cylindrical or so-called safety cutter blocks, the injury is usually confined to the loss of some flesh from the fingertips (Fig. 22). All planing machines can and should be fitted with cylindrical cutter blocks, and this is made compulsory as from 1 March 1924 by clause 13 of the Regulations. Figures 23 to 25 show various models of cylindrical blocks for two or three cutters, obtainable from the chief manufacturers of wood-working machinery. In addition to increasing the safety of the machine, the cylindrical block has other advantages. It makes it possible to use very thin knives, which are considerably cheaper and much more rapidly sharpened than those of square blocks. It is also claimed that circular blocks do smoother work and do it more rapidly. It is of importance that there should be sufficient clearance in front of the knife edge, and buyers are recommended to be careful in this respect. It is sometimes objected that the circular block cannot be used with knives intended for moulding. It may be replied that work of this kind is generally done more effectively with a spindle moulder or circular saw than with a planing machine. Figure 26, however, shows an ingenious device.
for fitting a moulding iron to a circular block by removing part of the cylinder so as to allow sufficient play for the knife.

Although the accidents from planing machines with cylindrical blocks are much less serious than those from machines with square blocks, it is nevertheless necessary to supplement the protection by one or other of the devices illustrated in figure 27, all of which are in essence a kind of "bridge" which can be adjusted both horizontally and vertically to cover the work just above the gap in the table. The width of the bridge must be considerably larger than that of the gap, otherwise it does not give sufficient protection when thicker wood is being planed. The use of this guard is made compulsory by clause 15 of the Regulations. It can be adjusted to give good protection in the two operations usually effected on the same piece of work in a planing machine, namely, planing first the two broad faces of the plank and then the edges. The bridge is placed above the table at a distance slightly greater than the thickness of the wood and at the same horizontal distance from the guide. The British factory inspec-
The torate does not consider that adequate protection is given by the kind of guard consisting of a sort of cover which slides over the table and is pressed against the work by the action of a spring or weight. This guard affords no protection against the risk of the wood being drawn back by the cutter, for it cannot possibly be brought back over the gap in the table quickly enough to cover the knives and prevent injury to the worker's hand.

Push blocks with good hand grips (Fig. 28) are very useful when planing short or thin pieces of wood. Their use is compulsory under clause 14 of the Regulations, which lays down that a holder must be used for planing all wood less than 12 inches
Fig. 30.
Planing machine feed roll guards.

Fig. 31.
Guard plate attached to hood over planing machine feed roll.
This provision does not apply to machines fitted with cylindrical cutter blocks. For repetition work on small pieces of wood an adjustable appliance of the kind illustrated in figure 29 may well be used.

The principle of thicknessing machines is the same as that of overhand planers, but from the point of view of safety there is the great difference that their cutter blocks are placed above the table, so that they are without the dangerous gap of the overhand planing machine. The work is wedged between the block and the table in order to be given the desired thickness. As a rule these machines are fed by mechanically driven fluted rollers, which must be protected so as to prevent the worker's hand from being drawn in; a provision to this effect is contained in clause 16 of the Regulations. Where the feed roller can be adjusted vertically so as to follow the irregularities of the wood there is an advantage in mounting the guard plate on the bearings of the roller itself, so that the two rise and fall together, thus obviating the necessity for separate adjustment (Figs. 30 and 31). Usually the cutter blocks of thicknessing machines are not accessible and therefore need no special guards, or else they can be covered by the guard for the feed roller (Fig. 32). Finally there is the type of machine which works simultaneously on the four sides of a plank by
means of several cutters operating in different planes. The gearing of such machines is very important and should be carefully covered, not only to avoid accidents but also to secure satisfactory working of the machine, which would otherwise be clogged by sawdust and wood waste.

**Spindle Moulders**

The vertical spindle moulder is one of the most dangerous machines in common use. The hands of the worker are brought into close proximity to the tool, and many accidents are due to the work being torn from his grasp owing to an irregularity in the wood. A considerable proportion result in serious injury and the loss of several fingers. Fatal accidents may be caused by the cutters breaking off or coming loose and then being hurled away with great velocity owing to the centrifugal force developed by the high speed of rotation, which may be as much as 7,000 revolutions a minute. It is therefore of the highest importance that spindle moulders should be fitted with suitable guards (clause 17 of the Regulations), and that the cutters should be set with scrupulous care.

Three types of cutter block or spindle are usually employed on these machines in Great Britain. The first (Fig. 33) is commonly used in the building trade for heavy joinery mouldings. For some work it is sometimes possible to use the much safer cylindrical block, as in the case of planing machines, but this is not suitable for all kinds of work. The collar spindle (Fig. 34) is used for lighter work, while the so-called French spindle (Fig. 35) is employed for finer work in cabinetmaking.

The same spindle moulder may be used with more than one type of block, as required for the work which may, for instance, involve long runs of one kind of moulding or giving a particular
shape to only one piece of wood. The conditions under which the work is done vary widely according as the moulding is to be high or low, concave or convex, on straight or curved pieces of wood. There cannot, of course, be any single type of guard suitable to such very varying conditions, but there are a number

![Fig. 36.](image1)

Spindle moulder guards for use with tools close to the table.

![Fig. 37.](image2)

of different devices for dealing with the different cases which may occur. The most important point is that the guard should be fitted in as practical a manner as possible so that the cutter can be rapidly adjusted and replaced. Small cabinet makers who have no machines of their own can have single pieces of work moulded by a machinist for an insignificant sum (twopence before the war), and this means that the machinist must set and adjust a different blade in his machine for every piece of work. Obviously, under
such conditions, if a guard is to be used it must be very easily adjustable.

For straight work, guarding is much simplified by the guide used to hold the work. Sometimes the gap in the guide through which the cutter passes can be made smaller by placing in front of the guide a board containing a hole of a size allowing only the particular cutter in use to pass. A block of wood is then attached to the board so as to cover the cutter. Figure 36 shows an arrangement of this kind for a thin blade projecting very little beyond the table. In certain cases the guide may even be replaced by a piece of wood to which a block covering the blade is attached, leaving just enough play between it and the table (Fig. 37).

This kind of guard is suited only to cutters nearly level with the table, and in general for straight work a kind of shield must be used to cover the gap in the guide above the cutter. This shield should be adjustable vertically, and also horizontally according to the size of the work. Figure 38 illustrates a very practical way of fixing this kind of guard in two different positions. There are many other types of support which can be fixed to the table in some way or other, either by a clamp or in a
groove or series of holes. If a clear table is wanted the method of suspending the guard from the ceiling, as described for circular saws, may be used.

![Spring guard](image)

**Fig. 39.**
Spring guard.

![Wooden comb spring guard](image)

**Fig. 40.**
Wooden comb spring guard.

![Shield and spring guard](image)

**Fig. 41.**
Shield and spring guard.

For straight moulding, it may be of advantage to put spring pressure on the work which, while keeping it in place, gives complete protection (Fig. 39). Such pressure shield appliances may even be replaced by the device shown in figure 40, where the work

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1 See above, pp. 14 and 15.
is kept in position and subjected to pressure by a sort of comb which can easily be manufactured in any workshop. Appliances of this kind are suitable only for uninterrupted work. The

![Fig. 42.](image)

Band-type guards for spindle moulders.

same remark applies to the special arrangement shown in figure 41, where the wood is passed between the guide and the cutter, the latter being protected both by a shield surrounding the whole spindle and by springs. Though this method is good from the
Fig. 44.
Band-type guard, with screw for vertical adjustment.

Fig. 45.

"Cage"-type guards for spindle moulders.
point of view of safety, it has the disadvantage of preventing "striking in" (i.e. cutting a moulding on parts only of the timber and not along its whole length).

In cabinet making spindle moulders are used chiefly for shaping curved work. In such cases it is impossible to use a straight guide, and guards in the form of rings, curved metal bands, or cages must be used. Figures 42 to 47 show better than any description the method of using these various appliances. The protection they give is not complete, however, and it may be necessary to use push sticks (Fig. 48) or similar devices for
keeping the work in position mechanically. Clauses 18 and 19 of the Regulations prescribe the use of such devices whenever the nature of the work is such as to prevent the use of a guard, and lay down that such push sticks must always be kept available for use at every vertical spindle moulding machine.

Fig. 49.
Guard for chain mortiser.

Mortising Machines and Frame Saws

Clause 20 of the Regulations specifies yet another group of machines, namely, chain mortising machines, the cutting parts of which must be enclosed completely by a sliding guard. This may be effected without great difficulty, and figures 49 and 50
show satisfactory types of this kind of guard, constructed in such a way that it is easy to see the protected parts. Similar appliances may be used for mortising chisels (Fig. 51), though guards for these tools are merely recommended and are not compulsory.

With frame saws, attention should be devoted particularly to guarding transmission gear, more especially the connecting rod or rods. The writers of the pamphlet consider that a guard consisting of one or two rails, such as is often used, is inadequate and that it should be replaced by netting, sheet metal, or boarding.
Fig. 51.
Guard for chisel mortiser.
Pneumatic Removal of Sawdust

This matter is not covered by the 1922 Regulations, but the attention of those concerned is drawn to exhausts for the removal of dust and chips. They have many advantages, for they not only reduce the risk of fire and dust explosion, but they also save the labour of sweeping up wood débris and diminish the risk of accidents caused by flying particles. Their use is no less to be recommended from the point of view of health. A special section is devoted to this subject, and practical advice on the best means of installing them is given together with a number of excellent photographs of typical plant which illustrate the explanations very clearly.
II

SWITZERLAND

The principles on which safety work is based in Switzerland differ somewhat from those generally adopted elsewhere. Section 65 of the Act of 13 June, 1911 on sickness and accident insurance contains the following provisions:

In any undertaking specified in Section 60 the employer or his representative shall take all such steps for the prevention of sickness and accidents as have been proved necessary by experience, in so far as the circumstances and the results of scientific progress permit.

The National Office may order any measure it considers necessary after consulting the persons concerned, and the latter may appeal to the Federal Council within twenty days.

Thus measures for the prevention of accidents in undertakings subject to Federal legislation or to sickness or accident insurance are entrusted to the National Accident Insurance Office at Lucerne. The orders and instructions given in each case by the National Office in accordance with the general principles it has adopted constitute the regulations for the prevention of accidents. The annual reports of its Accident Prevention Department and its special publications contain extensive information on the subject.

Since its establishment in 1919 the Accident Prevention Department has been obliged to pay very close attention to woodworking machinery. The use of such machinery is very general in Switzerland, it being estimated that not less than twenty or twenty-five thousand circular saws are employed in undertakings subject to compulsory insurance (about 35,000). The wood industry proper is a very important one in this country. According to the 1910 census, of a total of 809,114 persons employed in industry, 56,090 or 6.8 per cent. were engaged in woodworking. In addition many other undertakings employ woodworking machinery for some branch or other of their work,

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2 On 26 Sept. 1923, of a total of 337,403 persons subject to factory laws, 18,975 were engaged in woodworking.
under the most varying conditions. A chocolate factory, for instance, will have saws, planing machines, etc. for making packing cases, and an engineering firm will need the whole series of wood-working machines for its pattern-making shop.

The following table gives some idea of the relative gravity of the accidents due to the various kinds of wood-working machines. It shows the proportion of all accidents on wood-working machines notified under the compulsory insurance system (whether resulting in disability or not) which caused permanent disablement or death.

**CASES OF DISABLEMENT OR DEATH AS PERCENTAGE OF TOTAL ACCIDENTS ON WOOD-WORKING MACHINES IN SWITZERLAND, 1919 TO 1922**

<table>
<thead>
<tr>
<th>Type of machine</th>
<th>1919 per cent.</th>
<th>1920 per cent.</th>
<th>1921 per cent.</th>
<th>1922 per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular saws</td>
<td>11.9</td>
<td>13.3</td>
<td>16.9</td>
<td>18.9</td>
</tr>
<tr>
<td>Band saws</td>
<td>7.6</td>
<td>5.0</td>
<td>6.7</td>
<td>9.8</td>
</tr>
<tr>
<td>Frame saws</td>
<td>11.7</td>
<td>12.0</td>
<td>2.7</td>
<td>10.0</td>
</tr>
<tr>
<td>Overhand planing machines</td>
<td>6.8</td>
<td>9.6</td>
<td>11.2</td>
<td>10.1</td>
</tr>
<tr>
<td>Thicknessing machines</td>
<td>5.7</td>
<td>2.9</td>
<td>2.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Spindle moulders</td>
<td>14.0</td>
<td>20.0</td>
<td>20.3</td>
<td>20.3</td>
</tr>
<tr>
<td>Horizontal moulding machines</td>
<td>33.3</td>
<td>22.2</td>
<td>26.7</td>
<td>25.6</td>
</tr>
<tr>
<td>Other machines</td>
<td>2.2</td>
<td>7.8</td>
<td>7.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Average</td>
<td>9.5</td>
<td>11.7</td>
<td>13.7</td>
<td>15.1</td>
</tr>
</tbody>
</table>

These figures show that the average proportion of cases of permanent disablement is high, and that circular saws (including horizontal moulding machines) and spindle moulders are the most dangerous types of machine.

**Preventive Measures**

The Accident Prevention Department is, of course, in entire agreement with the British authorities as to the need for all the general precautions described in the previous chapter. Careful installation of the machines in the workshop, the lighting of premises, etc. are everywhere of the same importance. As a matter of fact, these matters had already been dealt with in most under-

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1 In this respect, as also in that of safeguards, interesting information from the international point of view may be found in the following:


takings by the Federal factory inspectorate before the National Office was founded. The inspectors of the Accident Prevention Department therefore rarely find it necessary to criticise workshops as unsuitable or badly illuminated. More frequently they find the transmission machinery improperly guarded, and they sometimes find it necessary to order improvements in the appliances for starting the machinery. The Department naturally requires that the machine shall be easily controlled from the place where the operative is stationed and particularly recom-

![Arrangement of loose and fast pulleys (circular saw)](image)

mends the construction illustrated in figure 52, an arrangement very easy to carry out, where the loose pulley is entirely independent of the fast pulley.

In the vast majority of cases the guarding of the machinery itself is the chief question, and in this respect the National Office has introduced a most interesting innovation, itself devising adequate safeguards, manufacturing them wholesale, and supplying them at cost price to manufacturers who apply for them.

Without absolutely requiring the standardisation of types of guards throughout the country the Office does much to promote it.

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1 Wood-working machines are very often accompanied by grinding machines for sharpening blades. Such machines are fitted with abrasive wheels which raise problems of safety naturally dealt with by the Accident Prevention Department at the same time as other such matters. Cf. *International Labour Review*, Vol. VIII, No. 1, July 1923, p. 126.
It considers such standardisation very desirable, on the ground that the worker cannot be expected, on leaving one factory for another, constantly to familiarise himself with different appliances. If, on the other hand, he always finds the same safeguard, he ends by becoming used to it and constantly employing it. Moreover, if all the safety appliances used are identical, it is very easy to introduce the improvements suggested by experience.

If an employer prefers himself to construct the guard prescribed by the Office the latter supplies the necessary designs and patterns and will even lend one of its own appliances in order to facilitate his work. In theory the employer is even entitled to devise an appliance of his own, but since such a device must satisfy very strict conditions, often the only acceptable pattern is that of the National Office. The latter is prepared to lend the heads of undertakings the sums needed for carrying out the prescribed measures on very advantageous terms, the interest charged being only 4 per cent. and repayment being spread over five years. This makes it easier for the Accident Prevention Department to obtain material results. It is thanks to its position as part of the compulsory state insurance system that it is able to make such an offer. The management of the National Office has decided to profit by any reduction in industrial activity such as the recent depression in Swiss industry, to enforce all suitable preventive measures. Under normal conditions the manufacturer would rather pay fines than interrupt urgent work, and indefinitely postpones the execution of improvements ordered on the plea that there has been no time for it. In a period of depression he cannot advance this excuse, and he then raises financial objections which the National Office can meet only by advancing funds.

It has already been seen that under the law the head of an undertaking must take all necessary steps for the prevention of accidents, which implies that he is under an obligation to provide guards for his machines. If he fails to do this he is liable to have his premium due to the National Office raised, quite apart from the possibility of prosecution. The Act does not expressly lay down that the workers must use the guards supplied by their employer, but under Section 98, if an accident is due to serious negligence on the part of the insured person, the benefit paid by the National Office is reduced according to the degree of negligence. The workers are informed of this provi-
sion by notices permanently posted beside the machines. The National Office, while insisting on the provision and use of safeguards with the utmost strictness, also makes it a duty to be in a position to recommend really effective and practical appliances. Did it not do so, it would meet with insurmountable opposition. The Accident Prevention Department has therefore made a very careful study of existing appliances. It has realised that in many cases these are far from satisfactory, and after ascertaining their defects it has constructed its own models for certain types of machinery which are particularly difficult to guard.

**Circular Saws**

In Switzerland, as elsewhere, circular saws vary very much in type, and it might at first sight be thought that this diversity would make it difficult to devise safety precautions. An examination of statistics shows, however, that this is not the case, as will appear from the following table showing the distribution by type of machine of accidents due to circular saws during the four years 1919-1922 inclusive:

<table>
<thead>
<tr>
<th>Type of saw</th>
<th>Accidents notified under compulsory insurance</th>
<th>Accidents leading to death or disablement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent. of total</td>
</tr>
<tr>
<td>Rack saw</td>
<td>767</td>
<td>25</td>
</tr>
<tr>
<td>Bench saw</td>
<td>1,472</td>
<td>47</td>
</tr>
<tr>
<td>Cross-cutting saw for fire-wood</td>
<td>275</td>
<td>9</td>
</tr>
<tr>
<td>Undefined</td>
<td>589</td>
<td>19</td>
</tr>
<tr>
<td>All circular saws</td>
<td>3,103</td>
<td>100</td>
</tr>
</tbody>
</table>

Thus in practice the legislation in force in Switzerland gives exactly the same results as those aimed at by the British regulations. The respective duties of employer and worker are the same, the only difference being in the kind of assistance given to the heads of undertakings by the authorities.

As has already been explained in the section on Great Britain, it is essential that in such a complicated matter as safety in the present state of industry the employer must be given the assistance of competent persons, for if left to himself he would not be able in many cases to supply adequate protection, however good his intentions.
Bench saws and rack saws alone are responsible for about a half and a quarter respectively of the total number of accidents; thus nearly three-quarters of all accidents are due to these very clearly defined types of machine, for which, fortunately, the same guards can be used. Cross-cutting saws for firewood also constitute a clearly defined type of machine, so that ultimately machinery of a special and more or less well-defined type is responsible for only 19 per cent of the total cases. It should further be remarked that the accidents in this last group are very much less serious than the others, to judge by the proportion of cases of death or disablement. From the technical point of view, therefore, rack and bench saws are of most importance. Cross-cutting saws for firewood and special machines such as swing saws or multiple saws, besides being less numerous, are generally not difficult to guard properly.

**Rack Saws and Bench Saws**

These two types of machine are used primarily for rip sawing, and the guard should consist of (1) a cover for the part of the blade underneath the table; (2) a riving knife; (3) a protective hood.

The lower part of the blade may be covered in the simple way already described. With rack saws, which are nearly always against a wall, it is enough to place a metal apron on the side next the operative. Sometimes the lubricators of the spindle bearings are placed much too near the blade and they must then be fitted with lengthening pieces.

Riving knives must satisfy the following conditions laid down by the Accident Prevention Department: they must be adjustable so that they can be brought to a distance of not more than 10 millimetres from the edge of the blade and so that the upper end is not more than 20 millimetres lower than the top of the blade above the bench table. These condition are fulfilled by the devices shown in figure 53. The Department considers that, in view of the vibration of the machine and the possible strain on the riving knife, it should be fixed by hexagon nuts. This necessitates the use of a spanner, and the Department therefore supplies a wrench with every riving knife which it issues, to be fastened permanently by a chain to the framework of the saw.

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1 See above, pp. 12 and 16.
Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 53.

Riving knives.
The minimum thickness of the riving knife, in the opinion of the Accident Prevention Department, should be half a millimetre less than the width of the saw-cut ¹.

The arrangement adopted by the National Office for the riving knives it supplies is that shown in figure 53, No. 3. There are three normal sizes, used for blades with a diameter of 250 to 450 mm., 450 to 700 mm., and 700 to 1000 mm. respectively. There are two thicknesses in the first size of knife and three in the other two.

While the riving knife usually employed to guard the back of the saw satisfies every requirement, so that there is no reason for devising anything different, the same cannot be said of the cover for the blade above the table, which required a special study. The only successful protective hood would be one not interfering with the operative in his work and capable of adjustment to the height of the work without appreciable loss of time. The first step, therefore, was to determine the conditions to be fulfilled by such a guard, and the results of this study are summarised below ².

1. When the saw is not in use the hood should completely cover the part of the blade not protected by the riving knife.

2. The hood should be adjustable to any height.

3. The hood should be adjustable without appreciable loss of time to the height needed to allow the work to pass.

¹ There is a slight difference of form in the recommendations of the British and Swiss experts on this point, but the difference is theoretical rather than practical. The width of the saw-cut may vary slightly after the teeth have been re-set, and as a matter of fact the riving knife may be considered satisfactory as long as its thickness is not markedly less than the width of the cut.

² It may be of interest to compare this specification with that given by American experts (National Safety Council's Safe Practices Pamphlet No. 20, p. 7).

(a) The guard (hood) should be of light weight yet of substantial construction. (b) It should preferably be made of aluminium, but brass, fibre, and wood are sometimes used. (c) It should permit a clear view of the saw blade at point of operation. (d) It should automatically and easily adjust itself to different thicknesses of material to be sawn. (e) It should be rigidly supported to minimise vibration and lessen the danger of guard coming in contact with the saw blade. (f) The guard supports should not interfere in any way with the usual action of the operator in feeding the machine. (g) It should be so constructed that it can be quickly swung out of the way and returned to position. (h) It should be permanently attached to the machine so that it cannot be readily removed.
(4) The hood should be narrow enough not to conceal the work too much and to allow the sawing of thin laths against the guide.

(5) Whatever its position, the hood should not interfere with the adjustment of the riving knife.

(6) The shape of the hood should be such as to allow of sawing along a line.

(7) It should be possible to adjust the position of the hood according to the size of the blade.

(8) Unfastening the nuts which fix the hood according to the height of the work must never cause it to fall on the teeth of the saw.

Such were the conditions observed by the National Office in designing the new protective hood illustrated in figures 54 to 56. The appliance consists of a support and a guard with balance weight.

The support consists of two flat bars A (Fig. 54) in which a series of holes are drilled, four fixing-bolts B, and a spindle C, fitted at the ends with nuts D, screwed by hand. The nuts D are prevented from becoming unscrewed when the height of the hood is adjusted by the cotter-pin E and the washer G on one side of the spindle, and the lock H kept in position by the pin F on the other side.

In the guard itself the protective hood L, fitted with a handle M so shaped as to facilitate the insertion of the work, is fixed at one end an arm K, at the other end of which is a balance weight N. The arm K is attached to the support by a bracket J, drilled with a hole through which the end of the spindle C passes. The balance-weight is so arranged as to allow the hood to descend and cover the blade automatically when the bracket is free upon the spindle. In large hoods, the balance weight is not rivetted to the arm, but suspended on a wire rope fixed directly to the hood L and passing over a pulley fixed to the ceiling. This method of balancing the hood may, of course, be used also for small sizes.

The protective hood should not, as on first consideration might be thought necessary, descend automatically over the work. It is preferable to fasten the nuts D in such a way that the hood remains fixed in whatever position it is placed. Its height is adjusted by hand, by means of the handle M. This handle carries an indicator O, showing the position of the blade, thus making
Fig. 54.
Protective hood for circular saw.

A. Flat bars.
B. Fixing-bolts.
C. Spindle.
D. Nuts.
E. Cotter-pin.
F. Pin.
G. Washer.
H. Lock.
J. Bracket.
K. Arm.
L. Protective hood.
M. Handle.
N. Balance-weight.
O. Indicator.
P. Wooden lining.
Fig. 55.
Protective hood, front view.
Fig. 56. Protective hood, back view.
it possible to saw accurately along a line without seeing the saw. Inside the hood a wooden lining $P$ is screwed to prevent the blade from injury if it should accidentally come into contact with the hood.

Figure 57. Nos. 1 to 4, show the most usual methods of fixing these guards; Nos. 1 and 2 illustrate the mounting of the hood on the table of the machine by two U-irons; No. 3 shows a very practical solution of the problem of mounting the guard for machinery placed against a wall. The system illustrated in No. 4 is also independent of the table of the machine. It is used when the table must be kept quite clear for work on large pieces of wood. The holes drilled in the flat bars $A$ make it possible to fix the hood in the position suited to each size of blade. In order to determine which hole to use, the hood is placed in position so that the indicator $O$ is as near as possible to the blade. The hole through which the spindle $C$ should be passed is then clearly seen.

The hoods stocked by the National Office are of four sizes, to be used for blades with a diameter of 250 to 350 mm., 250 to 450 mm., 450 to 700 mm., and 700 to 1000 mm. respectively.
Appliance for cutting very thin pieces of wood with circular saw.
appliance illustrated in figures 60 and 61. It consists of a slide fixed against the guide in which moves a handle fitted with a push block and an adjustable stop intended to keep the work against the table. The handle is hinged and can be made to swing above the slide so as to clear it, when the handle can be used as a guide for the work in the ordinary manner. This appliance, while allowing the use of a protective hood, very much facilitates the work and possesses all the necessary qualities of simplicity and strength. It has met with approval everywhere.

The Accident Prevention Department does not require a protective hood for circular saws with blades of less than 250 mm. diameter, but in such cases the employer must undertake in writing not to use larger blades, on pain of being made responsible for the results of any accident.

None of the operations effected with a circular saw are interfered with by the protective hood, except that of cutting a groove in the work when the blade is entirely buried in the wood. The Accident Prevention Department may authorise employers owning several machines to reserve a small bench saw for such work on condition that they post notices prohibiting the workers from using it for other purposes.

From the point of view of safety, it is important that circular saws should be worked at the right speed. If the speed is not high enough, the work is bad and the risk of the wood being thrown back is considerably increased. Sometimes the attention of manufacturers has to be drawn to this question of speed, for they often use the same spindle for blades of very different diameters. In such cases a series of pulleys should be used to vary the speed of rotation of the spindle so as to avoid too high or too low a speed.

**Cross-Cutting Saws for Firewood and Pendulum Saws**

There are two characteristic types of circular saw used for cross-cutting. The following precautions are prescribed by the Accident Prevention Department for chariot saws, which are the most usual type.

1. The part of the blade below the table must be covered (A).
2. A fixed cover must be placed above the table completely covering the blade when at rest (B).
3. A support for the work must be placed on each side of the cover above the table (C).
(4) There must be a device limiting the movement of the table in both directions (D).

(5) There must be an arrangement for preventing the table from rocking (E).

(6) There must be an automatic device for returning the table to the position of rest (F).

The design shown in figure 62, constructed in accordance with these provisions, is supplied as a model to persons concerned.

The compulsory precautions in respect of pendulum saws are as follows:

(1) The upper part of the blade must be completely covered (a).

(2) The outer side of the blade must be covered (a).

(3) A protection apron of sheet-iron must be inserted between the belt and the handle (b).

(4) A handle for moving the framework of the saw must be provided (c).

(5) A device for limiting the travel of the saw in each direction must be fitted (d). Pendulum saws are very often placed against a wall, which then serves as a stop in one direction.

Figure 63 illustrates these requirements.

**BAND SAWS**

The requirements of the National Office with respect to band saws coincide with those already examined for Great Britain. The Accident Prevention Department states, however, that it should be possible to lower the adjustable part of the cover of the descending blade to within 10 cm. of the table. The standard guard is illustrated in figure 64, No. 1; No. 2 shows how to cover the hollow very often to be found in the guard of the lower pulley supplied by the manufacturer.

**OTHER SAWS**

Multiple saws are usually employed for repetition work. Like all machines intended for specialised work, they are comparatively easy to guard, particularly as they are usually fed automatically. The serious accidents which have taken place have nevertheless proved the urgent need for precautions, especially to prevent the wood from being thrown back.
Fig. 1

 Guards for band saw.
or to the feed rolls necessitating certain elementary precautions. These machines, however, show a lower percentage of disablement than others.

**Spindle Moulders**

The National Office has tried to devise an effective guard for spindle moulders which may be used for all kinds of work; that is to say, which can be placed in position, adjusted, and removed as required and without appreciable loss of time. Guards satisfying the requirements of safety are to be found for nearly all kinds of work. Horizontal and vertical presser springs, for instance, are very suitable when cutting continuous mouldings on straight work. For adjusting the cutters, for "striking in" (cutting a moulding on parts only of the timber), or for cutting single pieces of wood, a curved shield closing the gap which must be left between the two parts of the guide may be used with advantage, while for moulding curved work preference should be given to ring guards.

There is some reluctance to use these appliances owing to the time needed for mounting and adjusting. In view, for instance, of the loss of time due to mounting the four presser springs, which must be fixed separately on the table or the guide and then adjusted to the height of the work, it is not surprising that they are used only for repetition work. The same applies to other appliances every adjustment of which means unscrewing and screwing one or more screws with a spanner. In order to turn the existing guards to account, some form of practicable support had to be found which could be used indifferently for all kinds of guard. This problem has been solved by the National Office with the appliances illustrated in figures 67 to 73. The appliance consists of (a) a device for fixing it to the table of the machine; (b) a holder for the guard with a locking device; (c) the various guards.

The fixing device consists of a spindle 1 (Fig. 67), the lower part of which rests on a step bearing 3. It is kept at the level of the table of the machine by a collar 2 fixed to the table in which it revolves freely.

The holder of the guard consists of two flanges 4, the upper part of which encloses an arm 17. At the lower part is a square-bar 16 with holes drilled at each end into which the spindle 1 and the locking pin 15 are inserted respectively. The framework formed by the flanges 4 and the parts 17 and 16 engages with
Fig. 67.

Spindle moulder guard.
the spindle 1, which is inserted in the hole in the block 16 and a hole at the end of the back of the arm 17. Between the flanges are levers 5 and 6, fixed to them at the points A and B, about which they pivot, and carrying a holder 7 hinged to a vertical rod 9. The apparatus is so devised that when the holder 7 is moved its end X keeps in a vertical line. The rod 9 hinged to the holder 7 slides in C in such a manner that it remains vertical when the holder is raised or lowered. It can be fixed firmly at any height by means of a set screw 14. The holder 7 and rod 9 are easily moved by the hand lever 8, which is fitted with a handle. A wire rope 13, fixed to the end X of the holder 7, carries a balance-weight 12 running on the spindle 1 and balancing the whole mobile system consisting of the levers 5 and 6, the holder 7, and the rod 9. The pin 15 is intended to keep the whole apparatus in a given position, being passed through a hole drilled in the table of the machine.

Any kind of guard may be used with this appliance. A guard closing the gap between the two parts of the guide is illustrated in figures 68 to 70, while figures 71 and 72 show the ring type of guard. The appliance in figure 73 is fitted with presser springs. The guards are mounted on two rods which fit in the slides 10 of the guard holder. They are kept firmly in position by the set screws 11.

When in use, the appliance is placed in the position shown in the drawing and fixed by inserting the pin 15 in the hole drilled in the table. The guard (18) is next put in position by fitting its rods into the sockets 10 to the required depth and then fastening the screws 11. The height of the guard is then adjusted by manipulating the holder 7 by the lever 8, which is fixed at the desired height by the set screw 14. When it is desired to move the appliance out of the way, the holder 7 is raised to its maximum height, the pin 15 is withdrawn, and the whole appliance is turned round, leaving the table quite clear. If the appliance is to be removed, which is seldom necessary, all that need be done is to unhook the balance weight 12 and raise the appliance to the desired height in order to set free the spindle 1. The latter may easily be removed by taking it out of the collar 2.

The appliance may be combined with exhausts for the removal of chips. The drawing (Fig. 67) shows that it is constructed to allow free passage for the suction tubing. The appliance for spindle moulders manufactured by the National Fund fits all sizes of machine in general use.
Fig. 68.
Spindle moulder guard, mounted for "striking in".
Fig. 69.
Spindle moulder guard at its maximum height, for adjusting or changing cutter.
Fig. 20.
Spindle moulder guard out of action, leaving table free.
Fig. 71.
Spindle moulder guard out of action,
back view.
Fig. 72.
Ring protector for spindle moulder in position for moulding curved work.
COMBINED MACHINES

There are in Switzerland a considerable number of combined wood-working machines, which in the most usual form combine a circular bench saw with a vertical spindle moulder. To guard them properly two separate appliances must be mounted on the same bench, and this is not always easy. In some cases, when one of the machines is to be used all the guards for the other have to be removed, which naturally involves a waste of time. As a
Fig. 74. Guards on a combined circular saw and spindle moulder.
rule the use of these machines is not economically advantageous, and as soon as they are in frequent use it is preferable to replace them by separate machines; the initial cost is rapidly compensated by the time saved, and the separate machines are very much easier to guard. The use of combined machines cannot be justified in other than quite small undertakings. Figure 74 is an example of the way in which they may be protected.

CONCLUSION

The preceding account will have shown that in the two countries under consideration the attention devoted to protecting the dangerous type of machinery used in wood-working leaves nothing to be desired. Both countries have reached the stage of systematic action for the prevention of a whole series of specified accidents. As might have been foreseen, the natural requirements of safety, as it were, have led to the establishment of principles of striking similarity although reached on independent lines. There is no need to emphasise the obvious analogy between the main features of the measures adopted in the two countries. The preceding account will have shown that the need for very strict and highly technical regulations has been fully recognised both in Great Britain and in Switzerland, and that the obligations imposed on manufacturers and their employees are the same.

There is complete agreement on the fundamental principles on which official action must be based and on the conditions to be fulfilled by safeguards, and this agreement would in fact remain to a greater or less degree even if the comparison were between several instead of between only two countries. Nevertheless certain differences at once appear in the methods of carrying these principles into effect. These differences are very largely the natural result of the legislative methods and the character of the bodies administering the law in the two countries.

The basis of all official action in Great Britain is to be found in the 1922 Regulations, which are necessarily limited to purely technical matters. The factory inspectorate must consequently accept as satisfactory any safeguard which does not actually
violate the text of the Regulations. In his official capacity the
inspector is merely in a position to ascertain that the appliance
used in an undertaking satisfies the Regulations. Although he is
quite prepared, at the request of the head of the undertaking, to
give advice on such matters as the most economical method of
fitting a guard or the ease or difficulty for the worker in using it,
he has no power to insist once the Regulations have been observed.
The inspector has no right to demand the adoption of measures
which he may advocate in an advisory capacity, and consequently
there is no certainty that any suggestions he may make for
standardising safeguards in his district will be carried out.

The devices accepted in the pamphlet which has been issued as
a guide for officials and employers are many and sometimes differ
considerably. It is clear from the illustrations in the pamphlet
that certain appliances are more costly and have perhaps reached
a higher degree of perfection than others. The authorities make
no choice among these appliances and express no preferences.
This attitude is reflected in the Regulations themselves, which,
after specifying the guards to be used for circular saws, band
saws, and overhead planing machines, state in clause 22 that the
said provisions shall not apply to any machine for which other
safeguards are provided rendering it as safe as it would be if
guarded in the manner prescribed by the Regulations. This is
characteristic of the spirit of British legislation which always
respects individual ideas and action as much as possible.

In Switzerland the administrative body responsible for
industrial safety is able to go further. It does not rest
satisfied with what it can obtain by general instructions,
but can require individual action. This gives it wide powers to
co-operate directly with those concerned, not only from the
technical, but also from the practical and economic points
of view. The Accident Prevention Department of the National
Office considers that the safeguarding of a given kind of machine
is a problem which should be solved so as to give the best possible
compromise between the different factors involved. It endeavours
to design such a standard model, and then aims at getting it
adopted everywhere. It is with this end in view that it manu-
factures the model wholesale and sells it at cost price.

The various appliances designed in accordance with these
principles by the Department possess in a marked degree all the
necessary qualities of simplicity, and therefore ease in manipu-
lation, strength, and efficiency. Under present conditions they
may be regarded as more or less final solutions of the problem, subject only to slight further modifications as suggested by experience. It is true that in applied mechanics it is very difficult to know whether progress will not lead to the substitution for a good model of another, still better, one. If, however, it is remembered that in this particular case the present safeguards apply to machinery which has undergone no particular change for many years, it is not rash to conclude that the principles on which these safeguards are constructed will continue to apply.

The Swiss employer is not compelled to accept the safeguard proposed by the National Office. He may employ a device of his own design, provided that it satisfies the requirements of the Accident Prevention Department; but since these requirements are very precise safeguards constructed thus independently can rarely be approved, and in any case they will probably cost very much more to instal. There are very strong arguments in favour of the standardisation of safeguards which is desired by the National Office. Only such standardisation allows of manufacture on a large scale and consequently of a reduction in the cost of production. If the worker finds the same type of safeguard in all undertakings he becomes used to it and ends by employing it constantly, but it makes a very much greater call on his good will if he has continually to accustom himself to new appliances. The importance of this consideration cannot well be over-emphasised.

It is perhaps permissible to believe that this attempt of the Swiss National Office to standardise safeguards has set an example which it is to be hoped other countries will follow. It would, however, be premature to attempt to draw too rigid conclusions from a system which is still in its inception. Moreover, it should not be forgotten that the position of the National Office is particularly favourable to its experiment. It need only be recalled that its power to adjust the rate of premium payable by the heads of undertakings to the results obtained constitutes in itself a very effective and flexible means of action. The Office has therefore very little need to resort to penalties, while it has been able to overcome much opposition by its system of advancing funds.

To complete the present comparative survey it is desirable to follow closely the practical results obtained in Great Britain and Switzerland, and to profit by the experience of these two countries.
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