

# Guide to Safety in Agriculture

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INTERNATIONAL LABOUR OFFICE  
GENEVA, 1969



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## FOREWORD

The present Guide to Occupational Safety in Agricultural Work, whose publication was authorised by the Governing Body of the International Labour Office at its 155th Session (May-June 1963), was drafted for the Office by Mr. H. RENNTUN of the Swedish Workers' Protection Board and finalised by a meeting of experts held in April-May 1964.<sup>1</sup>

The guide was revised and given its present form in the light of the views expressed and the amendments suggested by the meeting. The experts considered that it would have considerable value for economically advanced countries, but that it would be especially useful for developing countries, and countries where agricultural mechanisation was spreading rapidly.

In particular they hoped that it would be consulted with advantage by teachers in the field of agriculture, persons responsible for safety in large-scale and medium-scale agricultural undertakings, employers' and workers' organisations and public authorities and other interested bodies.

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The International Labour Office published in 1967 a Code of Practice on Safety and Health in Agricultural Work, which it prepared in collaboration with the same experts. It covers much the same ground as the guide, but its recommendations are expressed concisely in the form of rules, and it lacks explanatory material and illustrations. It may perhaps be described as a condensed version of the guide and many readers may find it a handy companion to the latter.

The Office will publish a separate guide to occupational health in agricultural work, and accordingly the present guide only deals in summary fashion with matters of health and hygiene.

The Office realises that it may be venturesome to attempt to deal in one volume with all aspects of safety on all kinds of farms, but it feels that the guide, the work of an international body of experts, will help to preserve life and limb in a vital but, from the prevention point of view, rather neglected branch of economic activity.

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## **1. ACCIDENT RISKS IN AGRICULTURE**

1.1. Throughout the world several hundred million persons are employed in agriculture. It has been estimated that from 75 to 100 million of them are accounted for by India alone. Nearly 30 per cent of the population of Japan live on farms and some 15 million persons work on them (1960). Agriculture, in fact, is the world's largest industry.

1.2. We do not know how many accidents happen every year in the world's agriculture. But the number is certainly very large, and there is evidence that agriculture is in many respects a dangerous activity. The cost of accidents is twofold; there is the cost in money and the cost in suffering.

1.3. The cost in money is accounted for by medical treatment, compensation, loss of output, loss of wages, damage to buildings, machinery and other property, and so on. A fire may cause only slight injuries to a worker but it may do a very great deal of damage to property.

1.4. In terms of human costs an accident to a farm hand may be a very serious matter for him and his family. On a family farm, where the livelihood of the family depends on the farmer's ability to work, a fatal accident or an accident that disables him for several weeks may be catastrophic.

1.5. Accidents—fatal, serious and minor—occur on all kinds of farms and related agricultural and forestry undertakings—cattle farms, fruit farms, wheat farms, vineyards and others. Even flower growers have been killed or permanently disabled by accidents at work. Moreover, accidents spare neither the very young nor the very old; every year large numbers of boys and girls, old men and old women are injured on the farms of the world, and thousands of them are permanently disabled or even killed.

1.6. The farm worker's natural environment presents numerous risks for him. He may be threatened by land, water, sun or wind. Disasters have been caused by floods, landslides and avalanches. Marshes may be a source of malaria and earth polluted by refuse a source of infection—cases of tetanus, ankylostomiasis and helminthic diseases still occur. Water from streams and wells is often not fit to drink. Lightning is a bigger risk in the country than in towns. In summer there may be a risk of sun-stroke, and in winter of frostbite. In some regions wild animals such as wolves and bears are risks; others are infested by snakes or insects such as scorpions and tarantulas; and in others again there are poisonous plants such as poison ivy and poison oak. The farmer's own animals contract diseases and communicate them to man. Thus there is plenty of scope for accident prevention and health protection.

1.7. Farm workers' living conditions are outside the scope of this manual, but for the large numbers who live in caves, huts and cabins in different parts of the world life is certainly unhealthy, if not actually unsafe.

1.8. Agricultural work embraces a very wide range of activities. Although the main activities are the cultivation of crops and the raising of livestock, on a modern farm or plantation a considerable amount of work may be involved in processing produce and in the maintenance and repair of buildings, plant, machinery and implements. It may be necessary also to generate electricity, dig wells, maintain irrigation systems, clear land, build roads, undertake drainage works, run sawmills and transport heavy loads of produce to the market. Many of these activities involve the use of machinery and other equipment, which if not properly handled and safeguarded may cause serious accidents. In others, the use of pesticides and other dangerous substances will threaten the health of workers. In fact, in all agricultural activities there will be some kind of accident risk. The general trend in agriculture is to rely more and more on machines, electricity and chemicals to do the work, and the occupational risks are in consequence bearing a closer resemblance to those in other industries.

1.9. It will be clear, then, that in an industry so large and so complex as agriculture, the prevention of accidents is of the greatest importance: if frequency and severity rates could be substantially lowered throughout the world, the whole agricultural population would reap a rich reward. The purpose of this guide is to suggest some ways and means of achieving progress towards greater safety on the farm. It will be seen that it is not only necessary to provide safe equipment and safe working conditions; everyone working on farms—farmers, foremen, specialists, labourers and the rest—must possess the necessary training and education to enable them to keep the work safe.

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## **2. SOME GENERAL PRINCIPLES**

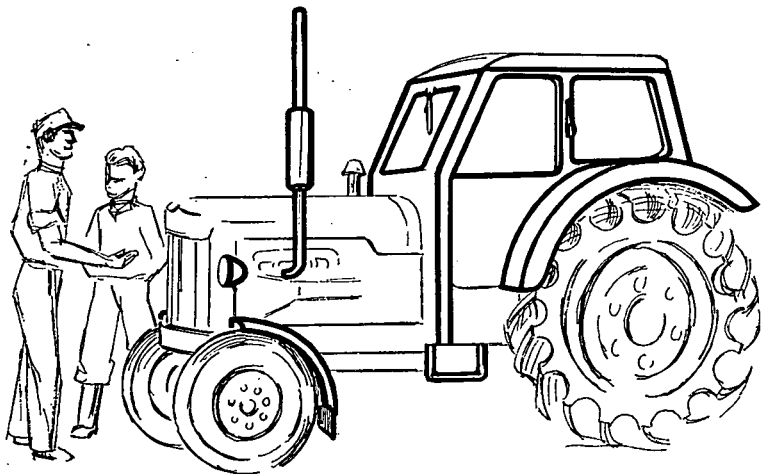
2.1. There are a few general principles of accident prevention that apply to all industries, and not only to agriculture. It may be useful to recall them at the beginning of this guide, if only because all that follows is based upon them.

2.2. The overriding principle is certainly that of placing the main responsibility for the safety of workpeople on the employer, here the farmer. Some countries have laws and regulations, and even inspectors, for the protection of farm workers, but laws and regulations cannot provide for every contingency, and inspectors, where there are any, cannot usually spend more than a few hours in a year at any one farm. The day-to-day work of promoting and maintaining safety has to be done by the employer or under his direction.

2.3. To begin with, when acquiring machines, appliances, vehicles or other equipment, the farmer should ensure that they should conform to any safety regulations or standards applying to them.

2.4. As regards the actual work, the farmer should provide such supervision as may be needed to keep his workpeople reasonably safe. Good supervision is particularly important with new workers.

2.5. The workers themselves need to be properly instructed in the hazards of their jobs and the precautions that they should take (fig. 1). Here again particular care must be taken with new workers. A worker who cannot recognise dangerous conditions, or who does not know how to do a job safely, is a danger to himself and to others. Safety education and training are therefore of vital importance. In fact, ignorance of danger can lead to very serious accidents. There have been cases where workers in a locality



**Fig. 1. Educating the young.**

**Young people's safety training is a valuable preparation for their future.**

have been poisoned by pesticides because they had no idea that they were dangerous. Employers are usually required to post up copies or summaries of national or local regulations, as well as appropriate instructions and notices, relating to protection against accidents and injuries to health.

2.6. Often rules are drawn up by manufacturers concerning precautions to be taken in the handling, operation and maintenance of equipment, e.g. in instruction books for machinery and on labels and containers for toxic substances. It is very important that all such rules should be obeyed.

2.7. Naturally workers as well as employers have duties in the domain of safety. One is to make proper use of all safeguards and other appliances, etc., furnished for their protection and the protection of others. Such means of protection should not be interfered with, altered, removed or displaced without proper

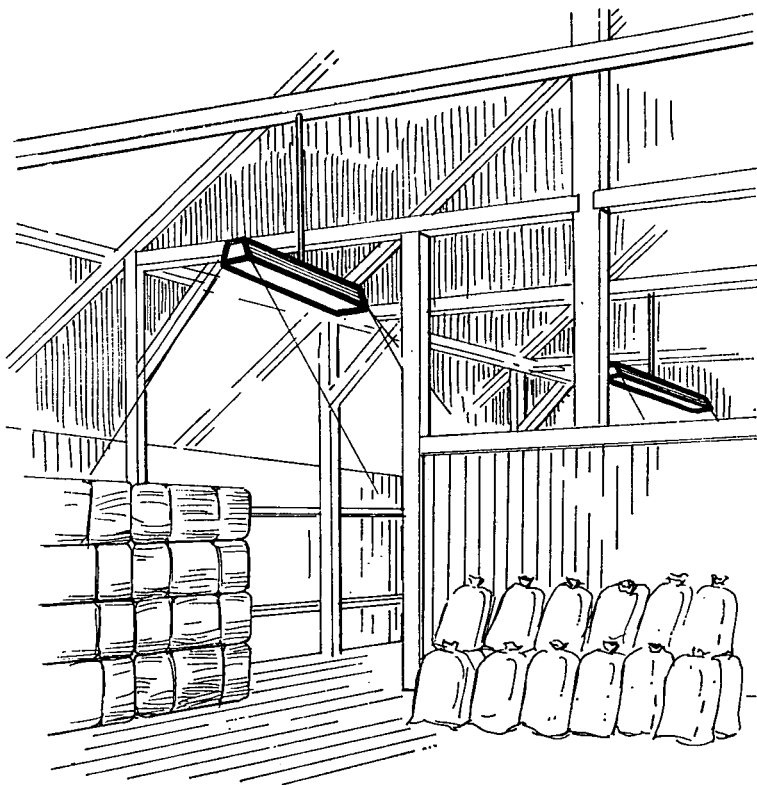


Fig. 2. A modern lighting installation.

authorisation, and should never be wantonly damaged. Other fundamental duties of workers are to conform to all safety and health instructions relating to their work, and to refrain from dangerously careless or reckless behaviour. Before beginning

work they should examine their workplaces and the equipment that they are to use, and should promptly report to their foreman or employer any dangerous conditions that they may find. If necessary to prevent an accident the use of the workplace or equipment should not be permitted until matters have been put right.

2.8. Restrictions on the employment of women and adolescents may be necessary or at least advisable. No young person—the notion of “young” will vary from one part of the world to another—should be employed on particularly dangerous work such as attending power-driven machinery, driving tractors, handling bulls, handling flammable liquids in unsealed containers, working with explosives, operating steam boilers or working with poisonous or corrosive substances.

2.9. Lighting is important (fig. 2). Places where lighting is required for the safety of workers, near moving machinery for instance, should be efficiently lighted, either naturally or artificially, as long as any workers are around.

2.10. Tidiness is also important. All places in farm buildings and yards where work is carried on, or people have to pass, should be kept clear of rubbish and obstructions that might cause slipping, falling or stumbling.

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### 3. FARM BUILDINGS

3.1. A good part of the farm worker's life is spent in buildings of one sort or another—living quarters, barns, stables, silos, garages, etc.—so it is important that farm buildings should be safe and healthy places to work in. Unfortunately they often are not: the statistics of some countries show that up to a quarter of all farm accidents take place in buildings. Some of these accidents are no doubt caused by bad working practices, but many are the result of faulty design or bad maintenance, or both. Much rural ill-health may also be ascribed to defective farmhouses or other living quarters. Large numbers of farm workers have no houses to live in.

3.2. Among the dangerous and unhealthy conditions that can be found in farm buildings are dirt, disorder, overcrowding, poor drainage, accumulation of garbage, neglected walkways, insufficient headroom, poor ventilation, darkness, floors uneven and in bad repair, lack of fire precautions, and rickety stairs and ladders.

#### GENERAL REQUIREMENTS

3.3. Farm buildings should be designed, constructed and equipped so as to provide good working conditions and reduce as far as is practicable risks such as fires, collapse of structures, falls of objects and falls of persons.

3.4. When new farm buildings are planned the following matters should be given special consideration:

- (a) siting, with a view, for instance, to avoid having a line of buildings in the direction of the prevailing wind, which would facilitate the spread of fire;

- (b) structural strength, soundness and safety (load-bearing capacity, protection against falls, fire hazards, etc.);
- (c) layout from the point of view of transport and means of access to storeplaces and working areas;
- (d) space requirements for storage and working;
- (e) heating, lighting and ventilation;
- (f) hygiene (sanitation);
- (g) protection against lightning.

3.5. In many countries there are national regulations or local by-laws concerning the planning and construction of farm buildings. When awarding contracts for new buildings or substantial alterations or repairs to existing buildings, farmers would do well to stipulate that the buildings, alterations or repairs should conform to any relevant safety regulations, or, if there are none, that they should conform to national or other recognised standards; if appropriate the competent authority should be consulted. Advice can also be obtained from other qualified persons such as consultants and building surveyors.

3.6. It is not enough simply to erect buildings that comply with safety requirements. They have to be maintained in a safe condition. If any dangerous condition is found in floors, steps, galleries, stairs, hatches, etc., it should immediately be remedied, or access to the place concerned should be prevented.

### SITING OF BUILDINGS

3.7. As already suggested, useful precautions against fire can be taken by suitable siting of farm buildings. In addition to a layout at right angles to the direction of the prevailing wind, a measure of insulation may be desirable. A concrete or masonry silo placed between two buildings acts as a fire-resisting barrier.

## CONSTRUCTION OF BUILDINGS

### *Structural Strength.*

3.8. All buildings, permanent or temporary, should be structurally safe so as to be free from any risk of collapse, and the roofs should be able to withstand normal stresses due to snow, ice, wind and rain, and, where necessary, to carry suspended loads. Advantages of single-storey buildings are that the absence of stairways, ladderways and floor openings reduces the risk of accidents by falls, and the buildings can more easily be designed to prevent the spread of fire.

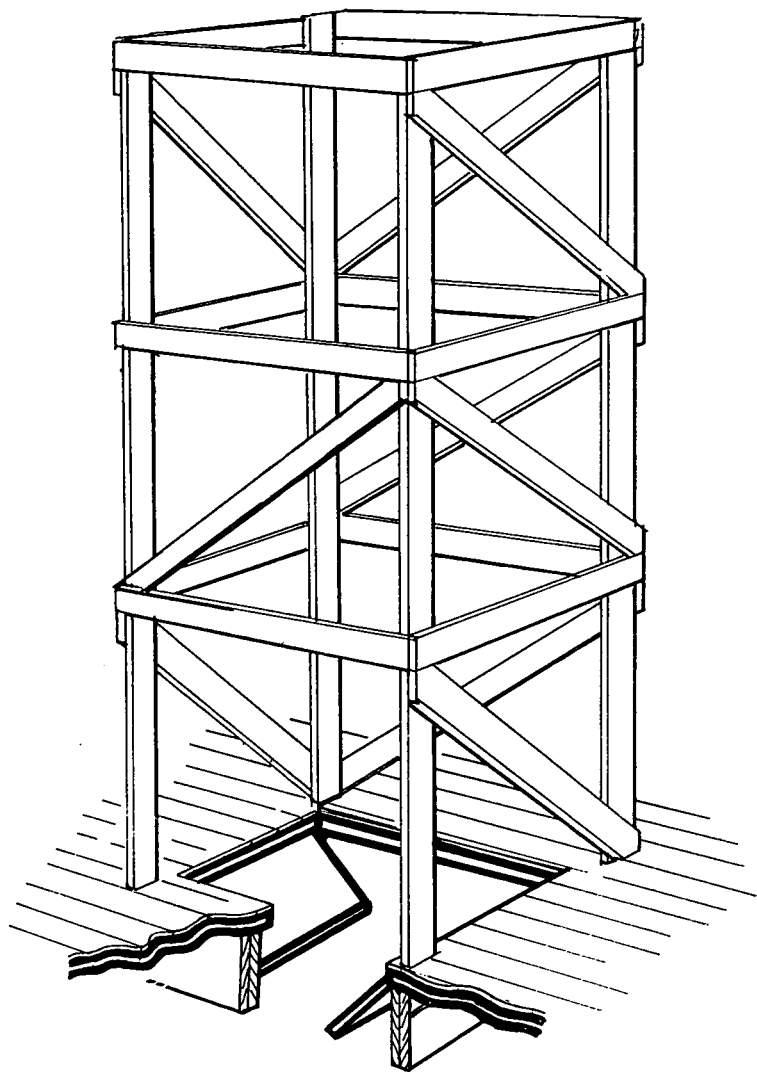
### *Fire Protection.*

3.9. Whenever possible fire-resistant materials should be used in the construction of buildings (fig. 3). The fire-resistance of wooden structures can be increased by covering the wood with cement, asbestos cement sheets, iron or steel sheets or compressed rubble. A sheet-steel construction has a high resistance to fire, and is preferable to wooden construction, provided that climatic conditions do not make the building too hot or too cold and so make work fatiguing. Impregnated wood can be used in new buildings, but it should be periodically reimpregnated.

3.10. Wooden floors in existing buildings can usually be made more fire-resistant at small cost by providing a covering of bricks or stamped clay, but if this is done care must be taken that the load on the floor is not excessive.

3.11. Many buildings have storage space for readily combustible materials. Cattle sheds, for example, may have a hay loft. In such cases it is particularly important to provide fire-resistant insulation for the storage space. Ventilating shafts in cattle sheds should be provided with fire-resistant covers that automatically close when a fire breaks out (fig. 3).

3.12. Roof coverings should be of fire-resistant materials such as tiles, slates, asbestos-cement sheets or sheet steel (fig. 4).



**Fig. 3. Trap-door in floor with fire-resistant layer underneath and self-closing fire-resistant covers.**



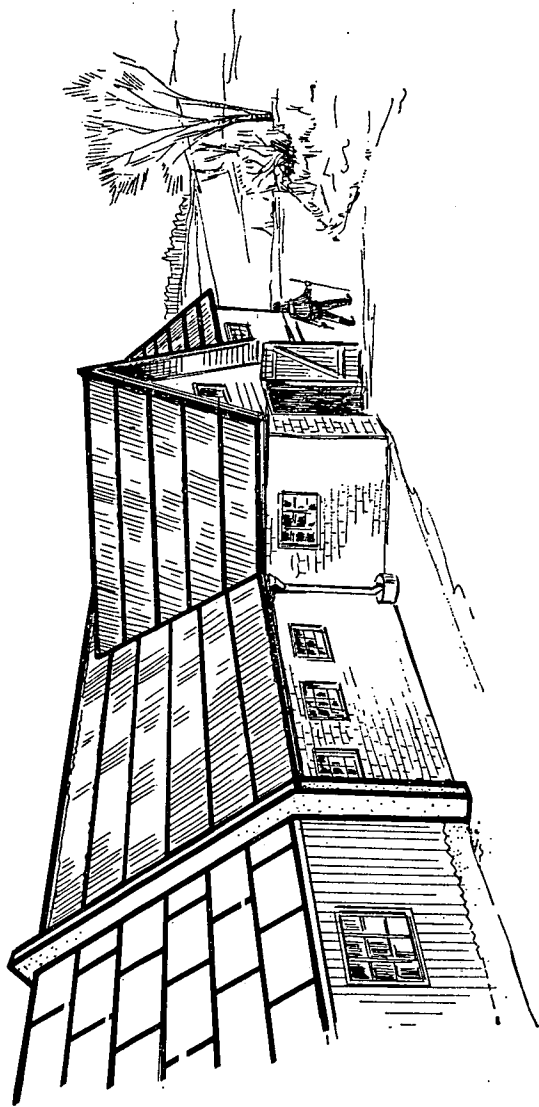


Fig. 4. Fire-resistant roofings and partitions.

Roofing of sheet metal (foreground) or asbestos-cement plates (background) resists sparks and flying embers. A fireproof partition prevents flames from spreading.

3.13. Access to upper floors and elevated workplaces in buildings should, as far as practicable, be by means of stairs and not ladders. There should always be stairs leading to upper floors to which workers have to go regularly.

### FLOORS

3.14. Floors and other walkway surfaces should be sufficiently firm, continuous and even to afford safe walking, and, if necessary, safe transport of materials.

3.15. In particular, they should be free from holes, splinters, improperly fitted covers for gutters and conduits, protruding nails and bolts, projecting valves or pipes, or other projections or obstructions that might constitute stumbling hazards.

3.16. Except for drainage purposes in wet places such as dairies, floors should be level as far as practicable. If a sloping floor is necessary it should not slope down towards an opening in a wall or floor.

3.17. Floors and walkway surfaces should be non-slippery; if necessary they can be roughened. Floor coverings and planks should be securely fixed to prevent tilting or displacement.

3.18. Gaps between floor planks should be avoided, but if they are necessary they should be as narrow as practicable and in no case exceed 2 in (5 cm).

3.19. The maximum load per unit of area to be carried by any floor of a storeplace and the maximum permitted load of any vehicle used on such floor should be clearly indicated on a notice.

3.20. Makeshift additional floors should be avoided as far as practicable and in any case should be laid only in storeplaces such as barns.

### FLOOR OPENINGS

3.21. Ladderway, stairway, hatchway and other floor or yard openings accessible to persons should be guarded on all

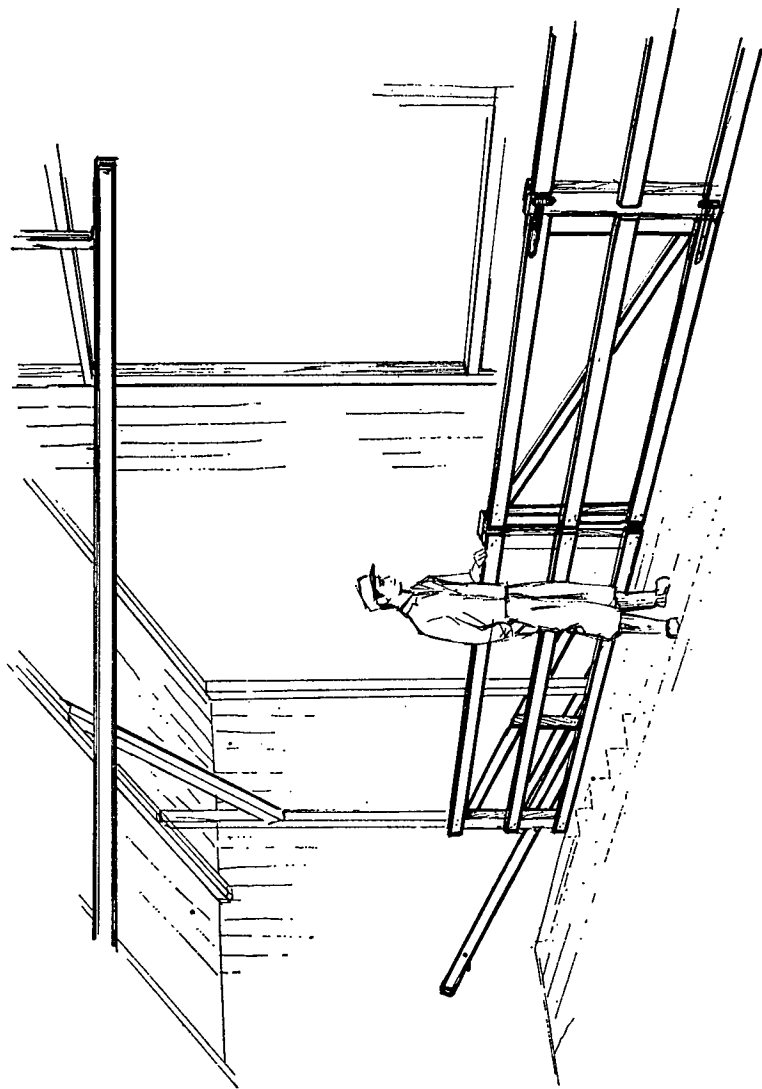


Fig. 5. Fencing 40 in (1 m) high, consisting of two rails and a toe-board 4 in (10 cm) high, which opens so that loads can be passed through it.

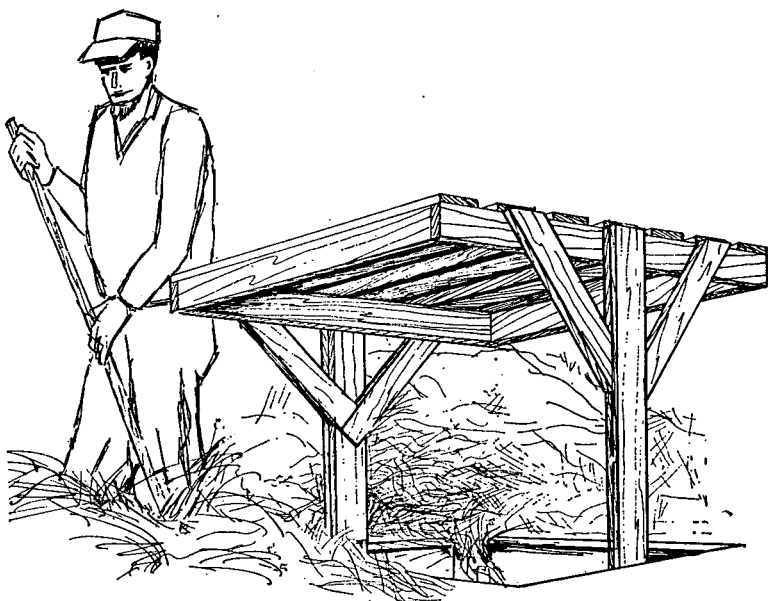


Fig. 6. Floor opening in hayloft with device to prevent workers from falling through. The height of the guard should be 4 ft (1.2 m).

exposed sides by permanent or removable railings or covers or other effective means (fig. 5).

3.22. If the guard is removed to allow the passage of persons or goods it should be replaced immediately afterwards.

3.23. Floor openings must be protected by railings and toe-boards so as to prevent persons and objects falling into them. If materials such as hay or straw are stacked so high and stored so close to an opening that railings would afford no protection against falls, the opening should be protected by a device such

as an elevated cover (fig. 6). Covers over manholes and other floor openings should be of substantial construction, safe to walk on and capable of supporting the weight of any vehicle likely to pass over them. Wherever possible they should be hinged; otherwise they should be securely fixed in position to prevent accidental displacement.

3.24. Openings in fire-resistant floors, as in haylofts, must always be kept closed by fire-resistant means when not in use. Openings in floors for sack hoists and similar installations should be provided with covers which close automatically after the passage of the sack.

### WALL OPENINGS

3.25. Wall openings less than 40 in (1 m) from the floor and measuring at least 30 in (75 cm) vertically and 18 in (45 cm) horizontally, from which there is a drop of more than 5 ft (1.5 m), should be protected to a height of at least 40 in (1 m) by rails (fig. 7), fences, doors or other effective means. Narrower wall openings should be protected by a toe-board if their lower edge is less than 6 in (15 cm) from the floor. If the protection of openings at least 30 in (75 cm) wide is removable an adequate hand-grip should be fixed on each side, or an adequate bar should be placed across the opening at chest height.

### DOORS

3.26. Doors that are opened and closed vertically should be provided with effective counterbalance weights or other effective devices to prevent them from inadvertently opening or closing or accidentally falling down. All doors and gates should be provided with effective means to prevent them from sliding or being lifted off their hinges (fig. 8).

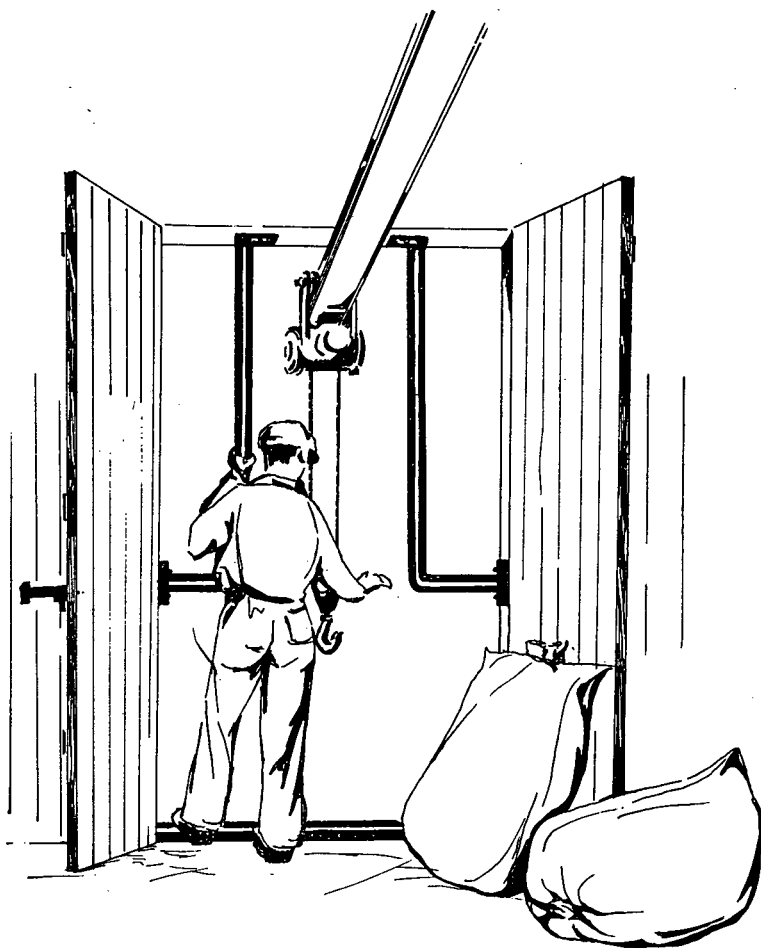


Fig. 7. Guards in wall opening above ground designed to fit a hoisting apparatus. The floor is fitted with a toe-board.

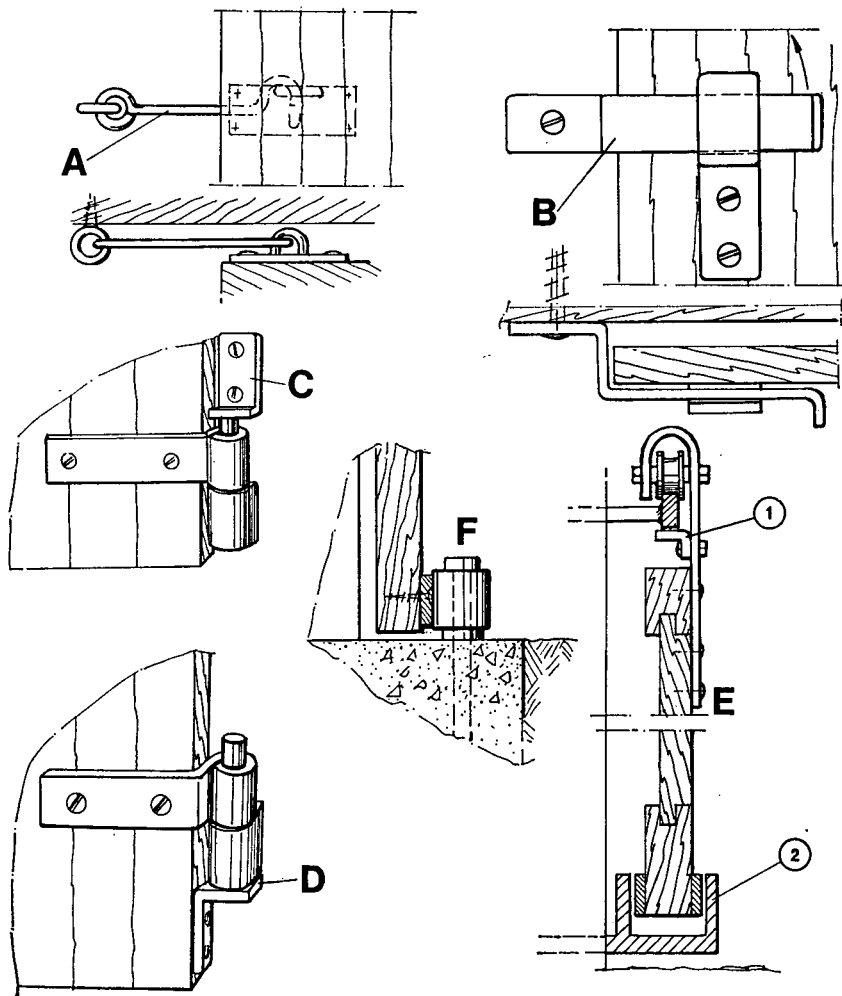


Fig. 8. Ways of securing doors.

A. Hooks. B. Latches. C. Stop applied above a hinge. D. Stop applied below a hinge. E. Guides placed on a sliding door (1) below the rail to prevent derailing; (2) at the bottom of the door to stop it from swaying. F. Roller to prevent the door from swaying.

### ELEVATED WORKPLACES

3.27. The open side of any working platform more than 5 ft (1.5 m) above the lower floor level should be protected to a height of at least 40 in (1 m) by means of upper and lower guard-rails or an equally effective enclosure and, if necessary to prevent persons slipping or objects falling off, a toe-board at least 6 in (15 cm) high (fig. 9).

### STAIRS

3.28. Stairs are preferable to ladders because they are safer to use, especially for older workers. Ladders should be provided only as an occasional means of access. Stairs must be strong enough to withstand the maximum loads that they may be expected to bear. They should be at least 3 ft (90 cm) wide. Figure 10 shows the recommended specifications for stairs and ladders.

3.29. Stairs with more than five steps should have railings on any open side (fig. 11). If they are more than 4 ft (1.2 m) wide they should be provided on both sides—and if narrower on one side—with an adequate hand-rail, or, if this is not practicable, with an adequate hand-rope.

3.30. Stairways at an angle of less than  $30^{\circ}$  to the vertical should be provided with a secure handhold at the top.

3.31. Movable and removable stairs should be adequately secured in the position of use.

3.32. Fixed ladders and portable ladders have been dealt with together in Chapter 16.

### RUNWAYS AND BRIDGES TO ELEVATED STOREPLACES

3.33. It is advisable to keep runways to elevated storeplaces away from roads carrying heavy traffic. If the nature of the ground allows, they should slope not more than 1 in 10, be properly constructed over the whole width and not merely over the width of the vehicle track, and be provided with railings (fig. 12).



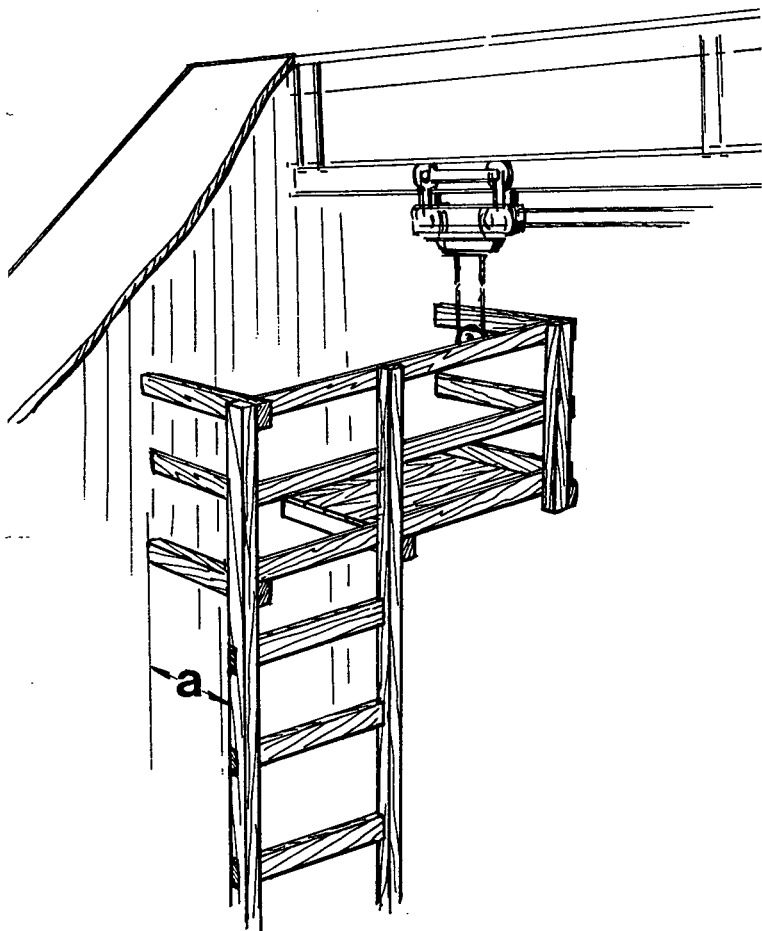


Fig. 9. Fixed ladder arranged for climbing on the inside to prevent falls if the climber loses his hold.

The platform for attending holsting equipment is fenced. (a) = 30 in (75 cm).

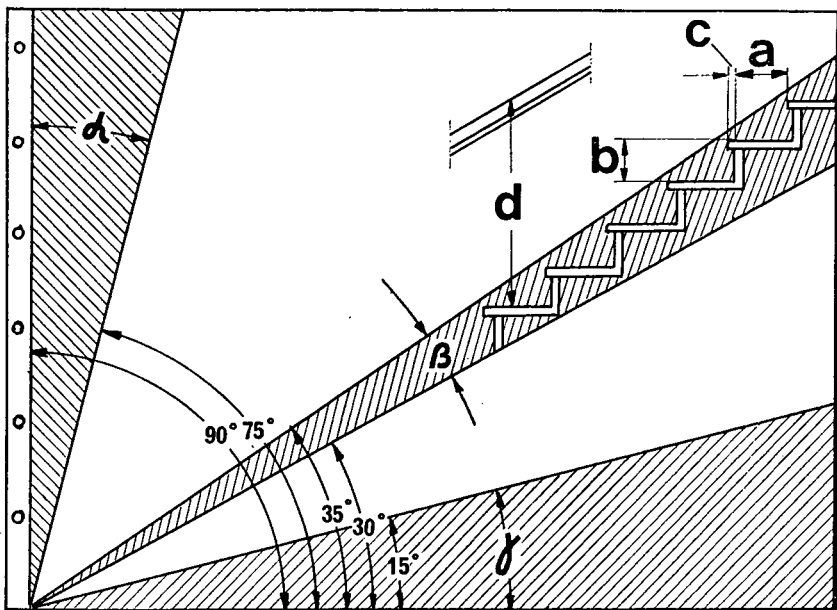


Fig. 10. Suitable angles and dimensions for ladders, stairs and ramps.

$\alpha$  = preferred angle for fixed ladder;  $\beta$  = preferred angle for stairs;  $\gamma$  = maximum angle for inclines of walkways.

Stair tread ( $a$ ) = 10 in (25 cm); riser ( $b$ ) =  $7\frac{1}{4}$  in (18 cm); nosing ( $c$ ) = 1 in (2.5 cm); height to handrail ( $d$ ) = 32 in (80 cm) (approximate dimensions).

3.34. The supporting parts of a bridge should be constructed of material such as stone, concrete or steel able to withstand damp and other climatic conditions. The surface should be kept in good condition: decayed boards, for instance, have caused many severe accidents.

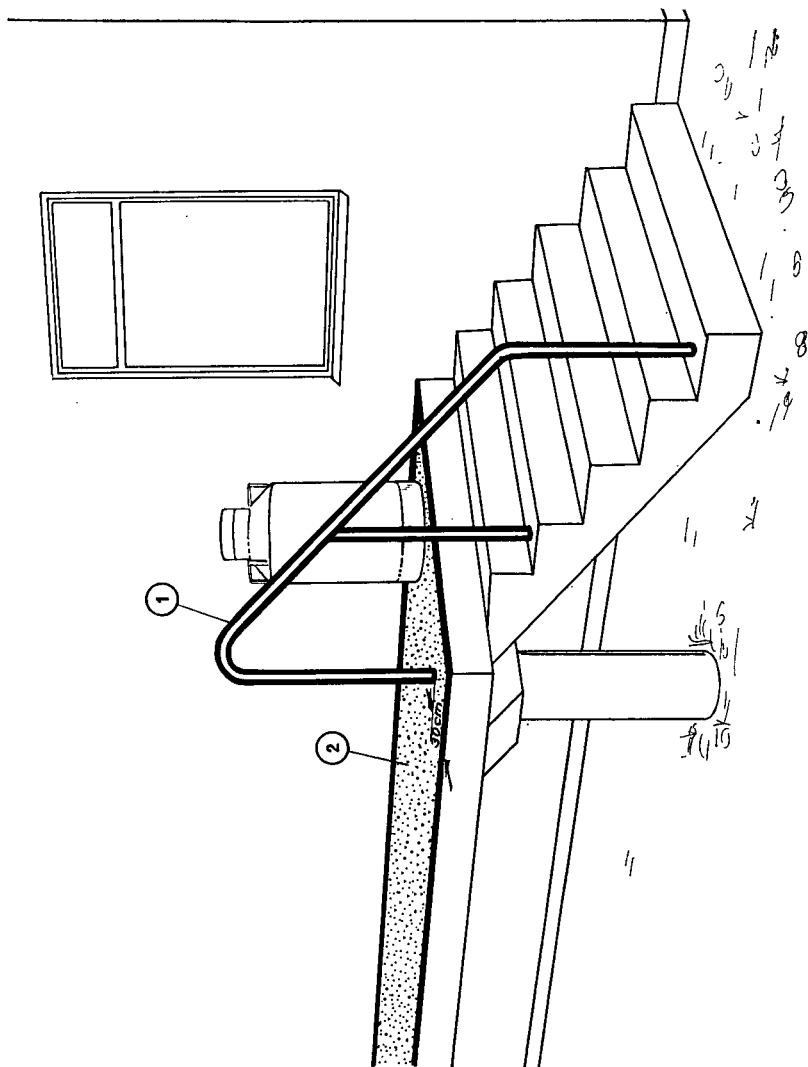


Fig. 11. Single-rail fencing for stairs to a loading platform.

1. Upper stanchion placed 12 in (30 cm) from the edge of the platform to prevent workers from being squeezed between the stanchion and vehicles. 2. Platform with non-slip surface.

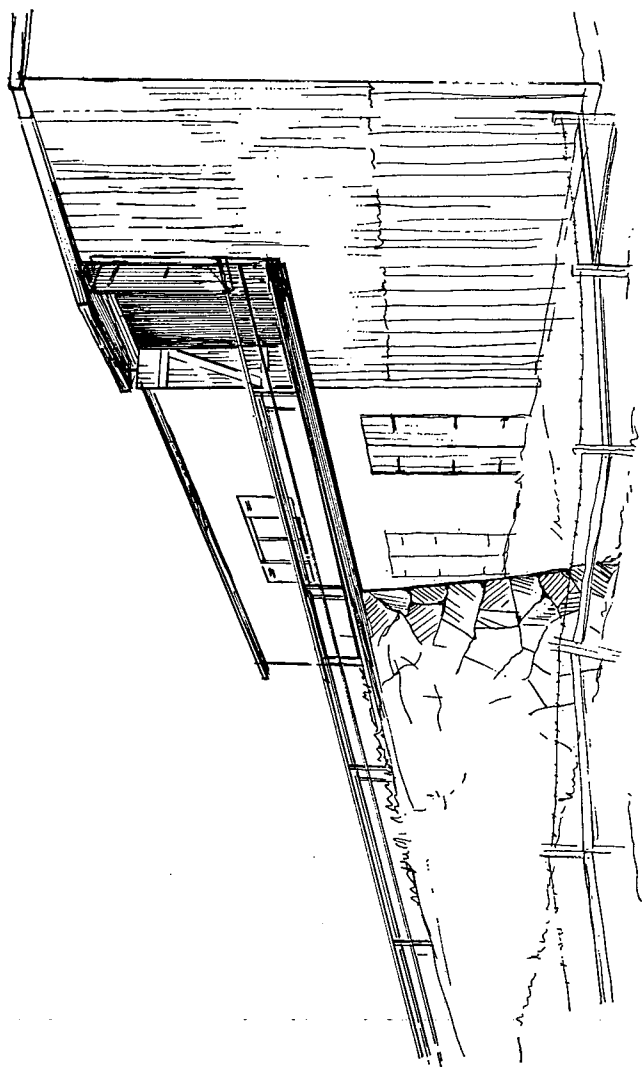


Fig. 12. A runway constructed of stone and steel.  
The slope should not exceed 1 in 10, and doors should be firmly hooked at all times when they are open.

### RAILINGS

3.35. Railings guarding floor openings or the open sides of stairs, or enclosing machinery, should not easily break or yield under slight pressure. Such guards would constitute a danger rather than a protection by giving a false sense of security. All railings serving as protection should be strong, at least 40 in (1 m) high and consist of two rails, or two taut ropes or chains, one at mid-height, with stanchions at suitable intervals, and, if necessary to prevent persons slipping or objects falling, a toe-board about 6 in (15 cm) high. A suitable interval for stanchions is 6 ft 6 in (2 m). If only temporary protection is needed railings may be replaced by a stout net securely fastened in position.

### SPACE REQUIREMENTS

3.36. Workers are in danger when they have not enough room to work in, especially if they are near machinery in motion or open fires. Rooms and indoor places where people have to work or pass should therefore not be overcrowded with machinery, gear or goods. They should also be high enough to enable people carrying loads to move about safely.

### HEATING, LIGHTING, VENTILATION

3.37. Heating, lighting and ventilation are matters that often receive too little attention. However, safe and healthy working conditions cannot be achieved unless they are properly attended to.

3.38. There are some essential precautions to be taken with heating installations, whether they consume wood, coal, gas, oil (fig. 13) or electricity. The first is to maintain them in good condition, and for this purpose they should be overhauled at least once a year. Flues in particular must be kept gastight, or escaping gas may cause a fire. Chimneys have to be swept at suitable intervals.

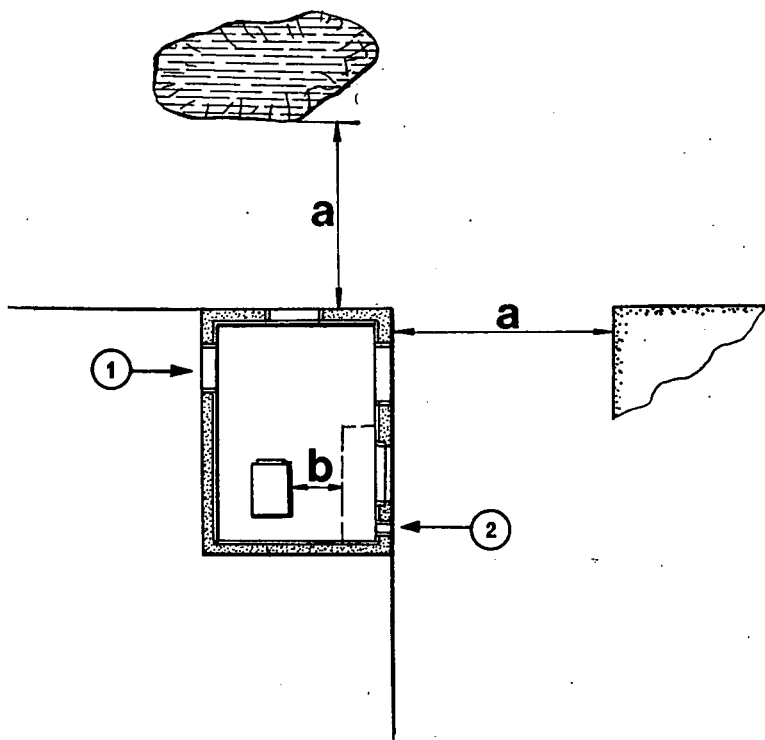


Fig. 13. Insulated furnace room.

The distance (a) from the furnace room to combustible material stored outdoors or to a building where animals are housed or where hay, straw or other flammable materials are stored should be at least 50 ft (15 m). The distance (b) between the furnace and the fuel should not be less than 5 ft (1.5 m).

1. Opening in the wall leading to another room protected by a fireproof door.
2. Air inlets.

Another general precaution is to keep all flammable and highly combustible material well away from the installation. Gas heating installations should be treated with respect. If they are in need of repair a competent person should be called in; makeshift repairs should never be allowed. A watch must be kept for leaks, but it is dangerous to test for them with a flame; soapy water is recommended for this. Open fires or braziers should not be allowed indoors.

3.39. It is easy to see why good lighting is necessary; in darkness or poor light one cannot see what one is doing or where one is going. One may bump into an obstruction, miss a step or stairs, fall into an opening, and so on. Good daylight is considered better than artificial light. If artificial lighting has to be used it should give good illumination, uniformly distributed and without glare.

3.40. Farm workers should always be in a wholesome atmosphere indoors: it is not good for them to be exposed to stagnant or polluted air, strong draughts, excessive heat or cold, sudden changes in temperature, excessive humidity or bad odours. It is therefore desirable to keep the atmosphere as free as practicable from dusts, fumes, gases and vapours. Special precautions are, of course, necessary when persons have to enter places where there is a danger of asphyxiation, such as liquid manure pits, fermentation pits or cellars and wine vats. The first precaution is to ventilate them thoroughly; for others see Chapter 6.

## HYGIENE

3.41. Toilet facilities, washing facilities, cloakrooms and other personal service rooms should, as far as practicable, have floors, walls and ceilings that are easy to clean; be maintained in a clean and sanitary condition and protected against rats and other vermin; and be well ventilated and lighted, and, if necessary, heated.

3.42. Washing facilities should be provided at, or adjacent to, toilet facilities.

3.43. Toilet facilities should conform to the requirements of the competent health authority.

3.44. All water furnished for drinking purposes should be from a source approved by the competent health authority and controlled in the manner prescribed by that authority. Drinking water for common use should not be contained in barrels, pails, tanks or other containers from which the water must be dipped, whether they are fitted with a cover or not.

### PROTECTION AGAINST LIGHTNING

3.45. Lightning may cause damage to property, fires and fatal accidents to persons and livestock. The risk of buildings being struck is greater when they are tall or when they are at high altitudes. A building can be protected against lightning by various means—a metal cage, a lightning conductor, lightning arresters, and electrical bonding. Lightning protection should be installed by a competent person.

3.46. It is particularly important to provide protection against lightning for—

- (a) buildings in which flammable materials are stored;
- (b) storage tanks containing flammable liquids; and
- (c) tall chimneys and stacks.

3.47. In localities where thunderstorms are frequent or severe, lightning protection should also be provided for grain elevators and for buildings with elevated features, such as steeples, flag-poles and water tanks.

3.48. A lightning conductor is one type of protection. It consists of a metal rod set up on a roof or mast, and connected with the moist earth or water below to provide a path for the lightning. However, the only sure way to prevent damage, and especially fire damage, from direct strikes by lightning is to install protection in the form of a Faraday cage, that is to say the structures to be protected are enclosed in a well-earthed metal cage. The space between the wires of the cage may be as much as 60 ft



(20 m). If lightning strikes, the protective system will lead the electricity to earth, so that the protected structures will not be struck and a flashover between parts of the cage or between the cage and the structures will be avoided. It should be borne in mind that lightning protection for one building is no protection for neighbouring buildings. On the structures to be protected, the catch lines (roof lines) and the discharge lines should be so arranged that no part of the surface to be protected is more than 30 ft (10 m) from them. The catch lines should be connected to earth by several discharge lines (fig. 14).

3.49. Buildings, tanks and other structures that are roofed or clad with electrically bonded metal, but which rest on foundations of non-conducting material, should be properly grounded or earthed.

3.50. In buildings with lightning conductors the following requirements should be complied with:

- (1) Structures of non-conducting materials, or whose metal covering is not electrically bonded, should be equipped with air terminals (lightning rods), conductors and ground connections.
- (2) Smoke-stacks, ventilators and other projecting metal objects should be securely bonded to the system.
- (3) Metallic bodies situated in a building within 6 ft (1.8 m) of a lightning conductor should be electrically bonded to it.
- (4) Metallic bodies of considerable size should also be grounded at their farther extremity inside the building.
- (5) Metallic bodies with any dimension exceeding 6 ft (1.8 m) situated within a building at a distance from a lightning conductor exceeding 6 ft (1.8 m) should be independently grounded.

3.51. All installations for protection against lightning should be inspected at least once every six months and kept in good repair.

3.52. Lightning arresters should be provided (except in cases where it has been established that their use is not necessary) on all

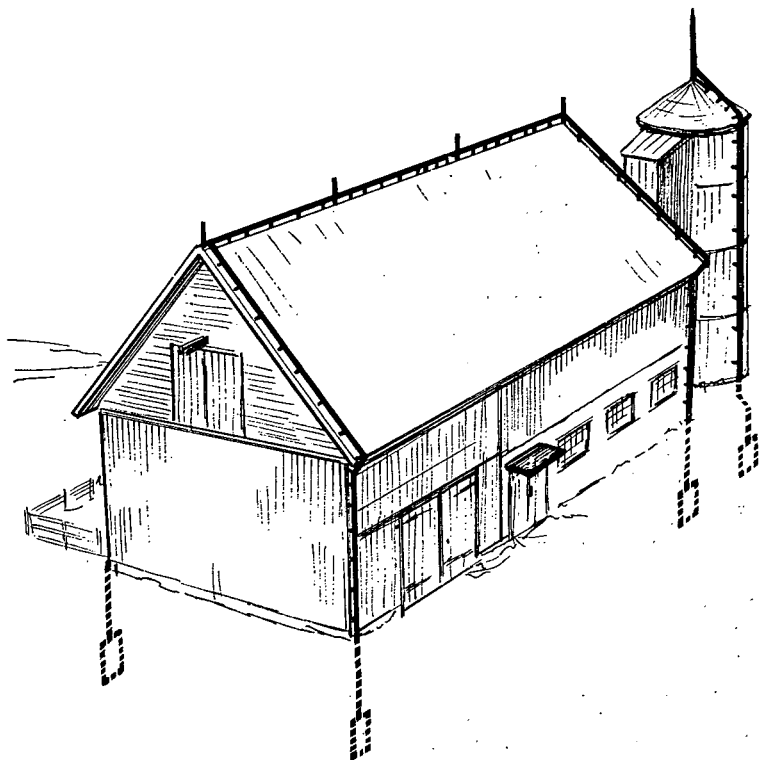


Fig.514. Lightning protection.

overhead light, power, telephone and radio conductors entering a building. Expert advice should be taken as to what precautions are necessary. Any such installation should be inspected periodically by a competent person to ensure that it is in working order.

## 4. ELECTRICITY

4.1. The use of electricity on farms is increasing day by day. It improves efficiency and eliminates drudgery, but at the same time introduces new risks.

4.2 An outstanding characteristic of electrical accidents and dangerous occurrences is the diversity of the ways in which personal injuries or damage to property are caused, as can be seen from the following brief description of the injuries.

*Injuries caused by flow of current through the body as a result of contact with live parts.*

4.3. Live parts, that is to say not only current-carrying parts of electrical installations but also parts of other installations and any other object or mass that has accidentally become live, need not necessarily be of metal. For instance, fatal electric shocks or burns have been suffered by human beings and animals standing on live ground, or with one foot on something live and the other or others in contact with conducting material such as a wet floor. In such cases current flows through them. Moreover, where a person is working at a place above ground level, even a small electric shock not sufficiently strong to produce direct injury may cause him to fall to the ground, with very serious or even fatal results, such as a fractured skull.

4.4. The severity of electrical injury depends upon the amount of current that passes through the body and this, in turn, depends upon two factors, the voltage and the resistance of the body. The higher the voltage the more current flows through the body; the lower the resistance of the body the higher the current. A current of 50-100 milliamperes passing through the body for a very short period (0.5 sec or more) is likely to be fatal. For 50 Hz alternating

current, the maximum safe voltage in general may be taken as 24 volts for children and 60 volts for adults. In wet situations the maximum is generally less. The resistance of the human body varies over a wide range from several thousand ohms with dry hands and low applied voltage to only a few hundred ohms with damp hands and mains voltages of 220-240. For safety it is wise to assume a value of 500 ohms for persons working in dry places and 200 ohms or less for those in wet places.

*Injuries without flow of current through the body.*

4.5. These comprise—

- (1) heat burns from electric arcs and spattered molten metal;
- (2) radiation burns from powerful arcs;
- (3) physical injury from inadvertent starting of machines, failure of crane controls, explosion of switchgear, falls, etc.;
- (4) injury from fire and explosion as a result of electrical ignition of flammable vapours, gases, liquids and solids;
- (5) eye injury from electric arcs (e.g. welder's eye flash).

4.6. Many electrical fires are due to defective insulation causing a short circuit that ignites combustible material. Overloading electrical installations can also raise the temperature enough to cause a fire. Improperly installed or handled electrical wiring and equipment and the careless placing of electrical apparatus are other fire hazards.

## GENERAL REQUIREMENTS

4.7. The installation, adjustment, repair or removal of electrical equipment requires special knowledge and instruments and for this reason only qualified electricians should be employed to do such work. Unprofessional work may create conditions that endanger persons, property and livestock. All electrical equipment and installations should comply with the requirements of the national electricity regulations and the electricity supply authority.

No electrical appliance should be purchased for use on a farm without the approval of a competent person such as an electrical engineer. This will ensure that every appliance is suitable for the electricity supply available and for the purpose for which it is to be used. Equipment and circuits used in hot, dusty or damp places, or where corrosive or flammable substances or vapours may be present, require special types of protection such as dustproof or flameproof enclosures for motors and switchgear. Fixed electrical installations are less exposed to wear and tear than portable equipment, and are consequently far safer. All apparatus and conductors should be sufficient in size and power for their load and should include sufficient reserves for any anticipated increased use of power.

#### NOTICES

4.8. If the electrical installations on the farm are extensive it will be useful to post up notices prohibiting unauthorised persons from entering electrical equipment rooms and handling or interfering with electrical equipment; the notices should also give directions as to procedure in case of fire, the rescue of persons in contact with live conductors and the resuscitation of persons suffering from electric shock.

#### TYPES OF PROTECTION

4.9. There are different types of protective arrangements for electrical installations—earthing, protection against accidental contact, protection against overload and short circuits, protection against fire and explosion, and so on.

4.10. Usually it is necessary to earth armouring and metallic coverings of cables, external metallic parts of electrical equipment which are not normally live, and metallic parts in the immediate vicinity of live conductors.

4.11. Accidental contact with live parts of an installation can be prevented by placing them out of reach, providing them with protective barriers, enclosing them or insulating them.

4.12. Installations can be protected against overloads and short circuits by fuses or automatic circuit-breakers of adequate but not excessive ratings.

4.13. Electrical equipment for use in places where there is an explosion risk should be of a suitable flameproof type for the atmosphere in question, and equipment exposed to the weather should be adequately protected against wet and corrosion.

4.14. Portable electric appliances and tools are often subjected to strain and wear which may cause the electric insulation or interior connections to fail, so that a live part may touch and charge the frame or the casing. This can also happen in stationary machines and other appliances. Sometimes a leak is caused by an unqualified person trying to make some repair or "improvement" on an appliance. Such occurrences are extremely dangerous. If there is no way to carry off the current safely, it passes to the earth from the frame or the casing through the body of the person who is holding the appliance. Many people have been electrocuted in this way.

## EARTHING

4.15. It is important that the electrical installation should be properly earthed, i.e. provided with conductors connected to conducting devices of larger surface area that are laid in the earth and through which leaking current can flow into the earth. If the installation is perfectly earthed, when an insulation defect occurs the current flowing to the earth conductor is so strong that the fuses will blow or the circuit breaker trip. In this way the defective appliance will be switched off. A qualified electrician should be called in to find the cause of the defect and to put matters right.

4.16. For earthing conductors, extensive and continuous water-piping systems may be used, or else special metal strips. In poor earthing conditions, for example when no extensive water-piping system is available or the metal strips can only be laid in dry sand, protective switches must be installed that immediately cut off the current from a defective appliance.

4.17. All external metallic parts of electrical equipment and those in the immediate vicinity of live conductors should be earthed; this rule applies to armouring and metallic coverings of cables, motor-controller cases, machine frames, electrical equipment of conveyors, and metal enclosures around portable equipment.

4.18. When wires are connected to plugs, machines, etc., live wires and earth wires should not be confused. Unqualified persons installing equipment may easily do this, thereby making outside parts live. Many countries have a colour identification system for the conductor wires, but this may vary from country to country and should therefore not be relied upon with imported equipment. An international colour identification for earth continuity conductors has been recommended by the International Electrotechnical Commission. This provides for the use of *green* and *yellow* (twin colours) for these conductors. Nevertheless, it is not unknown for some electrical machines or appliances to be supplied with three black wires. Then only a qualified electrician can be sure of connecting the machine or appliance to the supply so that proper earthing is provided.

4.19. Earthing is not the only means of protection against excessive contact voltages. Other means include double insulation, connection to earthed neutrals, and differential circuit breakers for overload and overcurrent protection. Appliances protected by double insulation do not need a protective conductor.

### SWITCHBOARDS

4.20. Switchboards containing electric meters, main switches and fuse boxes should not be placed in positions where there are fire hazards, e.g. in barns or haylofts or in damp places such as stables or wash-houses. The area in front of the switchboard should be left clear and not used for storage purposes.

### FUSES

4.21. If the wiring is overloaded or a short circuit occurs the intensity of the current will be higher than that which the installation was designed to carry. To prevent overheating and fire, fuses or circuit breakers can be installed to open the circuit automatically if the maximum safe intensity is exceeded. If the fuses blow repeatedly there is some defect in the installation or it is overloaded, and a qualified electrician should be called in to put matters right. The use of the wrong type of fuse or a fuse of the wrong rating may cause a fire or other accident or damage to equipment. Replacing blown fuses with substitutes for fuse wire or with other conductors should be prohibited. Fuses of the proper rated current capacity should always be available in sufficient quantity.

### SWITCHES, PLUGS AND SOCKETS

4.22. All switches, plugs and socket connections should be enclosed. Open knife switches are dangerous because of the exposure of the live parts and the arc formed when the switch is opened. Push-button or toggle switches are recommended. Socket connections for high voltages are usually of the switch or shutter type, i.e. the current is automatically shut off before connection or disconnection is possible. This is to prevent arcing. Damaged switches, plugs and sockets should immediately be replaced. Any exposed live part in them creates a serious shock hazard.

### CONDUCTORS

4.23. Conductors on a farm are often subject to mechanical or chemical damage or both. They should be kept out of rooms or places where fire hazards or corrosive fumes exist, or places where they can be damaged by vehicles, tools or animals. As far as practicable fixed conductors should be used. They should be installed only by qualified electricians and in accordance with any legal requirements in force.



4.24. Portable conductors should be used only for connecting portable appliances, e.g. portable motors and hand-lamps. Tough, flexible rubber-insulated cable incorporating an earth conductor should be used. (The earth conductor, is, however, not needed for double-insulated appliances.) Particularly tough insulation is required for cables used in places where severe mechanical damage or abrasion is likely, near moving machinery, etc.

4.25. If a cable is to be extended a conductor joint must be employed. Splicing is an unsafe method and should never be used.

4.26. Cables should be so handled that they are not kinked or excessively twisted or otherwise damaged. They should not be laid on the ground, but should be suspended on posts or the like—but not on sharp-edged pegs—to protect them from being trampled on, run over, or struck by sharp or heavy objects; they should be suspended high enough to allow persons or animals to pass safely underneath. Broken strands may pierce the insulation and cause a shock or short circuit. Conductors should be inspected regularly and damaged conductors should be taken out of use.

4.27. Cables should be stored on cable drums or saddle brackets (fig. 15) in a dry place where the insulations are not likely to deteriorate or be damaged.

## LIGHTING INSTALLATIONS

### *Fixed Lamps.*

4.28. Incandescent lamps give off considerable heat and should not be placed close to combustible material. In dusty places such as haylofts and cow-sheds the lamps should be provided with protective housings to reduce the risk of fire from dust settling on the hot surface of the bulb (fig. 16). Care should be taken that an electric lamp does not become embedded in grain, hay, straw or similar material, for the heat from it may cause a fire. A protective housing may delay but not prevent a fire, and a lamp should therefore not be installed in a position where it is likely to become embedded. If it is essential to have artificial light, an electric torch or a properly designed portable safety lamp should be used (see 4.31).

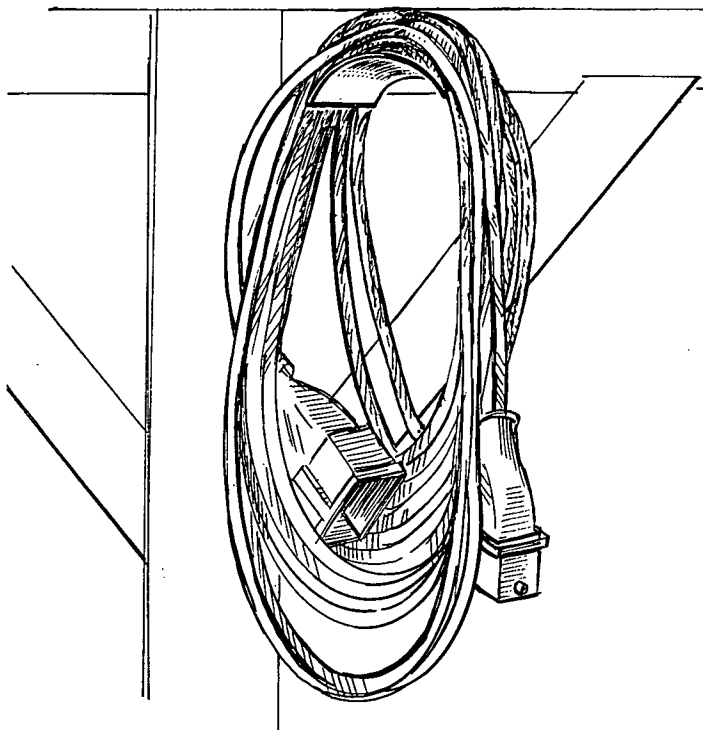
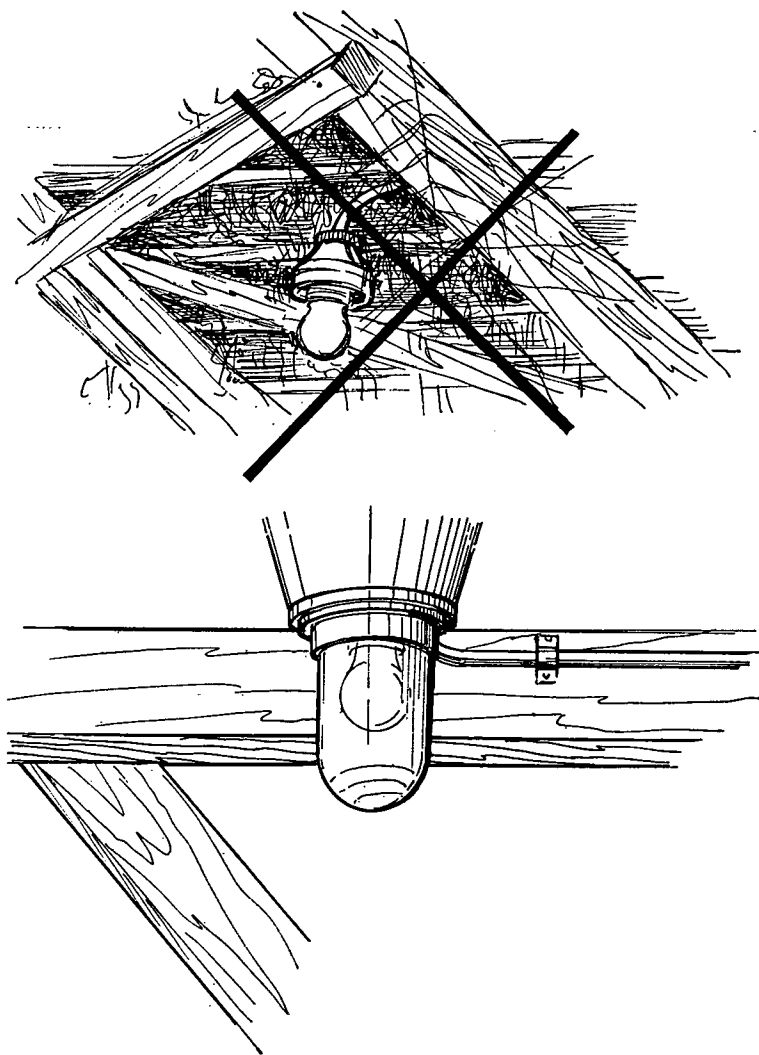


Fig. 15. How to store a cable.



**Fig. 16. Two fixed lamp installations.**  
**Above: wrong method. Below: right method.**

4.29. Temporary equipment such as socket adaptors should not be used because it increases the risk of contact with live parts and may also create sparks. Lamp holders should not be provided with switches, for damage to the bulb and consequently contact with live parts may occur; in addition the lamp leads are live, even when the lamp is switched off. In some places it may be necessary to have flameproof, dust-tight or watertight fittings and appliances to avoid the risks inherent in explosive atmospheres (grain dust, etc.) or wet surroundings (dairies, etc.).

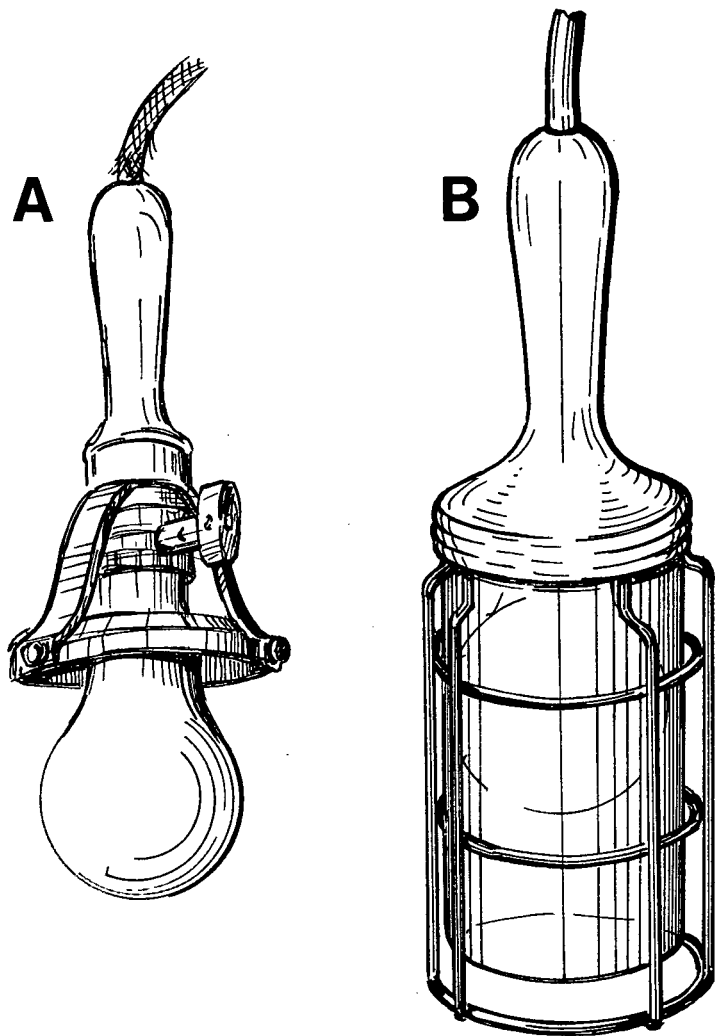
4.30. Regular cleaning and maintenance of a lighting system is necessary in order to get the maximum light output for the current consumed and to reduce the accident risks of poor lighting.

#### *Portable Lamps.*

4.31. Portable electric lamps should—

- (a) be used only where adequate permanent fixed lighting cannot be provided;
- (b) be provided with sockets or lamp holders of insulating material and suitable lamp guards of sufficient strength, completely insulated from any live part (fig. 17); and
- (c) be used only at a voltage considered to be safe in the particular conditions of work.

4.32. Portable lamps should not be employed for such purposes as sounding the depth in a grain bin. The lamp may be damaged and cause a fire or a dust explosion. It has happened that a lamp has been left hanging in a bin, been buried by the grain and started a fire. If a light is needed, a cap lamp can be used and sounding done with a plummet. A hand-lamp must never be taken into a liquid manure pit because an explosive gas-air mixture may be present. It is particularly hazardous to use a hand-lamp with the ordinary lighting voltage, 110 or 220 volts for example, in wet places such as washrooms or in boilers, cisterns or other confined spaces with conducting walls. Lamps supplied with very low voltage are essential. Plug-in safety transformers, reducing the voltage to 24-25 volts, are available.



**Fig. 17. Two hand-lamps.**

**A. Unsafe hand-lamp with frayed lead and unprotected bulb. B. Safe hand-lamp with sound cable, sturdy bulb socket and bulb enclosed in protective cage.**

### HEATING INSTALLATIONS

4.33. All electrical heating equipment should be specially designed for use in farms and should be installed in accordance with national or local regulations. Portable heaters should be avoided. Fixed heaters should be insulated with incombustible materials, e.g. with asbestos cement or gypsum sheeting. The heaters should, if practicable, be horizontally mounted and be suitably guarded to prevent clothing or other flammable objects from coming into contact with the heating element. For this purpose an inclined protective shield can be mounted above the heater. Easy access for cleaning and replacement should be provided.

4.34. Fires have been caused by overheating in home-made heat-lamp installations for pig breeding or rearing. Installations for such purposes should be permanent and consequently in accord with national or local regulations; the heating lamp should be of a type approved by the competent authority. It should be suspended securely by a chain, wire or bracket and should be high enough, or otherwise so protected, that animals cannot touch it. The surroundings are frequently of a flammable nature and special care should be taken to reduce the risk of fire. A distance of at least 20 in (50 cm) between the lamp and combustible material is recommended. The socket outlet should be fitted in a convenient position, preferably so that the flexible cord is vertical. The cord should be as short as possible, so that if the lamp accidentally falls the plug will be pulled out of the socket. Heating lamps should be protected by a reflector and by guards underneath.

### MOTORS

4.35. Dust, moisture and overloading are the most important problems with electric motors in farms. Dust settles on windings, slip-rings and commutators and finds its way to the bearings. It also clogs the ventilation openings. With oil it produces a greasy, gummy mass that will interfere with the cooling, damage the motor and create a fire hazard. Moisture may cause the electrical resistance to drop, so that leakages burn through the insulation,

creating risks of short circuit, fire or shock. Overloading may heat the motor enough to damage the insulation and bearings. Even a moderate overload may damage the motor and in time cause a fire.

4.36. Overload protection on motors prevents overheating by switching them off in good time. This form of protection should be provided on motors with automatic switching or remote control, and on motors that are not under continuous supervision, for example those of water pumps, hay ventilating fans, grist mills, refrigerating plant and dairies. As far as possible electric motors should not be installed in dusty or damp places such as barns, fodder lofts, cattle sheds or wash-rooms. If, however, they have to be used in such places they should be of the totally enclosed type complying with the special requirements of the competent authorities.

4.37. An electric motor should not be covered with a wooden box for this will tend to raise the temperature and increase the fire hazard. All electric motors should be kept clean.

#### PORTABLE AND TRANSPORTABLE EQUIPMENT

4.38. To prevent accidents due to shock, portable and transportable electrical equipment should be protected by adequate earthing, double insulation or other means as required by national regulations or standards. The equipment should be spring-controlled in such a way that it must be held in the closed position when in use.

4.39. Portable electric motors should always be of the totally enclosed type because they are likely to be used from time to time in dusty or damp places. A pipe-ventilated type of motor is satisfactory if the air intake is connected to a clean air source. Transportable motors should also be of the totally enclosed type.

4.40. Hand-held appliances should not be used with voltages exceeding 300 volts; they should be provided with built-in switches.

4.41. Every portable electric tool or appliance should be given a complete inspection, including cleaning and tests by a

qualified person, at regular intervals, depending on the frequency of use. Defective portable power-driven tools should be immediately repaired or removed from use. Serious electric shocks are a great hazard from electric tools, particularly if they are used in wet places or in metal tanks where the operator is exposed to conditions favourable to the flow of current through his body.

4.42. If portable tools and appliances are not built with double insulation and marked accordingly, they should always be protected against excessive contact voltage by means such as earthing.

4.43. The electric cord, including its connections, should be examined periodically and kept in good condition. When using the equipment the operator must keep close watch on the cord to ensure that it is not damaged or cut by the tool.

#### ELECTRIC FENCES

4.44. The use of home-made electric fence controllers should be strictly prohibited. They have often resulted in considerable damage to property, fires, injuries to persons and loss of livestock owing to faulty construction. The controller is the most important part of the equipment and it is essential that it should comply with the safety requirements of the competent authority.

4.45. Controllers should not be installed where they are accessible to children or where they are likely to be damaged by passing vehicles. If installed inside a building they should not be placed where there is a fire risk or where it is damp, e.g. in a barn or cattle shed. The fence controller should be connected to the power supply for which it is designed and set to the voltage of that supply. Only one controller should be used for one continuous fence, otherwise the current in the fence may be too high. Protection against lightning and good earthing must be provided for controllers.

4.46. Storage-battery-type controllers should not be re-charged while the fence is live, since there is a risk of the fence being charged with the mains voltage.



4.47. Fences should be so placed that no other wires or metal can come into contact with them. They should be kept at a safe distance from overhead power lines. They should not be fastened to posts or masts of overhead power lines or telephone or telegraphic lines. To avoid accidental contact between two fences only one fence, including its supply line, should be fastened to any post or row of posts.

4.48. Fences should be kept clear of combustible material such as hay, straw and wood. If vegetation touches the wires the performance of the fence will be impaired.

4.49. An electric fence cannot be relied on to restrain bulls, stallions and other vicious animals.

4.50. Children should be taught not to tamper or play with electric fences.

4.51. Warning notices should be affixed to the fence at suitable intervals, especially near buildings, roads and paths. Electric fences should not be installed in buildings without the permission of the competent authority.

### TEMPORARY ELECTRICITY SUPPLY

4.52. Collecting current directly from an overhead line by means of poles or hooks is a dangerous procedure, and should never be resorted to. If a connection to an overhead line is necessary, a qualified electrician should be called in to make it.

### MAINTENANCE AND OPERATION OF ELECTRICAL INSTALLATIONS AND APPLIANCES

4.53. In view of the flammable nature of materials and buildings on farms and the risks to people and animals from defective equipment, electrical installations and appliances should be well maintained. This will also ensure that they give the best service. Inspections of installations should be carried out by qualified electricians at regular intervals, and portable equipment

in use should be inspected daily by a competent person. Any defect found should be remedied as soon as practicable or, if serious, without delay. Repair work should be done by electricians only.

4.54. All equipment should be kept free from combustible materials and dirt, and should constantly be accessible. It should not be buried under straw or the like. Clothing, tools, etc., should not be hung or laid on electrical equipment of any kind. Protective coverings, caps, lamp covers, cages, etc., should be undamaged and properly secured.

4.55. No cleaning or maintenance work should be done unless the current has been switched off and measures have been taken to prevent it from being switched on again, e.g. by a notice on the switch "Do not switch on" or by locking the switch with a padlock.

4.56. *It is dangerous to touch any part of a circuit with the fingers or with any object.* People have been electrocuted in this way. No person not familiar with the operation of switches, fuses, connections, etc., and the precautions to be observed, should be allowed to operate or even handle the equipment.

4.57. Everyone on the farm should know how to disconnect the current in an emergency.

4.58. All work done in connection with electrical plant should be carried out by or in accordance with the instructions of a qualified electrician.

#### WORK IN THE VICINITY OF LIVE PARTS

4.59. No work should be done in the vicinity of accessible live parts. Scaffolding, ladders, straw ricks, wood stacks, sack piles, log stacks, etc., should not be erected so near to uncovered conductors that persons can touch them either directly or with implements, tools, etc. If this is not practicable the danger zone must be fenced off by boards, railings or other means. The fencing should have no opening permitting a hand or an implement

to touch the conductor through it. While the fence is being erected the current should be switched off.

4.60. During operations with mobile cranes or cranes mounted on vehicles a great many accidents have been caused by accidental contact with a power line. The risk of injury is particularly serious if the crane is insulated from the ground or when it is mounted on a vehicle with rubber tires. If the jib makes contact with the power line and a person standing on the ground puts his hand on any metal part of the vehicle, the result may be fatal. No mobile crane, elevator or any other machinery with parts which can reach a power line should be used under or in the vicinity of the line.

4.61. Precautions must also be taken in operations such as picking fruit, spraying trees, blowing up tree stumps or rocks, and felling trees. If a falling tree severs an overhead line, a whole town with its dwellings, factories, hospitals, etc., may be deprived of current. If the severed line touches a person he may be electrocuted and rescuers will be exposed to the greatest danger unless they are electricians. When trees are being felled near overhead lines it is a wise precaution to have the work supervised by someone from the electrical supply undertaking.

4.62. Any defects or suspicious occurrences noticed on overhead lines on or near farms should be reported immediately to the electrical supply undertaking or the police, and, if necessary, persons should be prevented from approaching the place.

4.63. When fixed agricultural rope-haulage installations pass under high-voltage lines the necessary precautions must be taken, for instance maintaining a safe distance, installing catch nets and earthing the installations.

4.64. If a mobile rope-haulage installation passes under overhead lines, there is a danger that the rope will touch the line and cause an electrical accident. It is therefore advisable not to take such installations under overhead lines, but if this is unavoidable the haulage rope should be kept at a safe distance by anchorages or rope fenders.

### TREATMENT OF ELECTRIC SHOCK

4.65. In many cases the life of a person who has received an electric shock may be saved by prompt application of artificial respiration. Information on these matters should be given by notices posted in a conspicuous place near the electrical plant. A placard which gives full details of the methods of treating persons suffering from electric shock can usually be obtained from the electricity supply authority or from the government department which deals with agriculture problems. It is essential that workers should be acquainted with methods of rescuing and treating persons suffering from shock from the time they begin to work on the farm. It is too late to start reading the electric shock placard after the accident.

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## **5. PRESSURE VESSELS**

5.1. Voluminous manuals have been compiled on the construction, installation, operation, maintenance, testing and inspection of steam plant and other pressure plant. This chapter cannot go into any detail and only a few essential matters will be discussed.

5.2. Steam boilers and pressure vessels, whether fired or unfired, can cause disasters if they explode. Even small boilers and vessels working at low pressures can cause accidents: electric water heaters in bathrooms have been known to explode and blow out walls. Pressure vessels containing liquids, air or other gases can also be very dangerous. Explosions of boilers and pressure vessels may be due to faulty design, use of unsuitable materials in their construction, failure of safety appliances, improper operation or poor maintenance.

5.3. Most countries have official regulations governing the construction, installation, operation, maintenance, testing and examination of steam boilers and pressure vessels. There are also many national standards on these subjects.

5.4. When steam or pressure appliances are purchased or installed it is advisable to obtain proper advice from a competent source such as an inspectorate or consulting engineer as to the most appropriate type of appliance and arrangements for installing it. Care should, of course, be taken to ensure that the regulations and standards are strictly observed. Makers usually supply an original test certificate specifying the maximum permissible pressure, but purchasers of second-hand boilers or pressure vessels should insist on a complete pressure test and examination by a properly qualified person. The original test certificate issued by the maker may be no longer valid, for the boiler or pressure vessel may have deteri-

orated after some years' use and may not be able to work safely at the certified pressure. In some countries there are government boiler engineers who have to test and approve any pressure-vessel installation before it is taken into use. In others, boiler inspectors are employed by insurance companies or firms of consulting engineers.

5.5. Briefly, all steam boilers, steam receivers, water heaters, fodder boilers and other pressure vessels must be so designed that they will be adaptable to the particular circumstances of their use, and be so constructed that they will be strong enough to sustain the internal pressures to which they will be subjected. They must, of course, be made of appropriate material of good quality, free from defects, and in all respects conform to the national regulations or standards either of the country in which they are used or the country in which they are manufactured.

### SUPERVISION AND OPERATION

5.6. Steam boilers should be under competent supervision at all times while they are in service. Persons in charge of the operation and maintenance of boilers should be properly qualified for the purpose.

### PERIODIC EXAMINATION

5.7. Most countries have regulations requiring steam boilers to be examined periodically by competent inspectors. The examination is in two stages: (a) when the boiler is not under pressure and is cold, and (b) when it is working under pressure. In some countries the two stages (a) and (b) are carried out alternatively at intervals of six or seven months. There are also regulations applying to pressure vessels. Even if there are no statutory regulations requiring inspections to be made, the owners of boilers and pressure vessels would be well advised to have them regularly carried out as protection against the risk of explosion. The interval between examinations, both internal and external, should not be more than fourteen months.

5.8. A maintenance register should be kept showing the dates of all tests, internal and external examinations, cleanings and repairs undertaken on boilers and pressure vessels.

### STEAM BOILERS

#### *Boiler Rooms.*

5.9. The room in which a steam boiler is installed should be large enough to enable it to be operated safely, and should have adequate arrangements for the evacuation of combustion gases.

#### *Safety Devices.*

5.10. Accidents with steam boilers may be due to excessive pressure, shortage of water, scale (including scale on regulating devices such as thermostats), poor maintenance and other causes. To prevent some of these accidents and facilitate smooth running, boilers have to be equipped with various safety devices, the most important of which are the following:

- (a) a steam pressure gauge, marked with a red line to show the maximum safe working pressure;
- (b) at least one water-level gauge of transparent material protected in front and at the sides by a guard of unbreakable glass, to prevent persons being struck by flying fragments if the gauge bursts;
- (c) a safety valve so adjusted as to prevent the boiler from working at a pressure greater than the maximum safe working pressure;
- (d) unless the boiler is externally fired, a suitable fusible plug or an efficient low-water alarm device;
- (e) a suitable stop valve connecting the boiler to the steam pipe;
- (f) a blow-off pipe discharging at a point where there is no danger of injury to workers.

#### *Boiler Attendants.*

5.11. A steam boiler should be in charge of a competent person who should be fully aware of the safety precautions to be

taken. In some countries there is legislation requiring a boiler attendant to possess an approved certificate, which may be issued after a test has been conducted by a government steam-boiler inspector.

### *Water Supply.*

5.12. Hard water which contains calcium can cause a great deal of trouble. Calcium deposits build up in steam pipes so that in time the pipes become completely blocked and cause an excess of steam pressure that may result in an explosion. Calcium deposits inside the boiler may result in its being overheated and bursting. The water supply should be tested by a competent chemist who will advise whether chemical treatment is necessary to soften the water and remove the calcium or other foreign substances in it before it is used for steam-raising.

5.13. It is usually necessary to clean out the inside of a boiler from time to time to remove deposits of scale. Where hard water is used this may have to be done as frequently as once a month. This is another matter on which advice from a competent source can usefully be obtained.

### *Water Level.*

5.14. It is important that the water in the boiler should be kept at the correct level. A low water level may cause overheating of the boiler plates, eventually distortion and perhaps an explosion. The water-level gauge should be checked frequently, and should be blown down at least once daily to ascertain whether it is working properly. If the water level cannot be seen in the glass, the stop-cock should be opened to show whether it is above or below the glass. If the water is too low the fire should be put out and the boiler left to cool down.

5.15. When a boiler is used only intermittently, care should be taken that it is filled with water to the correct level before lighting the fire. There have been very many cases of boilers collapsing or being severely damaged because they have been fired while empty.



*Starting Up.*

5.16. Only a slow fire should be used to start up a boiler so as to prevent uneven expansion of the boiler plates.

5.17. In cold climates precautions should be taken against the freezing up of water in boilers and steam pipes when they are not in operation.

**STEAM-HEATED PRESSURE VESSELS (STEAM RECEIVERS)**

5.18. Steam receivers include steam pipes not directly fired but receiving steam from a steam boiler; examples are air heaters, tubular driers and steam-jacketed pans. Care should be taken to see that the pressure of steam supplied to steam receivers does not exceed their maximum permissible working pressure. For example, a steam boiler whose maximum permissible working pressure is 150 lb/in<sup>2</sup> (10 kg/cm<sup>2</sup>) should not be connected to a steam receiver whose maximum permissible working pressure is 75 lb/in<sup>2</sup> (5 kg/cm<sup>2</sup>). If it is, the steam receiver may burst. A necessary precaution is to fit a suitable pressure-reducing valve between the boiler and the receiver.

**LOW-PRESSURE STEAM BOILERS**

5.19. These appliances generally work at a pressure not exceeding 15 lb/in<sup>2</sup> (1 kg/cm<sup>2</sup>) and the maximum permissible working temperature at or near outlets will not exceed 120°C (250°F).

5.20. As a rule, low-pressure steam boilers must have—

- (a) suitable manhole openings and hand-hole or wash-out openings to permit inspection and facilitate removal of sediment;
- (b) one or more safety valves or other pressure-relieving devices;
- (c) one or more water-gauge glasses;
- (d) two or more gauge cocks;
- (e) a bottom blow-off.

Care should be taken that the blow-off pipe is not in a position where it is likely to freeze up and plug the outlet, causing excess pressure to build up.

### WATER HEATERS

5.21. Water heaters must be equipped with—

- (a) one or more expansion pipes;
- (b) a pressure or water-level gauge;
- (c) a thermometer;
- (d) a temperature or combustion regulator;
- (e) a bottom blow-off.

5.22. The permanent outlet to the atmosphere must always be kept open and free from obstruction so that no pressure can build up.

### FODDER BOILERS

5.23. If a steam-jacketed pan is used for boiling fodder, pig-swill, etc., it should be equipped with—

- (a) a steam-pressure gauge on which a red mark shows the maximum safe working pressure;
- (b) a safety valve or other pressure-relieving device;
- (c) a stop valve;
- (d) a reducing valve or other automatic pressure-regulating device on the steam supply pipe-line.

5.24. Before steam is admitted to the space between the inner and outer shells the steam space should be drained. In cold climates adequate precautions should be taken against the freezing up of fodder boilers when they are not in use.

### COLD-WATER PRESSURE SYSTEMS

5.25. Cold-water pressure tanks sometimes explode because of faulty construction. They should as a rule be provided with

pressure gauges and safety valves. However, the safety valve may be omitted on equipment with a centrifugal pump (but never with a piston pump) if the pressure tank is designed to withstand the maximum pump pressure. Periodic inspection and maintenance are necessary to keep them in good operating condition. They should be effectively protected against freezing in cold weather.

### AIR RECEIVERS (AIR TANKS)

5.26. Air receivers should have the safe working pressure marked on them, and be equipped with—

- (a) a safety valve;
- (b) a pressure gauge on which the maximum pressure is shown by a red mark;
- (c) an appliance for draining them at the lowest point;
- (d) a hand-hole or other means that will allow the interior to be thoroughly cleaned.

5.27. Air receivers should be thoroughly cleaned internally and examined at least once every two years.

5.28. Under no circumstances should home-made or improvised air receivers be used. Very serious explosions have occurred when oil drums have been converted for use as receivers.

### COMPRESSED GAS CYLINDERS

5.29. Cylinders for compressed, liquefied and dissolved gases should be equipped with a protective cap or other means of protecting the valve and, if necessary, a device that prevents damage to the bottom.

5.30. Cylinders should be clearly marked to show the maximum permissible charging pressure, the maximum weight of the charge, and the cubic capacity, and to identify their contents. In some countries there are standard colours for the various gases that may be contained in cylinders.

5.31. Cylinders should be adequately protected against excessive variations of temperature, direct rays of the sun, accumulations of snow and continuous dampness.

5.32. When charged cylinders are stored inside buildings their number should be kept as small as possible; the cylinders should be placed at a safe distance from a source of heat, and secured against falling and rolling; and smoking in the storeroom should be prohibited.

5.33. An oxygen cylinder should never be used to start up a diesel engine because the oxygen will form an explosive mixture with the diesel oil. Very serious accidents causing loss of life and the complete destruction of the diesel engine have occurred in this way. Fittings of oxygen cylinders should not be greased since this creates a dangerous ignition risk.

### PRESSURE SPRAYERS

5.34. The containers of compressed-air sprayers operated by hand pumps sometimes explode and cause injuries. Containers made of brass should not be used for more than five years unless they have been inspected and approved by a competent person. When purchasing new compressed-air sprayers farmers should see that the containers are made of phosphor bronze, copper or steel.

5.35. Instructions for operators should explain, in terms that can readily be understood by laymen, all the maintenance operations required to keep the appliance in safe working order, and, in particular, should refer to the risks of improper handling and neglect of precautions.

5.36. A compressed-air container should be provided with a safety valve and a pressure gauge. A relief valve or pet-cock is also necessary so that the air pressure can be reduced to normal atmospheric pressure before the container is opened. Failure to relieve the pressure may cause an accident to the operator. If no relief valve is provided, the container should be turned upside down and the air released through the spray gun.

5.37. Before a compressed-air sprayer is taken into use for the season, the container should be subjected to a hydrostatic test by a competent person, and the safety equipment checked. The test can be done as follows:

- (1) Remove the pump.
- (2) Fill the container completely with water; no air must remain in it.
- (3) Replace the pump and fill it with water. Press the piston downwards until the maximum permitted pressure is reached. Check the safety valve and the pressure gauge.
- (4) Relieve the pressure, remove the safety valve and plug with a tube-end plug.
- (5) Press the piston downwards until a pressure of one-and-a-half times the maximum permitted pressure is reached. Higher pressure may damage the container. *No air must remain in the container or in the pump.*
- (6) Let the pressure remain for ten minutes and inspect the container.
- (7) If any leak or permanent deformation is observed, the container should not be used.
- (8) If there are no defects, replace the safety valve.

If the container is supplied with a combined safety valve and pressure gauge, it has to be removed and a special gauge inserted for the test.

5.38. After each use and at the end of every day the container should be thoroughly cleaned with water, or, if there is a coating inside, with a warm light soda solution. To keep the container dry it should be stored upside down with the pump removed.

5.39. Safety goggles should always be used when spraying lime or other dangerous liquids and when cleaning the nozzle or the cut-off valve. Cleaning should never be done while the equipment is under pressure.

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## 6. DRIERS, SILOS, STACKS AND PITS

### DRIERS

6.1. Various types of drying plant are in use for the artificial drying of grain and herbage. As some of these are liable to cause fires, it is advisable to install them in a separate building. It may also be necessary to take precautions against dust explosions and to prevent workers from inhaling dust-laden air.

6.2. Three methods of drying are in common use:

- (a) cold air;
- (b) hot air; and
- (c) gas heating.

#### *Cold-air Driers.*

6.3. These do not present any special fire risk. The motor should be directly coupled, and provided with an overload circuit breaker. The blower should be carefully mounted and the fan blades guarded by strong wire mesh. The formation of air pockets should be avoided by the design of the appliance and by carefully feeding in the material to be dried. Excessive spontaneous heating should be prevented by temperature controls at regular intervals, and by adequate ventilation.

#### *Hot-air Driers.*

6.4. The material being dried should not come into contact with fire or smoke from the furnace or with hot objects, or be put into silos or otherwise stored before it has cooled down.

6.5. The furnace should be placed in a separate room (fig. 18). The hot-air, hot-water or steam pipes should be insu-

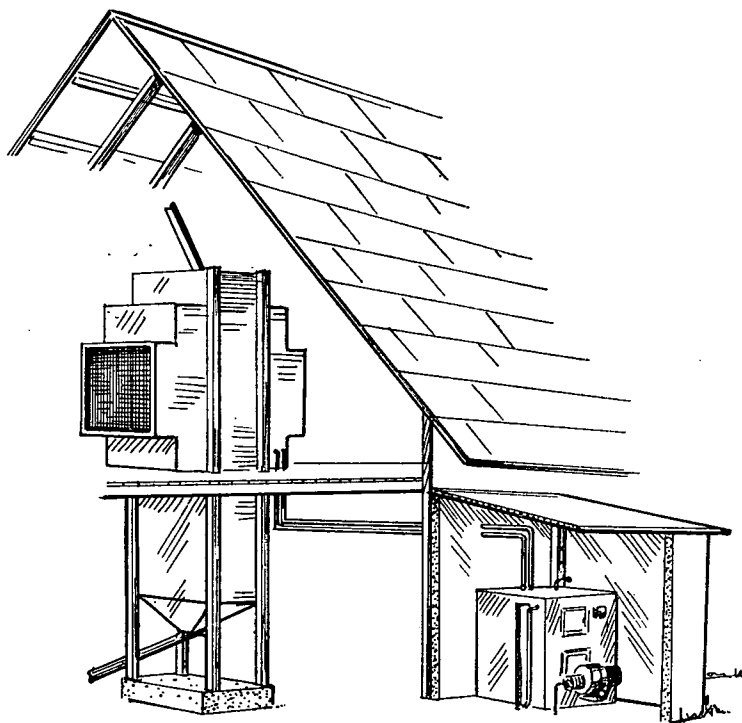


Fig. 18. Hot-air grain drier equipped with water-heated radiator. The furnace is in a separate fireproof room outside the building.

lated by fire-resistant material to avoid heating of flammable dust or material in the building and so creating a fire risk.

6.6. Hot-air driers with a radiator that is heated by steam or hot water from a boiler are considered free from fire risks. Steam or water pressure should not exceed  $15 \text{ lb/in}^2$  ( $1 \text{ kg/cm}^2$ ) in order to avoid too high a temperature in the pipes. Hot-air

driers with an air-heating furnace are more hazardous than most other types. If the partition plate in the furnace is burned through, gases and sparks may follow the air into the drier and ignite the material being dried. This type of drier should be approved by a competent person before being-taken into use.

6.7. If an air-heating furnace is used to supply hot air for mixing with cold air, the plant must be so arranged that no negative pressure can occur in the air space of the furnace. To prevent suction in the hot-air pipe, there should be a distance of 6 in (15 cm) or more between the discharge of the pipe and the cold-air blower.

6.8. Electrically heated driers of various types are in use. The air is indirectly heated by hot water or steam from electric water heaters or boilers. Direct heating of the air by electric elements is a fire hazard and should be avoided. Automatic temperature control is necessary, and disconnecting devices must be reliable. With all hot-air driers care must be taken to avoid over-heating, and close supervision is essential.

#### *Gas-heated Driers.*

6.9. These present a considerable fire risk from the heat given off by the furnace or from sparks. It is better not to install them in, or within, 150 ft (45 m) of buildings. The manufacturer's instructions for operation should be observed. The drying plants are usually tall, so the platforms require fencing. As recommended in Chapter 3, only fixed stairs with railings should be used for access to the different parts of the plant. It is particularly important to have good lighting for gas-heated installations.

### SILOS

6.10. Flour and grain dusts are highly flammable, and, when suspended in air, explosive. Buildings in which they are likely to be present in large quantities should have explosion-vent areas such as thin glass panels, and easily opened hinged windows or skylights. Other precautions include the provision of flame-



proof electrical equipment, dust-tight covers for grain bins, exhaust ventilation, a separate venting to the outside through vertical stacks, and placing of grain driers in individual fire-resistant rooms or compartments.

6.11. Fodder, too, may ignite spontaneously if damp. When stored in bulk it must be kept dry and its temperature noted, for example by probing it with a thermometer at frequent intervals. This applies particularly to hay. Loose hay with a moisture content exceeding 25 per cent, and chopped or baled hay with a moisture content exceeding 20 per cent, should not be stored. If the temperature rises above 60°C (140°F), preparations should be made for dealing with a fire and the fire brigade should be called. Overheated hay should not be uncovered or removed before it has been thoroughly soaked in water.

#### *Grain Silos.*

6.12. No worker should enter a silo containing grain unless he is wearing a safety belt with a lifeline attached. Another person should watch from outside at the top of the silo and be able to assist in pulling the worker out in case of danger. There is always a risk that he will be buried in the grain and suffocate. Many fatal accidents have occurred in this way. Openings on the top of silos should be covered with gratings to prevent anyone falling in accidentally. Silos should be provided with fixed ladders. It should be prohibited to enter a silo on ladders resting on the stored material.

6.13. No person should be working inside the silo when grain is being discharged, because a vacuum may be created and he may be rendered unconscious through lack of air. It will be necessary in any case to check the oxygen content of the silo before entering it as well as the possible presence of noxious gases.

6.14. Silos should be treated as places with a fire and explosion risk; the use of hand-lamps, for example, should be prohibited.

*Tower Silos.*

6.15. Tower silos should be adequately fenced around the top. The fencing should be strong enough to withstand rough treatment such as blows from fodder elevators. The guard-rails can be made to open when material has to be hoisted into the silo. Safe means of access should be provided to the top of the silo and any intermediate platforms. Here again, stairways are safer than ladders. If ladders are used they should be securely fixed in position. A good practice is to construct a vertical ladderway so that a man has to use the two sides alternately between the different platforms, since this limits the distance which he can fall to the height between two platforms, which should not exceed 10 ft (3 m). If such protection is not provided the ladder should have a cage or similar device.

6.16. If weights are used for pressing green fodder they should have handles. Instead of weights, barrels or plastic sacks filled with water can be used. These are convenient and simple to handle.

6.17. On silos for fermenting fodder there should be a notice warning against the risk of asphyxiation. Before anyone enters a silo, the atmosphere should be tested with a flame. If it goes out there is a risk of asphyxiation by carbon dioxide. If a person loses consciousness in a silo, rescuers must be securely roped before entering it. The victim must be given artificial respiration immediately he is removed from the silo, preferably by the mouth-to-mouth method.

6.18. When the walls of a silo are being coated with lacquer, all appropriate precautions must be taken against fire and explosion risks. The formation of an explosive mixture of air and thinner vapour must be prevented by ample ventilation.

6.19. As mentioned in Chapter 3, tower silos sometimes serve as fire-breaks.

*Horizontal Silos.*

6.20. Several accidents have occurred to people driving tractors over green fodder to compact it. A bedding of this kind

does not give sufficient support for the tractor, and it can easily overturn sideways or rear. On silos above ground level, a tractor coming too close to the edge may overturn sideways. A strong railing is needed to prevent this if the sides of the silo are not sufficiently high (fig. 19). The material should be laid out as evenly as possible.

### *Ensilage Pits.*

6.21. Ensilage pits whose tops are less than 3 ft (1 m) above ground level should be protected by railings.

## HAY AND STRAW STACKS

6.22. Fire can easily be started in stacks, e.g. by children playing with matches, careless smokers or sparks from chimneys. Hay and straw burn violently and can be blown over long distances. Consequently, stacks should not be placed near buildings, particularly if the buildings are combustible, or near flammable stores, but at a distance of at least 50 ft (15 m) from them; the space between must be free from combustible rubbish, lumber, vegetation and the like.

## MANURE PITS

6.23. Liquid manure pits should be covered over. A considerable number of lives have been lost by persons—mostly children—being drowned in them. The covers should be either fixed in position or made too heavy for children or cattle to move or dislodge. If a cover has to be removed, the pit should be under constant supervision. If necessary, ventilation openings covered with suitable grids or gratings can be provided. If liquid manure pits or urine vats are not covered over for any reason, they should be adequately protected by fences.

6.24. A liquid manure pit contains toxic gases and flammable gases (marsh gas). As the gases are heavier than air they remain in the pit when the covers are open. Before any person enters it, the pit must be thoroughly aired by a blower or other

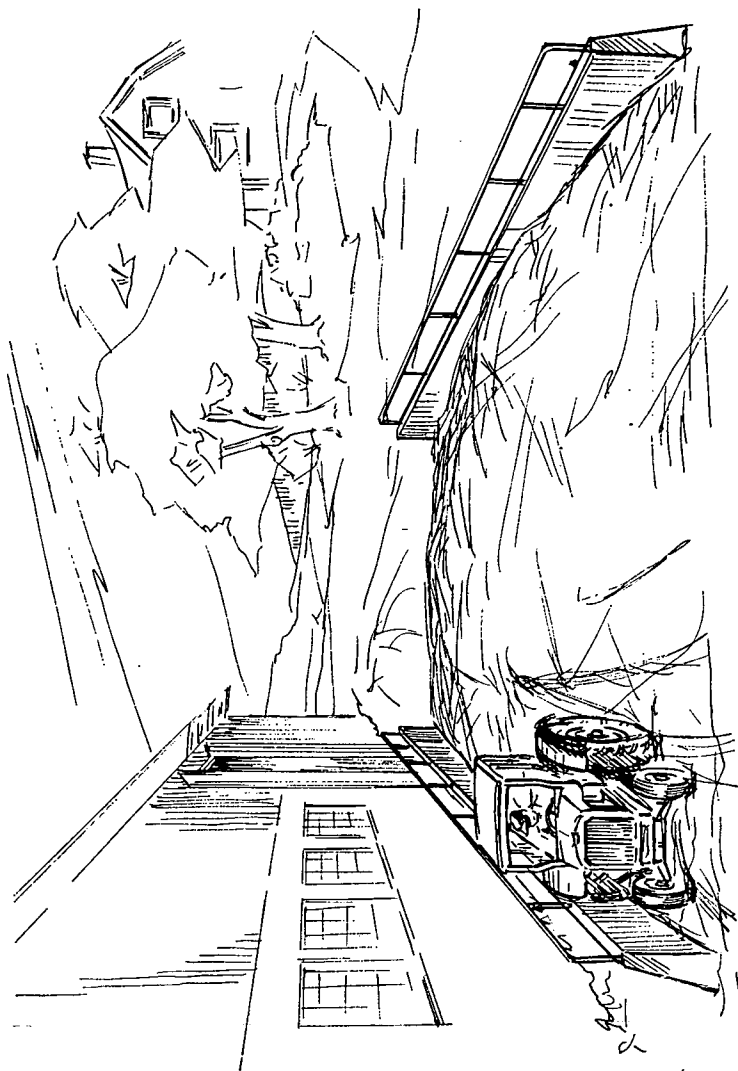


Fig. 19. Railings along horizontal silos to protect the tractor driver.

effective means. The person entering should be attached to a lifebelt and lifeline, and a second person should hold the line and keep watch. If the person working in the pit feels ill he should immediately leave or, if necessary, be hauled out. If he is unconscious, resuscitation should be practised and a doctor called immediately.

6.25. Because of the explosion risk, no open flame or light or smoking should be permitted in or near open pits.

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## 7. GARAGES AND ENGINE-ROOMS

7.1. Tractors, trucks, automobiles and stationary engines should not be housed or operated in barns or in other farm buildings with serious fire hazards. Some farm buildings contain combustible materials and explosive mixtures of gases or dust, and an engine in them may backfire when it is starting and cause a fire. While an engine is running, a fire could be started by an overheated or faulty muffler, hot or burning carbon deposit or faulty ignition.

7.2. If it is necessary to drive a tractor inside buildings, e.g. for hauling in loads, it should be equipped with a spark arrester of an approved type. This does not mean that the tractor may be housed in the building concerned. However, provided the battery is removed, a motor vehicle may be kept in a building other than a garage. A combine may be kept *temporarily* in a room other than a garage if no flammable materials are within 20 ft (6 m) of the engine or the exhaust pipe, and if the battery is removed.

7.3. Except where otherwise stated the following recommendations concerning garages also apply to rooms housing stationary internal combustion engines.

### ISOLATION

7.4. A garage should preferably be an isolated building situated at least 20 ft (6 m) from any other building or store of highly combustible material. It should, of course, comply with all regulations or standards in force concerning fireproof construction, electrical installations, etc.

7.5. If a garage is in a building or close to a building containing highly combustible materials, such as hay or straw, it should always be of fire-resistant construction, i.e. with walls and roof of stone or cement or equivalent material. If a garage has been converted from existing premises, e.g. an unused stable, it may be sufficient to cover the walls and ceiling with fire-resistant material such as grouting, sheet metal or asbestos-cement sheeting.

7.6. The doors and openings in a garage that is not an isolated building should normally be in outside walls only. No opening should be allowed in walls giving access to cattle sheds, rooms containing flammable materials, boiler rooms or the like. The floor should be of fire-resistant material, i.e. earth, stone, concrete or equivalent material.

7.7. The exhaust pipe from a stationary engine should lead directly into open air and discharge at a safe distance, at least 20 ft (6 m) from any combustible material, and in such a position that the exhaust gas will not enter buildings or in other ways endanger persons or animals.

7.8. To prevent the spread of fire through openings in the walls for driving belts, etc., power should be transmitted only by shafting passing through the wall in tight-fitting bushing.

## VENTILATION

7.9. A garage should be adequately ventilated. Normally, openings in the lower part of the doors act as fresh-air inlets, and one or more openings at the top of the opposite wall as outlets. The outlets should lead directly into the open. Larger garages may require mechanical ventilation. Ventilation openings should not be kept closed at any time of the year. Notices about the risk of poisoning by exhaust gas and prohibiting smoking and open lights should be posted in the garage.

7.10. Exhaust gases from motor vehicle engines are extremely dangerous to health owing to their carbon monoxide content. Many fatal accidents have occurred through keeping the engine running in a badly ventilated garage or in one with the doors

and windows closed. Even with the doors and windows open it is possible for such accidents to occur. The engine should not be run inside a garage more than is required for driving in or out unless the garage is equipped with metal suction hose that can be connected to the exhaust pipe and efficiently remove the gases.

### HEATING AND LIGHTING

7.11. Heating appliances in a garage should not involve any risk of fire or explosion. No flames or incandescent parts likely to ignite petrol vapours should be used. Hot exhaust pipes or flues from stoves or furnaces in an adjoining room should not be allowed to pass through a garage. The hot-water boiler for the heating system of a garage should be in a separate room not directly in communication with the garage. Fixed electric elements embodied in heating tubes are sometimes used, and in a garage for only one vehicle infra-red elements may be permitted. Air from a hot-air furnace installed in a separate room may also be used for heating. Another solution is to provide a special heater for the motor instead of heating the garage.

7.12. The garage should be well lit by electric lighting if practicable. In any case, no open lights or flames should be allowed.

7.13. Electrical installations, including the lighting installation, in garages should comply with the requirements applying to rooms where there is an explosion risk if petrol-driven vehicles are housed in them.

### FLOORS

7.14. The floor of an engine-room should, if practicable, be sunk or the threshold raised so as to form a basin which, in case of an accident, can retain all the flammable liquid likely to escape. In both garages and engine-rooms a drainage system, including a trap for petrol and oil, should be installed.



### STORAGE OF FLAMMABLE MATERIALS

7.15. As a rule, petrol should not be stored in garages. Other fuel oils should be stored there only in conformity with legal requirements. Oily and greasy waste should be kept in metal receptacles.

### SPARKS FROM WORK

7.16. Work such as welding, that involves the generation of arcs and sparks, should not be carried out in a garage.

### FIRE-FIGHTING EQUIPMENT

7.17. Adequate fire-fighting appliances should be provided. Foam, carbon dioxide or dry chemical extinguishers and sand are suitable.

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## **8. GENERAL PRECAUTIONS WITH MACHINERY**

8.1. Nowadays farms are using machines in increasing numbers and variety. In this guide they have been classified as follows:

- (a) engines, or prime movers including engines driven by wind or water, internal combustion engines and electric motors. The last-named are dealt with in Chapter 4 and the others in Chapter 9;
- (b) transmissions, such as shafting, belt drives and gears, dealt with in Chapter 9;
- (c) soil and crop preparation machines such as ploughs, harrows and cultivators, dealt with in Chapter 10;
- (d) harvesting machines such as reapers, combines and threshing machines, dealt with in Chapter 11;
- (e) miscellaneous agricultural and forestry machines such as log saws, wood-splitting machines, and centrifuges, dealt with in Chapter 12;
- (f) power take-off of tractors, dealt with in Chapter 13;
- (g) fixed hoisting and transport machinery such as cranes, winches and conveyors, dealt with in Chapter 15;
- (h) non-agricultural machines used in farm maintenance and repair shops, for instance woodworking saws and planers and metalworking lathes, drills and grinders, dealt with in Chapter 19.

8.2. The machines used in agriculture cause many accidents, in some countries 10 per cent or more of all accidents. This is bad, but what is worse is that they usually cause a much larger percentage of serious and fatal accidents. The main risk with machinery of all kinds is coming into contact with moving parts.

Mobile machines that work in the fields have risks of their own: people may fall off them or be run over by them. With some machines such as grinders there is the risk of being struck by flying fragments.

8.3. There are different kinds of moving parts with which a person may come into contact—shafting, belting, gears, tools, etc.—and contact may be made in different ways—by a hand slipping, by loose hair or clothing, by an object being carried, and so on. The result may be crushing, squeezing, bruising, abrasion, laceration, puncture, concussion, internal injury, or a combination of these. Any part of the body may be injured—head, eyes, hands, feet, trunk. Uncovered or inadequately guarded transmissions such as gears, belt drives and shafts, as well as cutting tools, may be sources of accidents, and worn bearings may constitute fire hazards. However, a satisfactory degree of safety can be obtained if suitable measures are taken to prevent both accidents and fires.

8.4. The present chapter sets out some general precautions designed to avoid injuries from machines. Particular precautions for certain types of machines are discussed in the following chapters. Most of the measures described below, which relate to the design and the constructional features of machinery, can be introduced only by the manufacturer of the machine, but should be of interest to the farmer in guiding him when acquiring new or second-hand machines.

8.5. As far as practicable, machines should conform to the principles of built-in safety, that is to say they should be safe by design and not require the subsequent addition of guards. But this principle cannot be fully applied to field machines.

8.6. A well-designed and well-guarded machine not only prevents accidents but also enables a worker to perform his duties with ease and efficiency. Guarding is required not only at the point of operation of the machine but also at all points where a person can come into contact with moving parts. It is a mistake to think that “nobody ever goes there” or “nobody has anything to do there”. Experience has shown that sooner or later a person does come into contact with unguarded moving parts of a machine.

8.7. When machinery is purchased it should be specified that all the guards required by national regulations must be built in as part of the machinery. In particular—

- (1) Flywheels and spoked wheels should be fenced, and if the fencing revolves with the wheel it should be solid.
- (2) Toothed, chain, friction and belt drives should be totally enclosed.
- (3) Projections such as keyways, keys and screws on revolving or reciprocating parts should be enclosed.
- (4) Shafts and crankshafts should be totally enclosed.
- (5) Shaft ends should be totally enclosed if they project more than one-third of their diameter, and be rounded off if they do not.
- (6) Nip-points and points where crushing or shearing is likely should be enclosed.
- (7) Belt fastening should be smooth.
- (8) Paths of counterweights, pendulum weights and the like should be fenced.

### GUARDS

8.8. The guard or protective device should be suitably designed, afford maximum protection and, as far as possible, not interfere with efficient operation of the machine or cause discomfort to the operator. The device should give protection against unexpected risks, for example intermittent movements of a machine part, as well as against normally expected risks. Furthermore, it should be well constructed and securely fixed in position and, when necessary, resistant to fire and corrosion.

8.9. A guard which has to be opened from time to time should be fitted in such a way that it need not be taken away; for example it can be suspended on hinges.

8.10. In some cases it is necessary to have the guards or the cover for a machine part interlocked so that it cannot be removed while the machine is in motion and the machine cannot be started up unless the guard or cover is in position. If it is not practicable

to provide an interlocking guard or cover, there should be a notice on the part of the machine concerned reading: "Caution. Do not open unless the machine is stopped."

#### *Removal of Guards.*

8.11. No person should remove or make ineffective any safeguard, safety appliance or safety device guarding a dangerous machine or machine part, except when the machine is stopped and for the purpose of immediately repairing or adjusting the machine or the protective device. Upon completion of the repair or adjustment, the protection should be replaced immediately. It should not be possible to remove a guard without a tool.

### DEFECTIVE PARTS

8.12. Defects or deficiencies in a machine or its protective devices should be reported promptly by the operator. The power should be cut off and the control locked or a notice conspicuously placed on the machine, prohibiting its use until the necessary adjustments or repairs have been made.

### STARTING AND STOPPING

8.13. Every machine should, as far as practicable, be equipped with individual starting and stopping devices; the starting of several machines together can surprise a person attending one of them and lead to injury.

8.14. If danger can arise when machinery is started, a pre-determined signal, clearly audible at the place where the machinery is situated, should be given in good time before starting up.

8.15. A starting device should be arranged so that it cannot engage itself or be engaged inadvertently. A starting button should be countersunk and not be placed so that it can be depressed from above unless it is securely covered. In order to prevent children and other unauthorised persons from starting a machine, it is advisable to have a starting device that can be locked.

8.16. No machine should be left running when the operator leaves it, because other persons, especially children, may come into contact with it.

#### *Emergency Stops.*

8.17. Adequate means of stopping a machine quickly from the operator's working place should be provided. Stop buttons should be coloured red, and no starting device should be red. Stop buttons should preferably be of the "mushroom" type. This rule makes it possible for any person to stop a machine in an emergency even if he is not acquainted with it.

8.18. In addition to the stopping device at each machine, there should be provided in each room, section or department emergency stops or switches, properly marked and easily accessible, by which each complete and separate unit of power transmission in it can be quickly stopped.

### OPERATORS

8.19. Experience and training are of great importance. When the persons operating the machines and doing the repair work are skilled, the risk of accidents is reduced. On small farms such work is often done by persons who have insufficient knowledge of the risks.

### OVERSPEEDING

8.20. Machines are usually constructed to run within a certain range of speed. If the maximum permitted speed is exceeded there will be excessive wear and tear and the risk of an early breakdown. In some cases excessive speed may cause the rupture of a flywheel. No machine should be run at a higher speed than that recommended by the maker. Abrasive wheels are very prone to break if they are run at a speed above that indicated on the wheel when it is purchased.

8.21. If hand-operated machines are converted for power operation, care should be taken that they are not overspeeded. It

is advisable to consult the makers before making any modifications.

8.22. Even if a machine is not overspeeded, it may still be overloaded by being called upon to undertake work for which it was not designed. This will lead to excessive wear and the possible breakage of some part of it sooner or later.

### MAINTENANCE AND CARE OF MACHINES

8.23. Adequate maintenance and care of machines decreases the risk of accidents and fire. Machines should not be placed among flammable material, and foreign bodies should not be allowed to get into them. Worn and defective parts are dangerous and should be replaced in good time. If there is any risk of overheating, machines should be periodically checked when in use. A fire will easily spread if waste, dust, oil, etc., are allowed to remain on or around machines, particularly in carpenters' shops where the waste is very flammable. The shop and the machines must be kept clean.

8.24. Machines should be easily accessible. If necessary, stairs, ladders or steps and, where required, hand-grips should be provided. Sometimes platforms or lubricating stands are needed and should, if practicable, be fixed installations, since chairs and movable ladders are dangerous to stand on. Furthermore, experience has shown that maintenance and care of a machine will often be neglected if it or any part of it is not within reach or easily accessible.

8.25. No part of any machinery which in is motion should be examined, lubricated, adjusted or repaired unless it is securely guarded or other adequate steps are taken to prevent injury.

### LOOSE CLOTHING

8.26. Many accidents are caused by loose or torn clothing and neckties being caught by revolving parts of machinery. When selecting working clothes, consideration should be given to the hazards to which the worker may be exposed and clothing should

be selected which will reduce the hazards to the minimum. Working clothes should fit well; there should be no loose flaps. Shirts with short sleeves should be worn in preference to shirts with rolled-up sleeves. The subject of clothing is dealt with in more detail in Chapter 24.

### WORKING SPACES

8.27. Agricultural machines are too often designed and constructed with little consideration for the health and comfort of the persons who have to operate them. Unsuitable seats, inadequate foot-rests, awkwardly placed control gears, inconvenient access to the operator's position, vibration and noise are common faults. For machines already in use it is difficult to take satisfactory measures to remove such defects but since they can affect the operator's health all possible steps should be taken to neutralise them.

8.28. An operator's workplace or stand should be as safely and easily accessible as practicable. Access to it should, if necessary, have a foot-scraper, foot-rests and hand-grips or a hand-rail. It should be sufficiently spacious, with the foot-rests so arranged that the work can be done safely and without causing unnecessary fatigue. Seats should be provided for operators as far as practicable.

8.29. Seats on mobile machines should be so arranged that the driver or operator is in a safe position both when starting up and when driving. If necessary, protective railings should be installed. Seats should be well sprung and, if practicable, provided with a back-rest. If a seat is not sprung, or is inadequately sprung, it should be provided with a cushion.

8.30. In front of the seat there should be a floor or board, or, if that cannot be provided, a foot-rest of suitable shape in a suitable position—preferably foot-plates. Foot-plates should be of sufficient size and so arranged that the feet will not slip off. Floors or foot-plates should have a rough surface, and be so arranged that they do not accumulate soil or snow. Foot-pins do



not afford a good foothold and have caused accidents when a foot has slipped off. They should never be used on tractors.

8.31. The working platforms on machines should be provided with guard-rails and toe-boards. In the case of a working platform near ground level at the back of the machine, this requirement can be satisfied by a hand-hold at a suitable height along the front of the platform, unless the machine is designed to have another machine or implement coupled behind it. If this is the case, a guard-rail should be placed at a suitable height at the back of the platform to prevent the operator from stepping or falling backwards under the machine or coming into contact with dangerous parts. To prevent him from slipping down in front of the platform, a toe-board should be fitted along the front.

8.32. The controls should be of sound construction and so made and placed that they can easily be operated from the machine operator's stand. They should be designed in conformity with ergonomical principles.

8.33. On some machines or implements moving parts are so placed that there is a risk of crushing or shearing between the moving part and an operating lever, pedal, foot-rest or some other part of the operator's working place. An example is the power lift on certain tractors or on a horse-rake, where a driver may place his foot on the rear angle iron of the rake and have the heel injured when laying off the material. All such moving parts should be adequately guarded or enclosed. This also applies to parts that might be used as support for the hand or foot.

#### TRANSPORT OF MACHINES AND IMPLEMENTS

8.34. When agricultural machines and appliances are being transported from one workplace to another, adequate measures should be taken to prevent accidents and damage to plant or appliances due to insecure loading, parts projecting from a machine, unsecured parts which may start to move during transit, overloading a vehicle, unguarded tines and cutters and unlocked hydraulic lifts which may descend during handling.

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## 9. ENGINES AND TRANSMISSIONS

### ENGINES

9.1. Engines (prime movers) include water-wheels, water turbines, windmills, steam-engines, internal combustion engines, electric motors and any other initial source of power for driving machinery.

#### *Flywheels.*

9.2. Every flywheel directly connected to any prime mover, and every moving part of a prime mover, should be securely fenced. A prime mover is often housed in a separate engine-room in which no person is employed except the engineman who only goes there for the purpose of starting it up and stopping it. It is often assumed that fencing of the flywheel and moving parts and the transmission belt are not necessary because no person is employed continuously in the engine-room. Experience has shown, however, that serious accidents occur if fencing is not provided in such cases.

9.3. When a flywheel has to be barred, provision should be made for this to be done on the periphery of the wheel through a slot in the guard.

#### *Water-wheels and Water Turbines.*

9.4. The head and tail race of every water-wheel and water turbine should be securely fenced.

#### *Internal Combustion Engines.*

9.5. Exhaust gases from internal combustion engines contain carbon monoxide, which is very dangerous. In its pure state,

carbon monoxide is colourless, odourless and tasteless so that it cannot be detected by the senses. A concentration of more than 0.1 per cent in the atmosphere is dangerous to health and may prove fatal if breathed long enough, while a concentration of 1 per cent is fatal in a few minutes.

9.6. Experience has shown that it is in the overhaul of engines in workplaces and in the use of mobile and portable internal combustion engines that most gassing accidents occur. Mobile plant such as trucks, stackers and tractors should not be used indoors or in confined spaces. When an engine is running in a confined space, for instance an automobile engine in a garage or a portable pump in a basement or in a well or excavation, the exhaust fumes should be led out to the open air. Exhaust gases from a machine, motor vehicle or tractor should be discharged so that neither the driver nor any person working nearby can be exposed to them.

9.7. When machines are equipped with internal combustion engines there is considerable danger of fire. Exhaust pipes should not discharge near the ground so as to be likely to ignite straw or any other combustible material; this is particularly important in dry periods. The pipes should be provided with spark-arresters and discharged at the highest point possible.

9.8. The engine must be kept clear of chaff, dust or other substances that might be ignited by hot parts. Compressed air is suitable for cleaning. Hot parts of the engine can sometimes be shielded so that chaff, etc., cannot collect around them.

9.9. When the fuel tank is being filled the engine must be stopped. If fuel is spilt, it must be dried up immediately and the machine must not be started until the engine is entirely free from the fuel.

9.10. The conditions that engine-rooms should satisfy have been described in Chapter 7, and precautions with tractor engines in Chapter 13.

#### TRANSMISSIONS

9.11. Transmission machinery includes all shafting, wheels, drums, pulleys, couplings, clutches, driving belts, chain drives and

any other device by which the power of the prime mover is transmitted to or received by any machine or appliance.

9.12. Every part of transmission machinery should be securely fenced unless it is in such a position or of such construction that it is as safe to every person employed or working on the premises as it would be if securely fenced. It cannot be considered safe by position unless it is at least 8 ft 6 in (2.5 m) above floor level or the level of any working platform.

9.13. No work should be carried on at or near overhead shafting when it is in motion. It may be necessary, from time to time, for a worker to climb a ladder near overhead shafting in order to oil or grease bearings, replace electric light bulbs, clean down the walls or carry out some maintenance work. In such cases the shafting should be stopped.

9.14. In a room where work is carried on efficient devices should be provided by which power can be promptly cut off from the transmission machinery in the room.

9.15. Suitable striking gear or other efficient mechanical appliances should be provided to move driving belts to and from fast and loose pulleys which form part of transmission machinery; any such gear or appliance should be so constructed and maintained as to prevent the driving belt from creeping back onto the loose pulley.

### *Shafting.*

9.16. In addition to shafting forming part of transmission machinery, consideration has to be given to shafting which forms part of a machine, e.g. side shafts, underbench shafting, or any other exposed shafting, whether horizontal, inclined or vertical. Even if it is smooth and appears harmless, revolving shafting is always dangerous and has caused many fatal accidents. It can catch loose clothing or a person's hair or take hold of a cleaning rag and drag the person holding it against or around the shaft. The hazard increases if there are any projections on the shafting such as keys, screws, grease fittings, locks or couplings. Unfortunately,

many people do not realise the extremely dangerous character of unfenced shafting.

9.17. Exposed shafting, including all protruding parts, should be completely enclosed (fig. 20). If tubes are used as guards, they should be fixed to the framework. A loose tube on a shaft is risky because rust, dirt or a slight deformation can cause the tube to stick to the shaft and itself become the hazard it is supposed to eliminate, and—what is worse—a hazard unknown to the operator.

9.18. Special precautions should be taken to prevent persons or objects on trucks or trailers from coming into contact with shafts and protruding shaft ends above a gangway.

9.19. The protruding end of a shaft which is not used should be either cut off or enclosed. Where the length of rotating shafting exposed is variable during the cycle of operations of the machine, it is possible to provide a telescopic guard which will at all times give adequate protection.

9.20. Close attention should be paid to the power transmission shafting between a tractor and a machine or implement. Such transmissions have caused many serious accidents, a large number of them being fatal. This subject is dealt with in Chapter 13 on tractors.

9.21. Shafting can cause fire by friction heat if hay, straw or cord winds around it and is rubbed against nearby machine parts. Machines such as threshers, fans and chaff cutters have caused fires in this way. Shafting has also started fires in other ways, for instance when a bearing has sunk and the shafting has pressed against a fixed object. Fires have resulted from overheated bearings that have not been properly maintained and oiled. Since this happens mostly with ordinary bearings, roller or ball bearings are advisable, but self-oiling bearings can also be recommended.

### *Belt Drives.*

9.22. All belt, rope and chain drives located 8 ft 6 in (2.5 m) or less above the ground or working platform should be guarded

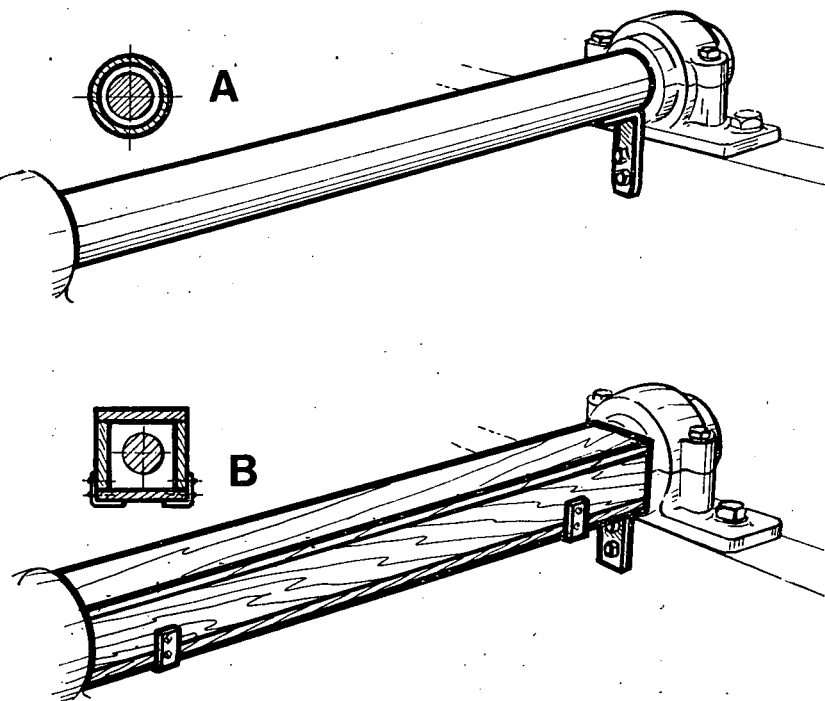


Fig. 20. Fixed guards for shafts.

A. Steel piping. B. Wood.

unless they are in a position that effectively prevents persons or their clothing from coming into contact with them.

9.23. The underside of heavy overhead horizontal belt drives should be protected so as to prevent injury to workers if a belt breaks and is thrown downwards.

9.24. Temporary belt drives between mobile prime movers and machines should be protected on both sides for the full length of the belts, and the pulleys should also be protected.

9.25. Particular care should be taken to ensure that all V-belt drives and pulleys are fully protected. Because the belts are very narrow and short, it is often thought that they do not require fencing, but experience has shown that very serious accidents can occur.

9.26. Driving belts should not be shifted by hand when they are in motion. If it is necessary to shift them while they are still running, a belt shifter, or in a default a pole, should be used. When a belt is removed, it should be thrown off the drive, not off the driving pulley. Driving belts, when not in use, should not be allowed to ride idly on the shafting but should be suspended on hooks above it.

9.27. Care should be taken to prevent a belt drive from rubbing against any combustible material that may cause a fire. For instance, belts passing through wall openings, especially if the walls are of wood, may chafe against the edges of the opening and so create a fire risk.

#### *Gear-wheels.*

9.28. Exposed power-driven gear-wheels should be guarded, preferably with a complete enclosure. A partial guard, such as a nip guard that only protects the in-running nip of the wheels, usually presents a risk because a person may still be able to have a finger trapped between the wheel and the gap in the guard.

9.29. Sprockets and chain drives are very dangerous and should be completely enclosed.

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## 10. SOIL AND CROP PREPARATION MACHINES

10.1. It is advantageous to choose implements which the tractor can pull even under the hardest conditions that may occur during work on the farm. This means that under normal operating conditions all the power of the tractor will not be used, and there will be some in reserve. If a tractor works well when pulling an implement, it is making the work safer. A jerky drive imposes unnecessary strain on the driver.

### PLOUGHS

10.2. If a plough strikes a stone or some other fixed object in the soil, it may be damaged, but—what is more serious—the tractor may rear. Some kind of releasing device for the plough or the plough body should be used. There are tractors with automatic releases for mounted ploughs. One type of releasing device lets the plough automatically swing backwards when it strikes an obstruction. The plough is reset by backing the tractor. With another type the plough swings up and returns by itself as soon as it has passed the obstruction. Tractor-mounted ploughs often have a toggle joint. When the plough hits an obstruction the joint is released and the plough turns up. The toggle joint is relocked when the plough is clear of the obstruction.

10.3. The drawbar on a trailer plough is often fitted with a spring-tipped coupling. This should be adjusted so that it releases the bar if the plough gets stuck and is unable to turn up.

10.4. If they are to function properly, the releasing devices must be adequately lubricated and maintained. If, after its seasonal work is finished, the plough is stored without the necessary cleaning and lubrication, its releasing device may be damaged by



rust. Before a plough is taken into use the device should be thoroughly inspected, and it should be examined from time to time during the working season.

10.5. A plough should not be hitched to the upper hitch point of the power lift but to the drawbar. Because a high hitch on a tractor may increase its traction when pulling a plough, some people use such a high hitch point that the front end of the tractor tends to rise. This increases the danger of the front wheels leaving the ground and the tractor tipping backwards, if no preventive measures are taken. Weights on the front wheels are sometimes used to counteract rearing.

## HARROWS

10.6. Spike-tooth harrows and spring-tined harrows do not cause much trouble from the safety point of view when used in field work. It has happened, however, that while a tractor is turning, a draw-chain has been caught by one of the rear wheels and the harrow has been pulled up against the driver. If such a possibility exists, measures should be taken to prevent the chains coming into contact with the back wheels.

10.7. Disc harrows and rotary hoes are more dangerous in field work because they are driven at a somewhat higher speed and have rotating teeth.

10.8. If anyone falls in front of a harrow, particularly a disc harrow or a rotary hoe, he may be seriously injured. No driver pulling a harrow should permit anyone to ride on the tractor or the harrow. If it is necessary to weight the harrow, only weights for that purpose should be used, never a man standing on the harrow.

10.9. Harrows should not be stored in such a way, or otherwise be so placed, e.g. in a repair shop, that people can be injured by coming into contact with sharp components such as teeth or discs.

10.10. When harrows are transported by road, care should be taken to avoid injury to persons.

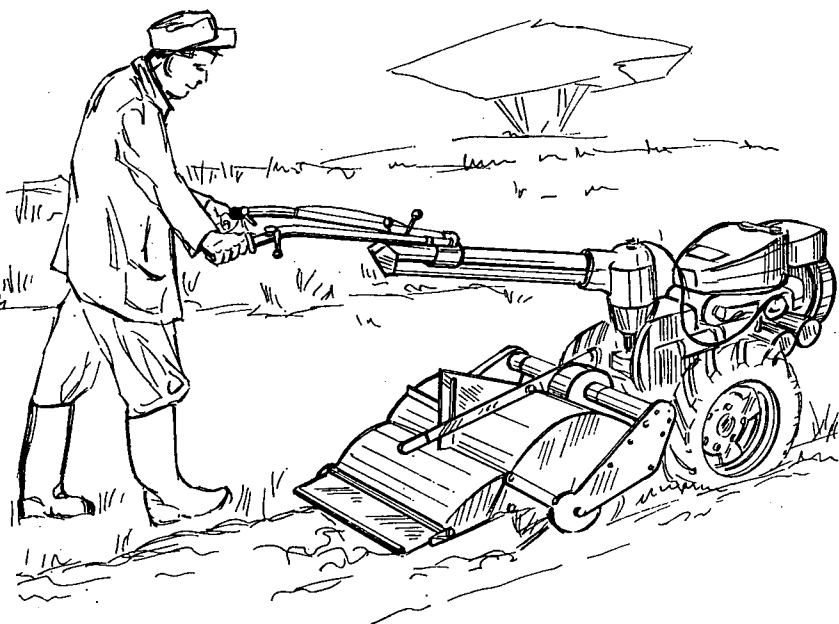


Fig. 21. Rotary cultivator properly designed and protected.

### ROTARY CULTIVATORS

10.11. If a hand or a foot comes into contact with the hoes of a moving rotary cultivator, serious injury may result. Another hazard is the possibility of being hit by a stone or a broken hoe flying off the machine. To avoid such incidents, the rotary "mill" should be protected by a hood (fig. 21). The hood should either have side-plates that cover the upper parts of the mill ends down to the shaft, or plates that extend horizontally beyond the mill ends. The cover should be strong enough to deflect stones, broken

hoes or other objects. It should be noted, however, that a hood cannot entirely prevent objects being thrown out. The operator should, therefore, see that other people, especially children, do not come near the machine. The handles should be long enough to allow the operator to keep clear of the danger zone.

10.12. Sometimes it may be necessary to remove roots twisted around the shaft. It is important that the motor should be stopped and secured against starting before any work of this kind is done. Disengaging the motor is not to be depended upon, for inadvertent engagement is possible and can cause serious injury. Motors on small machines, which can be turned by hand, may easily start if the mill is moved while the motor is engaged.

10.13. Some rotary cultivators, particularly small ones, are very noisy, and ear protection may be needed.

### MANURE SPREADERS

10.14. Manure spreaders driven by tractor power take-off shafts should, besides the regular power line protection, have any exposed revolving shaft properly shielded. The power shaft, which is often placed on the side of the box, may catch clothing and cause accidents if it is not guarded. All moving parts of the conveyor mechanism and the beater drive which project beyond the sides of the box should be enclosed (fig. 23). The enclosures should be so made that manure cannot accumulate inside the guards.

10.15. Spreaders should not be overloaded. The manure may get packed against the rear end of the spreader in front of the beaters and get stuck. This may result in a cavity in front of the spreader. In such cases people have mounted a spreader while it is in motion and tried to pack the manure. They have come into contact with the beaters either directly or by sinking down into the cavity, and the result has been the loss of legs and even death. No one should stand or ride on a spreader when in motion.

10.16. The operator must disconnect the power take-off drive before working on any of the spreader mechanisms. Disen-

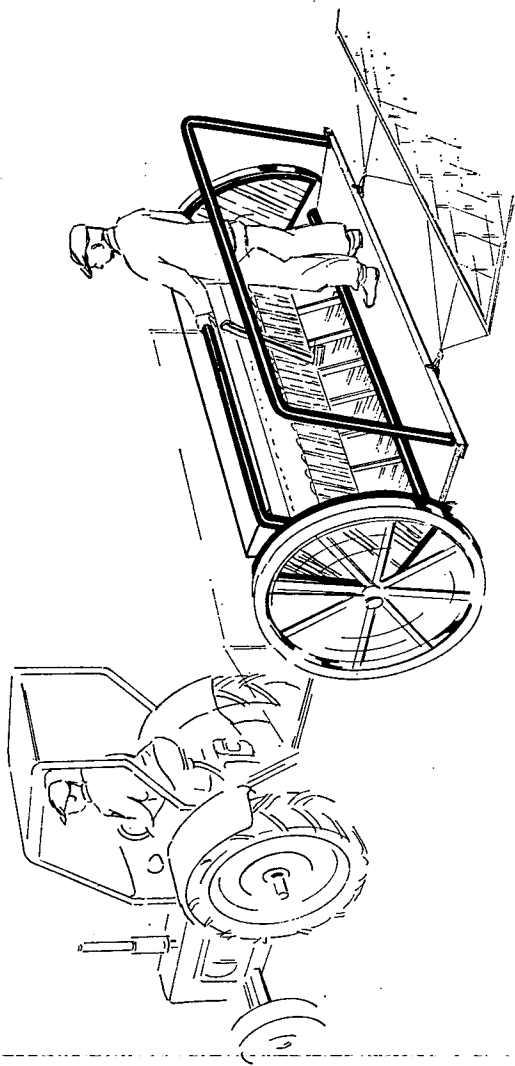


Fig. 22. Seed drill with operator's platform protected by handrail in front, rail on the back, toe-board and wheel-guard.

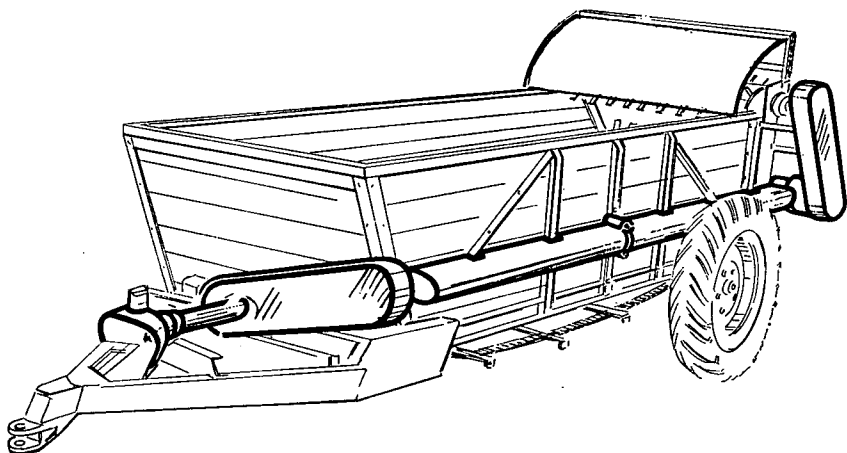


Fig. 23. Manure spreader with guarded moving parts.  
Guard for shaft on side of box.

gaging the drive is not reliable, for it can be inadvertently re-engaged.

### SEED DRILLS

10.17. The seed-feeding device at the bottom of the seed box may cause injury to persons reaching into the box. To prevent such accidents the inside of the box can be equipped with a grating, iron rods, or other guard, to prevent a hand from coming into contact with the feeding device. Such protection will not interfere with the dumping of the seed or affect seed-feeding. Furthermore, a guard of this kind will prevent a sack from being caught by moving parts.

10.18. For any helper travelling on the drill there should be a safe stand and hand grips (fig. 22).

## **11. HARVESTING MACHINES**

### **GENERAL PRECAUTIONS**

11.1. The cutter bar on harvesting machines is very dangerous. Workers standing in front of the bar when making some adjustment or doing cleaning work have been badly injured when the horses have pulled forward or the tractor clutch has been inadvertently engaged. Children playing in the grass unnoticed by the driver have been severely injured. No one should stand in front of a cutter bar unless the draught animals are unharnessed or the engine has been stopped. Children should not be allowed near the machine or in the field where the machine is working, for they do not understand the risks they run.

### **MOWERS**

11.2. Most power-driven mowers have cutter bars that can swing out of harm's way. The releasing device for that purpose should be inspected from time to time and should be kept in good condition. A horse-driven mower can be connected for haulage by a tractor. To prevent damage and accidents the drawbar should be equipped with a device that will release it if the mower strikes an obstacle. Furthermore, the tractor driver should be able to raise the cutter bar from his seat. During transport of a mower, the cutter bar should be securely hooked in an upright position and the knife and fingers should be well guarded (fig. 24).

### **ROTARY CUTTERS**

11.3. Rotary cutters employ high-speed shearing or shredding tools. The operator must be thoroughly protected from flying stones, debris or pieces knocked off the whirling tools (fig. 25),

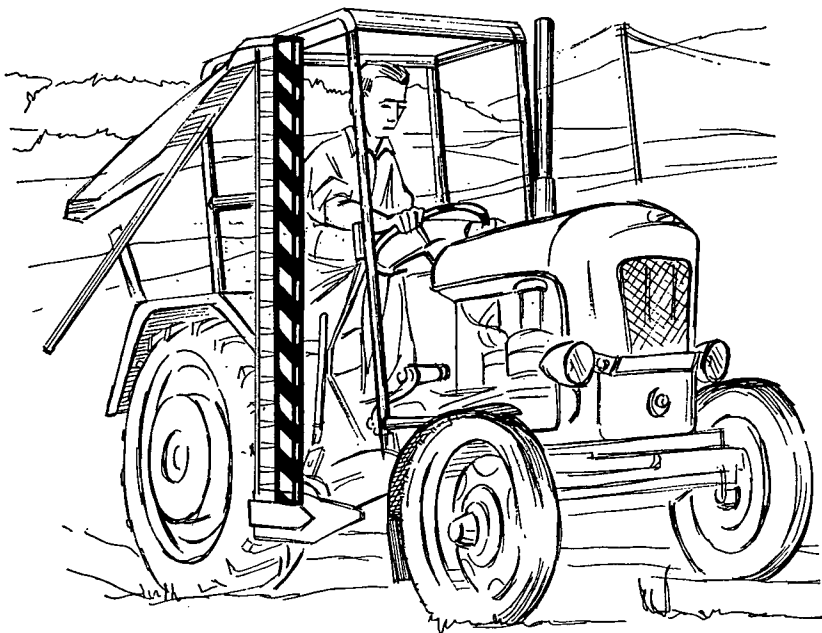


Fig. 24. Protection of a motor mower.

The cutter bar should be guarded when not in use, particularly during transport.

which can seriously injure and even kill him. The machine should be inspected to see that ample protection is provided. The guards should, as far as practicable, be so constructed that they protect not only the operator but also other people. No one should be within reach of objects which may fly off a machine since the guards cannot be made to ensure complete safety for persons on the ground. The power take-off shaft, belt pulleys, etc., must be adequately guarded in ways such as those described in Chapter 13 and Chapter 10.

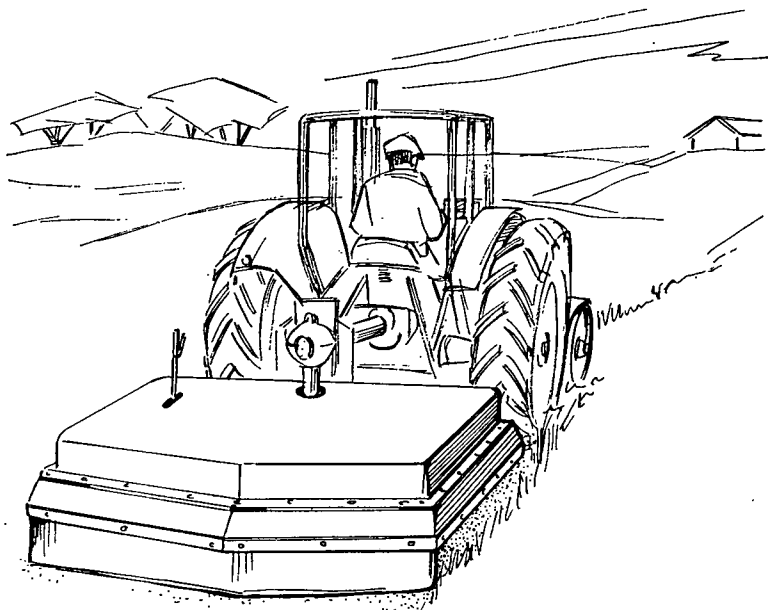


Fig. 25. A properly guarded rotary cutter.  
The lower part of the guard is made of rubber.

## COMBINES

11.4. Belts, pulleys, protruding shafts, etc., on combines should be protected on both sides of the machine. It is often thought that no one can come into contact with the side of a combine that is turned towards the cornfield when working. This is not so. At times both sides of the machine are accessible, even during static operation, and when preparing and testing a machine the operator—and possibly other people—are near it. Furthermore, a combine is often used for mobile operations, such as



swath or stock harvesting, which is another reason why it should have guards on both sides.

11.5. The cutting and feeding unit of a self-propelled combine is sometimes raised to permit a man to step under it to inspect it, adjust it, etc. The device for raising the unit may not be reliable, particularly if it is a hydraulic lift. If it fails while a man is under the unit he may be crushed. It should, therefore, be fitted with some kind of a stop with which the unit can be blocked in the upper position. No one should step under the unit unless it had been securely blocked.

11.6. The driver's seat should be comfortable, protected against heat from the engine and dazzle from the sun, and furnished with a back-rest; the means of access to it should be free from hazards (fig. 26).

11.7. A self-propelled combine is equipped with an internal combustion engine, and it should therefore comply with the requirements of Chapter 9 concerning such engines.

11.8. As a combine costs a lot of money, and a fire might cause expensive damage, it is worth while to equip it with a fire-extinguisher. Carbon dioxide, dry chemical or vaporising liquid units are suitable for this purpose.

### THRESHING MACHINES

11.9. Although threshers have mostly been superseded by combines, there are still many in use. They have caused a great number of accidents, usually due to unprotected transmissions and drums.

11.10. All accessible belt lines and shafts, irrespective of size and position, should be guarded. The belt lines should be guarded with hinged shields which are securely held in position when in use but which can easily be opened for putting the belt on, for taking it off or for changing a belt pulley. If the shield does not cover the whole belt line, it should reach sufficiently far in the belt's direction to prevent a hand or clothing from inadvertently coming into contact with the nip-point between the pulley and the in-

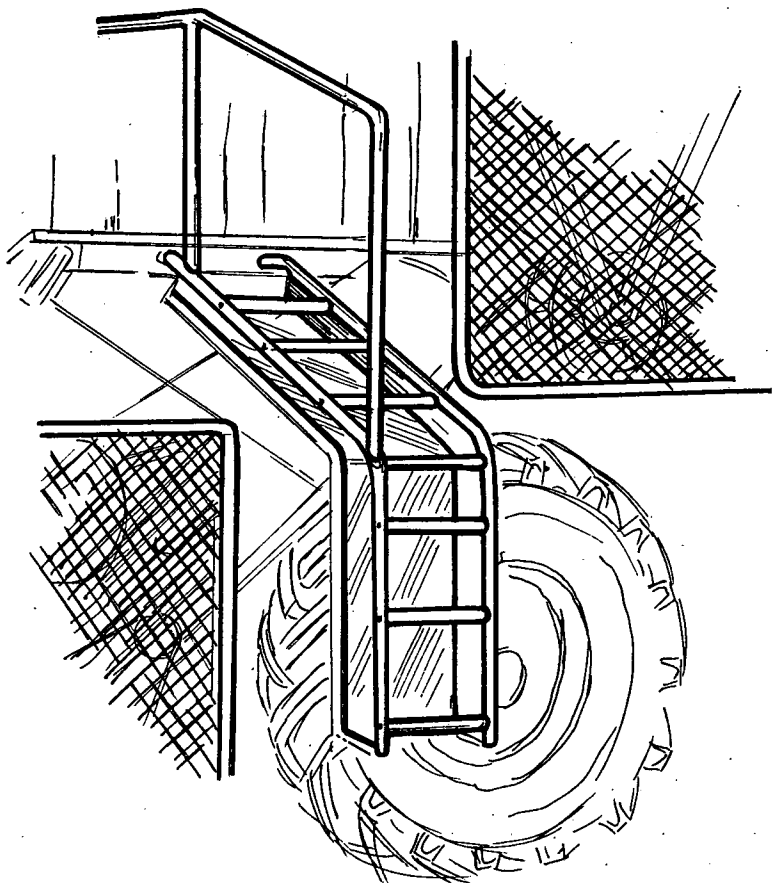


Fig. 26. Access to a combine fitted with a handrail.

A sheet-metal guard is fitted 6 in (15 cm) behind the rungs to prevent a foot from coming into contact with the moving parts.

running part of the belt. If there is a risk of the belt slipping off or breaking, as is sometimes the case with the main belt or the straw-blower belt, an iron bolt or stud will prevent the belt from wrapping round the pulley.

11.11. The drum must be carefully balanced to prevent vibration. The steel beaters should be securely mounted on the drum by bolts or by welding, or by other reliable means. Beaters should not be fastened by peg-teeth, for these may break during the operation of the thresher. A beater coming loose can cause considerable damage and seriously injure the operator.

11.12. To separate grain and chaff the thresher is equipped with air blasts. Although these are quite well enclosed, hands have been injured by the fans at the air intakes, and clothing and sacks have been pulled in by the airstream. It is easy to cover these openings with mesh that will not affect the blast.

11.13. Threshers which are fed from the end of the machine are usually supplied with a feed table. This should be so constructed that the operator cannot unintentionally touch the drum (fig. 27). No one should be allowed on any platform attached to the feed table, for there is the danger of a hand or foot coming into contact with the drum.

11.14. Threshers with the feed opening on the top of the machine have caused a great many severe accidents when the opening has been unguarded or insufficiently guarded. Operators have inadvertently stepped down into the feed opening instead of the operator's stand, or have slipped down and have lost one or both legs or even been killed. Different kinds of protective devices have been developed which reduce the hazard to some extent. Although no completely reliable construction has been devised, the use of self-feeders has practically eliminated the hazard. The self-feeder also facilitates the work and increases the efficiency of the thresher. A self-feeder should therefore always be fitted on top-feed threshers. There are, however, still some hazards involved in the use of a self feeder if it is not properly constructed. It should be well enclosed or be so arranged that the risk of an operator's inadvertently coming into contact with dangerous Parts

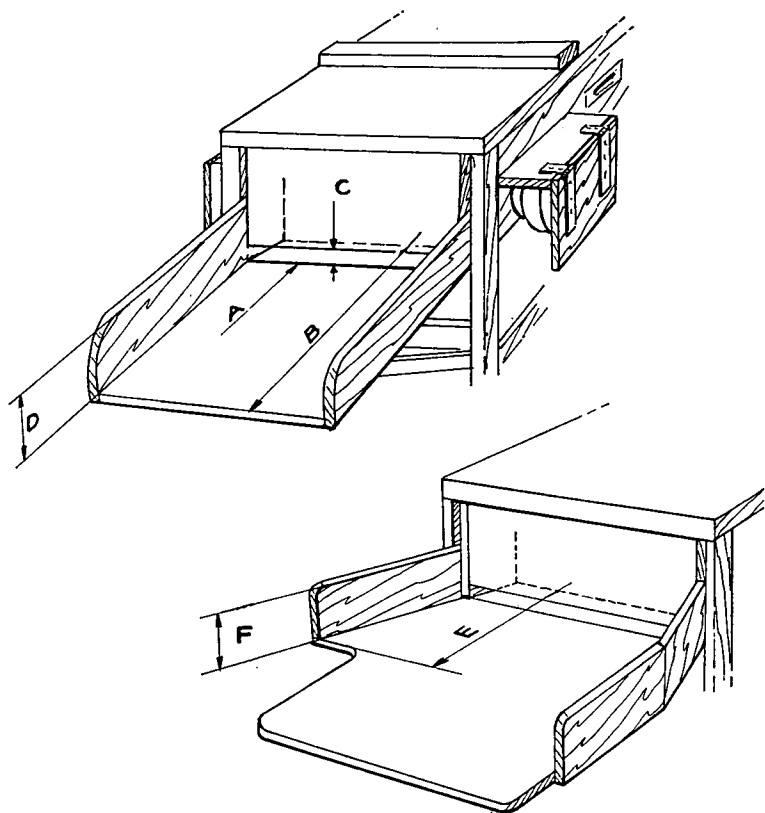


Fig. 27. Examples of feed tables for end-feed threshers.

Top: Feeding from the end of the table. Bottom: Feeding from the side of the table.

A. Distance between the opening and the drum: 12 in (30 cm). This surface is inclined towards the drum. B. Distance between the front end of the table and the drum: 39 in (100 cm). C. Opening between a loose-hanging shield and the table: 2 in (5 cm). The shield prevents grain, etc., from flying out through the opening. D. Height of side fence of table: 6 in (15 cm). E. Distance to the drum: 30 in (75 cm). F. Height of side fence of table: 8 in (20 cm).

is practically non-existent. Every self-feeder should be provided with a disengaging device, the control of which should be easily accessible and placed preferably at the level of the top edge of the feeder or above it.

11.15. The deck of every thresher on which persons work and from which they are liable to fall more than 5 ft (1.5 m) should be fenced at each end and at the side that is not being used for the movement of material. For access to the platform there should be a stout ladder or stairs of sufficient length. One of the uprights should reach about 40 in (1 m) above the side board as a support for persons stepping on or off the platform. A loose ladder should be equipped with hooks to fit over the side board.

11.16. If a chute is used for feeding the thresher, or the material to be threshed is fed through an opening in the floor above the thresher, adequate precautions should be taken to prevent people from falling into the chute or through the opening (fig. 28).

11.17. When working, a thresher should be supervised by a competent person. Before the machine is started, he should make sure that all guards are in position, and that everyone who has to work near the machine is acquainted with the hazards involved. Before the machine is started an authorised person should give a clear signal that is understood by all concerned so that anyone who might be inspecting or making some adjustment on any part of the machinery has ample time to get out of danger.

11.18. Sometimes grain or fragments fly out of the machinery towards people working on or around it, particularly towards the man who is feeding the thresher, and cause eye injuries. People who are exposed to them should wear safety goggles.

11.19. Hands and fingers have been injured when the covers of moving parts, e.g. bucket conveyors or rotary screens, have been opened for the purpose of taking samples, making adjustments or removing impurities. Covers or guards protecting moving parts should never be opened or removed while the machinery is in operation.

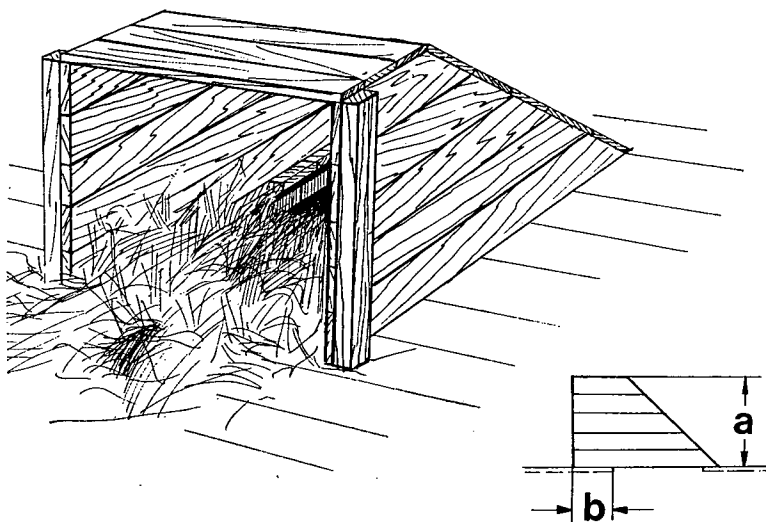


Fig. 28. Guard for a floor opening above a feed opening of a machine.

Suitable dimensions: Height of guard ( $a$ ) = 2 ft (60 cm); distance from guard opening to floor opening ( $b$ ) = 1 ft (30 cm).

## RAKES

11.20. There are many kinds of rakes or haymaking machines: dump-rakes, sweeps, tedders, reels, finger-wheels, rotating heads, etc. Although some of these machines, particularly those driven from power take-offs, involve certain dangers while in use, modern types do not cause accidents such that they call for any special measures as regards protective devices. Naturally the driver has to see that nobody rides on the tractor or the drawbar and that the power take-off guards are properly mounted.

11.21. A horse-rake should be equipped with a guard protecting the driver's foot; it should also have a rail that prevents the driver from falling forward if the machine stops unexpectedly and that he can hold on to if the horse runs away (fig. 29).

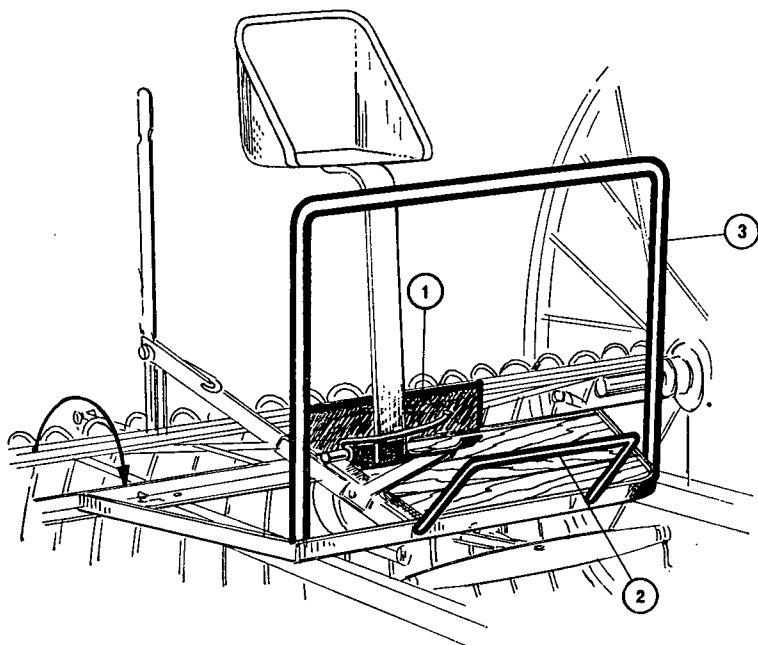


Fig. 29. Guard on horse-rake.

1. Foot-guard. 2. Foot-rest. 3. Rall to prevent the driver from falling forward if there is an unexpected stop.

11.22. Buckrakes and hay sweeps on tractors should be handled with particular caution on account of the tines. Serious injuries and even fatalities have occurred on roads when hay-loaded buckrakes have been run into by cyclists or other road users who could not see the tine points because they were covered with hay or because of the dark. When a buckrake is travelling along a road the points of the tines should be guarded.

## CHAFF AND GREEN-CROP CUTTERS AND BLOWERS

11.23. The old type of chaff cutter, hand-driven or power-driven, as well as the modern type of chaff and green-crop cutter, cutter-blower, and even the regular transport blower, have proved to be very dangerous machines. The principal risk is that of coming into contact with the knives. Hands have been drawn in by the feed rolls or by the material when the operator has tried to release jammed material. A hand holding a brush may also be pulled into a machine if a worker tries to clean near the knives when the machine is in motion. This kind of accident is serious, for fingers, hands and even arms may be injured.

11.24. Excessive speed of the cutter wheel can cause accidents, e.g. when a machine designed for hand operation is equipped with an air engine and a knife becomes loose and hits someone. A chaff or green-crop cutter designed for hand operation should not be power-driven without permission from the competent authority. No such machine should be operated at a higher speed than that for which it is designed.

11.25. All feed rolls should be covered. Feed tables should be provided with a solid enclosure on the top and both sides over a distance of at least 2 ft (60 cm) from the cutting point, or at least 16 in (40 cm) measured horizontally from the edge of the feed roller. As fingers have been caught between the ridges of the feed roll and the end of the feed table when reversing the feed, there should be a space of at least 1 in (2.5 cm) between these parts of the machine if such a risk exists (fig. 30).

11.26. Cutter wheels should be provided with solid enclosures that effectively prevent inadvertent contact with moving parts and withstand flying stones or parts torn off from the wheel.

11.27. For practical reasons the cutter wheel guard on a *hand-operated* machine should cover only the upper part of the wheel on the discharging side of the machine.

11.28. *Power-driven* wheel cutters should be provided with devices by which the feed can easily be stopped and reversed from the feeding point (fig. 31). If the machine is not provided



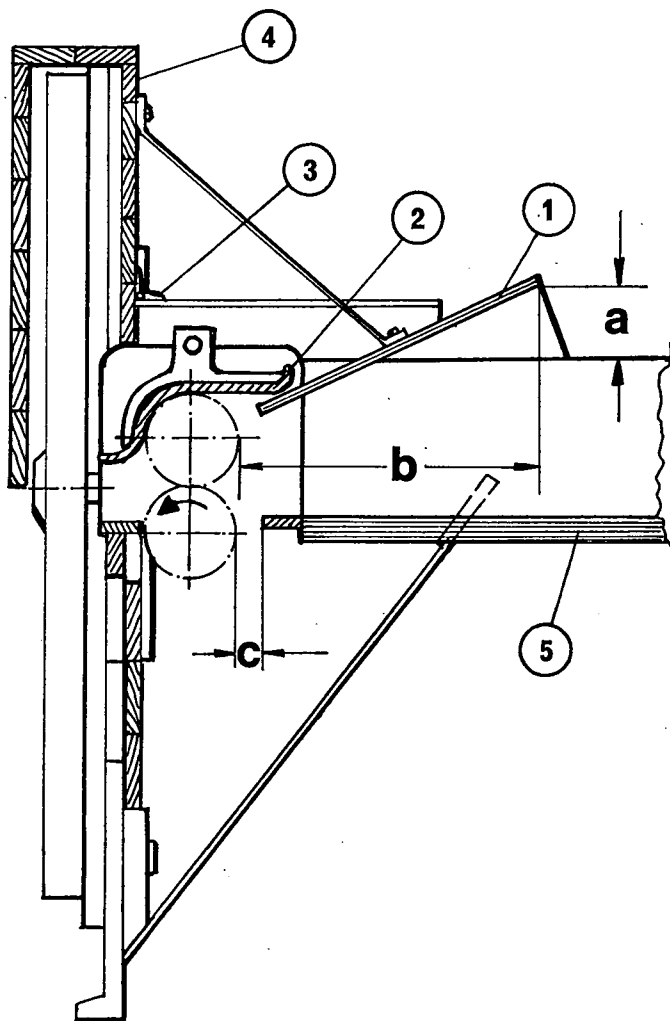


Fig. 30. Section through an old type of chaff cutter.

1. Hood in front of feed rolls. 2. Guard over the feed rolls. 3. Hinge attaching gear hood to wheel-guard.  
4. Wheel-guard. 5. Bottom plate. (a) =  $2\frac{1}{4}$  in (7 cm); (b) = 16 in (40 cm); (c) = 1 in (2.5 cm).

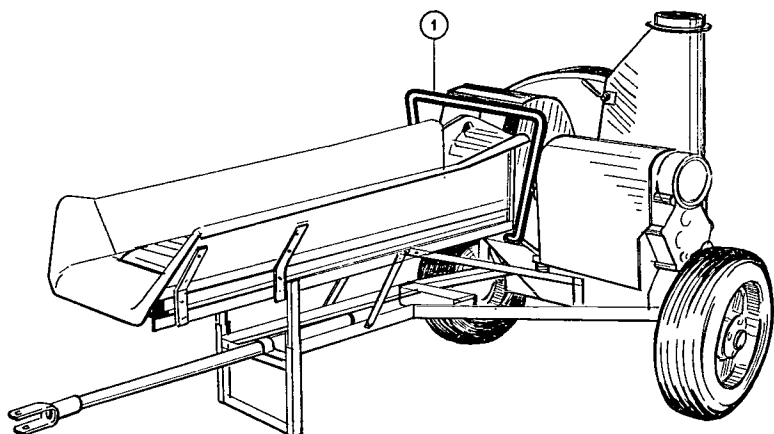


Fig. 31. Power-driven wheel cutter with feed conveyor.

All moving parts are properly guarded. 1. Handle which when pushed in the feeding direction stops the feed and reverses it.

with a hood of sufficient length over the feed table, the control of the stopping and reversing device should be by a bar on the front side of the rolls so arranged that if it is lightly pushed by a hand or an arm the feed is stopped and reversed.

11.29. Conveyors, chains, sprockets, etc., should be adequately protected at all points where inadvertent contact may cause injury. Uncovered conveyors should be of sufficient height to prevent anyone falling down into the trough. A distance of 4 ft (1.2 m) or more between the ground and the top of the trough is common.

11.30. A great many cutter-blowers and transport blowers are fitted with feed hoppers. The cutting tools or the blower fans of these machines are often uncovered and constitute a serious danger.

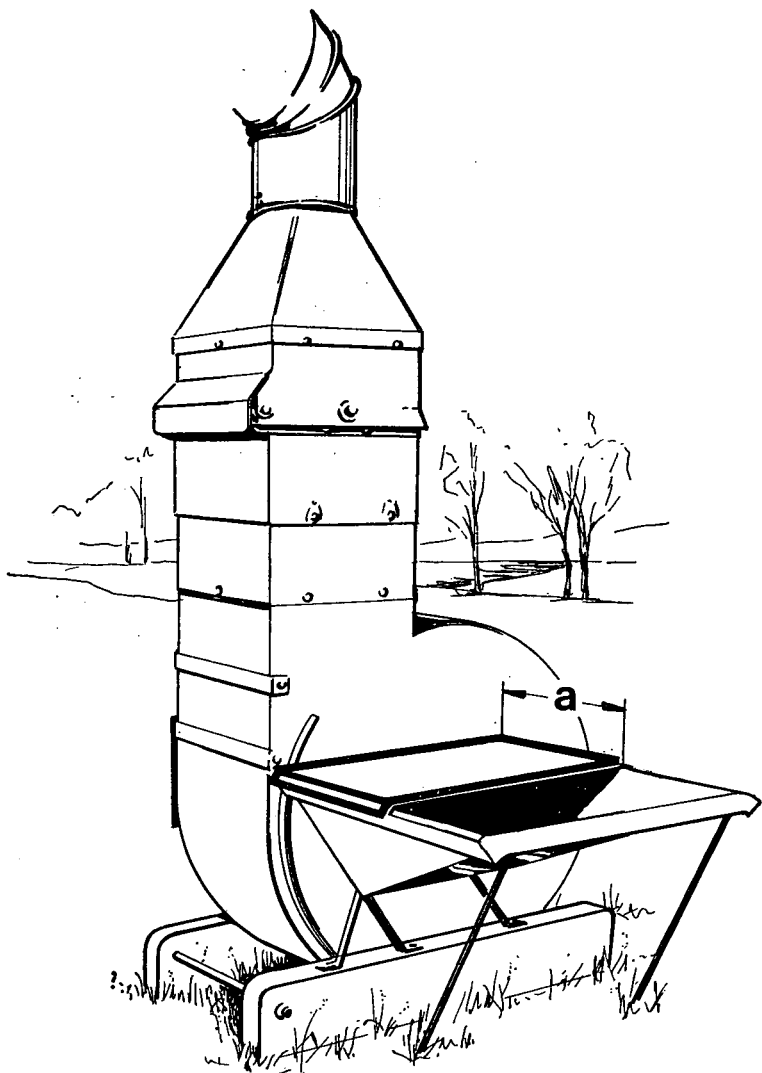
11.31. Feed hoppers should be so constructed or guarded that accidental contact with moving parts is prevented. This can be accomplished by covering part of the hood so that the distance between the moving parts of the machine and the edge of the cover is at least 2 ft 6 in (75 cm); or by making the hopper at least 4 ft (1.2 m) high, measured from the ground, and the distance from the edge of the hopper down to the moving parts at least 16 in (40 cm); or by other means giving similar protection.

11.32. Apart from those mentioned above there are other safe feeding devices, e.g. a short pipe adapted to the blower opening. The shortest distance between the moving parts and the outer edge of the pipe should not be less than 2 ft 6 in (75 cm) (fig. 32). If the pipe opening is near the ground, it is sometimes provided with a hinged cover by which the opening can be shut if the machine is left for a moment while running. This is done to prevent small animals or birds, e.g. poultry, being sucked into the machine.

11.33. At the outlet of the rotary cutters accidents have happened by inadvertent contact with the knives from below. To prevent such accidents, a distance of 12 in (30 cm) between the lower edge of the outlet and up to the lowest point of the rotary cutter is maintained.

11.34. Cutters or blowers are often placed in such a way that people feeding them stand on a higher level than the top of the feed table or the hopper and thus run the risk of falling down onto the table or into the hopper. If it is necessary for persons to feed a machine from a higher level than its base, protective measures should be taken to eliminate the risk of their falling onto or into the feeding device. A machine should not be placed unguarded close to a stack, nor should a loaded cart be stopped close to a machine for unloading. A safe distance must be maintained. A conveyor or a man on the ground is often employed to do the actual feeding.

11.35. Inadequately guarded chaff cutters used with combine harvesters or threshing machines have caused accidents when people inspecting the discharge from the machine above or below



**Fig. 32. A roller cutter guarded above the fan outlet.**

The cutter is entirely enclosed; the hopper is covered 30 in (75 cm) from the wheel (a) to prevent hand injury from accidental contact.

the cutter come into contact with the knives, or when a hand has been pulled down into the cutter in trying to clear straw which has become jammed in the hopper. A chaff cutter used with a combine harvester or threshing machine should be so installed that there is no uncovered opening between the other machine and the top of the cutter and no possibility of anyone coming inadvertently into contact with the knives from below the cutter.

11.36. Cutters and blowers can easily start fires if hay, straw or twine becomes twisted around shafts and other rotating parts and the friction creates enough heat to ignite the material. The machines should be inspected from time to time to prevent this. All parts that are liable to catch and twist hay, etc., should be shielded to prevent the material coming into contact with them. A belt-driven machine may cause a fire if the belt slips. If a blower or cutter wheel is out of line and rubbing against the inside of the hood, as sometimes occurs with old machines, the friction may cause fire. Also, foreign bodies which have got into machines have started fires by sparks.

### BALERS

11.37. There are two main types of baler—stationary and windrow pick-up. The stationary baler can be moved from place to place but does not pick-up windrows. The pick-up baler can also be used for stationary work. The two types are equally in need of safety measures.

11.38. A baler has a number of moving parts which, if not adequately protected or safe by position, constitute hazards. Accidents that have occurred include feet crushed by the plunger, hands or arms squeezed by the needles, and other injuries caused by the crank and the transmission.

11.39. Before a baler is put into use, the machine should be inspected to find the points where accidents may occur. As with other machines the chances of injury may be reduced by the wearing of tight-fitting clothing and by the enclosure of

all moving parts that can cause accidents, e.g. transmissions, link motions, cranks and feeding and binding mechanisms. There should be no openings or slots through which fingers or a foot can enter and come into contact with moving parts.

11.40. If the machine is so constructed or placed that people working at it or passing near it can fall into the feed hopper, feed track or ram track, measures must be taken to prevent such accidents.

11.41. If necessary to prevent the hand or fingers from being squeezed when the needle is threaded, a strong shield should be mounted at the side of the needle and as close to it as practicable (fig. 33). A distance of 1 in (25 mm) from the needle is usual. It should not be possible to put a hand above the needle. People have been severely injured when the needle has moved unexpectedly. The knotter drive should have a device for disengaging the needle and it should not be threaded unless it is disengaged.

#### PREPARATION OF FODDER

11.42. Many types of machines are used for chopping, shredding, crushing and grinding fodder. The tools in these machines are mostly knives, pegs or hammers mounted on wheels or cylinders, or rolls, millstones with ejector wings and the like. All these tools can cause injuries when persons accidentally come into contact with them. All the machines in question should be so constructed and protected that a person working at one cannot inadvertently come into contact with the moving parts. Protective devices such as hoppers, grids or railings can be used. A hopper with an unguarded opening should be of such a height that the moving parts cannot be reached. If a person can come into contact with dangerous parts at the discharge end of the machine suitable protection should be provided there.

11.43. Hoppers should, as far as practicable, be so constructed that material does not jam. Wooden hoppers, e.g. of peat-litter grinders, can be lined on the inside with sheet steel

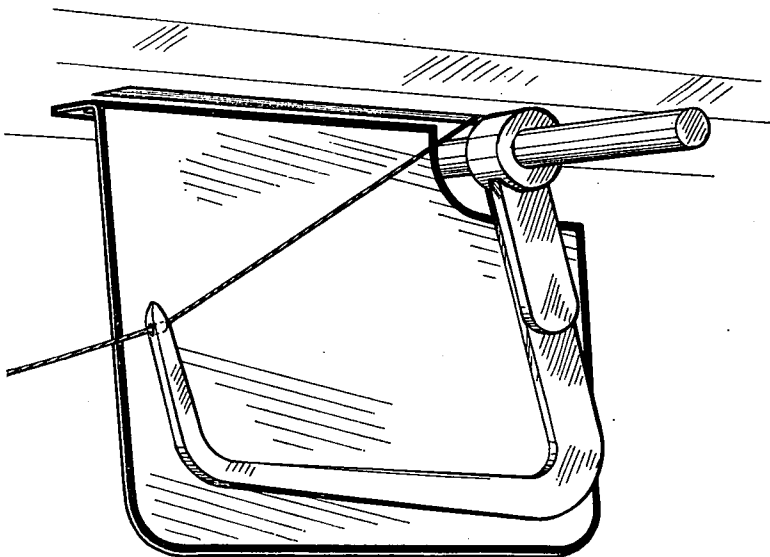


Fig. 33. Guard for a baler needle.

A stout shield close to the needle prevents a hand or fingers from passing above the needle and being crushed when the needle unexpectedly swings upwards. However, a baler should be provided with a device by which the needle can be disengaged while being threaded, and the device should be automatically locked in the off position.

or other suitable smooth-surfaced material. Such lining often has the advantage of preventing the jamming of processed material at the discharge of the machine.

11.44. Material must never be fed in by hand. If pushing, loosening, scraping or other handling of the material in the machine is necessary, a suitable device, such as a rammer, should be used. The device should be chained to the machine to prevent it from being taken away.

11.45. If a machine is installed with the feed opening in or under the floor, the opening should be guarded with a suitable

protective hood, and the machine so installed that its moving parts cannot be reached through the opening by a foot. As a protection, a grid covering the opening can also be used, if it is so arranged that a hand or a foot cannot reach moving parts through the grid.

11.46. The danger of fire when a belt-drive slips has already been mentioned; it is particularly grave in the case of machines such as grain mills, which are often left working unattended. Belts should therefore be well stretched. Fodder-processing machines should be looked at periodically when working.

11.47. Hammer mills run at very high speeds and must therefore be of strong construction. The cover should be strong enough to prevent broken parts of hammer heads and other heavy objects from flying off. Foreign bodies entering the mill can cause fire or explosion, but the provision of a magnetic separator at the feed inlet will reduce the risk of such accidents. Hammer mills grinding dry material into powder present a dust explosion hazard. In some countries there are regulations regarding the construction and siting of such machines. Instructions should be obtained from the manufacturer regarding the precautions to be observed in their use.

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## 12. SOME OTHER MACHINES

### CROSS-CUTTING LOG SAWS

12.1. The standard of fencing for cross-cutting log saws should be the same as that for woodworking circular saws as specified in Chapter 19.

12.2. To hold the log securely, a feeding appliance, such as a rocking or swinging frame or a roller table, should be provided. Figures 34 and 35 show the two kinds of feeding appliance.

12.3. A saw is sometimes used for both cross-cutting and ripping. Cross-cutting saw blades and rip-saw blades have different types of teeth and each type should be used only for the work it is designed to do. General-purpose saw blades for use in machines for both rip-cutting and cross-cutting are available.

12.4. The ground or floor around a log-cutting saw should be kept in good and level condition, and as far as possible free from chips and loose material, and it should not be allowed to become slippery.

### WOOD-SPLITTING MACHINES

12.5. Wood-splitting machines with an up-and-down motion should have a distance between the axe in its lowest position and the table of at least  $2\frac{3}{4}$  in (7 cm), which is considered the minimum safe space for the operator's hand. To prevent the wood from slipping it is advisable to have a grooved table on which it can be placed for splitting.

12.6. A guard should be provided to prevent the connecting rod or shaft from falling forward in case it breaks, and a screen or other device should retain flying pieces of wood.

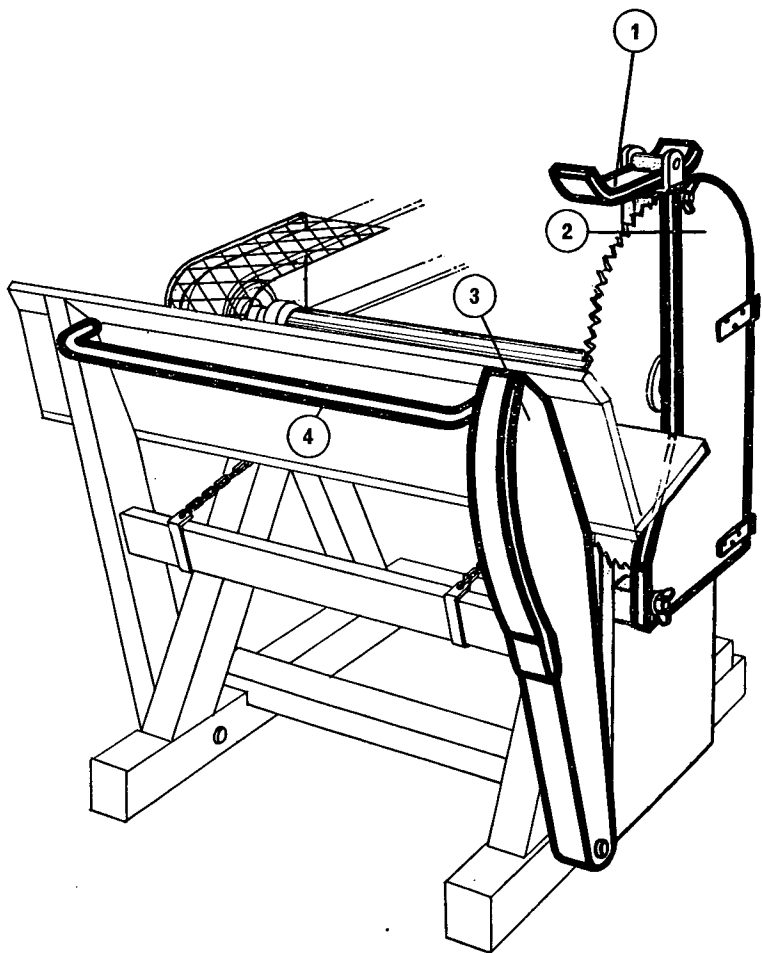


Fig. 34. Cross-cutting saw with rocking frame.

The saw-blade is guarded, except for the part used for sawing. 1. Flat metal guard which will be raised if a large piece of wood is pushed against it, but cannot be raised so far that it does not fall back by itself into the protective position. 2. Front of the saw-blade guard which can be opened for changing blades. 3. Rocking frame, constructed to hold the wood firmly and give adequate protection for the blade. It should extend outside to the right of the blade so as to give good support for the wood being cut. 4. Hand grip.

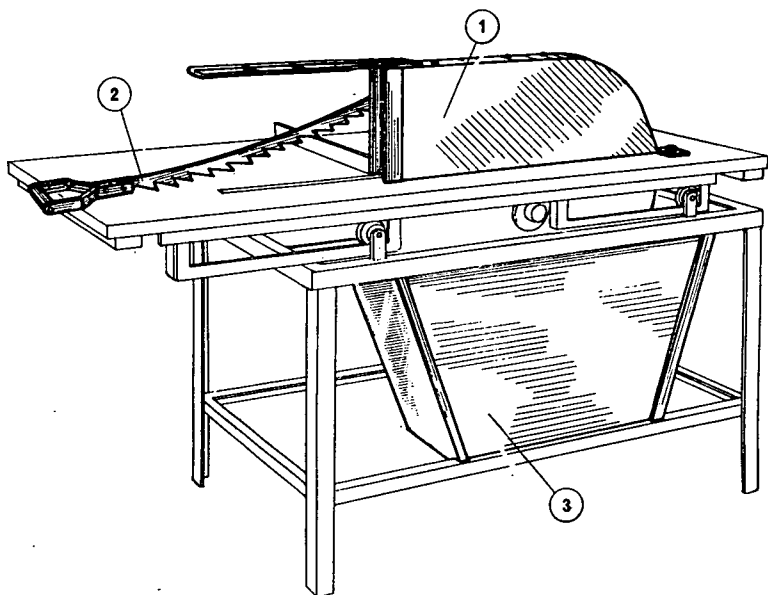


Fig. 35. Cross-cutting saw with roller table.

1. Hood. 2. Device for holding wood. 3. Fixed hood open at the bottom for discharging sawdust.

The frame is provided with a stop preventing the table from moving so far that the hood opening passes the back edge of the blade. The construction of the rails prevents the table from tipping.

12.7. On rotating axe-wheel machines the axe-wheel should be covered by a hood that has openings only for the belt drive and the splitting work.

12.8. The axes should be so designed that they are not likely to throw the wood out of the machine against the operator. This can happen if the axe edge is slightly inclined so that its outer point strikes the wood first. As the wood is held horizontally in the machine, the table or support for the wood should have a slightly concave form, with grooves to make it easier for

the operator to hold the wood in position. The back of the table or support should be provided with a stop to prevent the wood from coming into contact with the wheel.

12.9. In recent years a wood-splitting machine with a conical screw has become common. This machine is not a safe one because the fast-running screw can sometimes catch a glove or clothing and cause injury. If a piece of wood is fed in with its end against the screws, it easily starts rotating and may be thrown out of the machine. For protection and efficiency the machine should be provided with two wedges with sharp edges at the front end to prevent loose material from wrapping round the screw. The space between the wedges and the screw should not exceed  $\frac{1}{16}$  in (2 mm). The wood should be held at the top when fed into the machine. A solid guard on the front of the table protects the operator from coming too close to the screw.

#### BRUSH-CUTTING SAWS

12.10. A brush-cutting saw is equipped with a circular blade and is as dangerous as any other circular saw. As it is carried around by the operator it is dangerous to others who are near him. When the operator is running the saw, he should realise that he is responsible for seeing that nobody is too near. The minimum safe distance from the saw is 16 ft (5 m).

12.11. It is difficult to fit satisfactory guards on a brush-cutting saw, but a shield behind the blade (fig. 36) is used as protection for the operator. It is so designed as not to trap sticks or twigs between the guard and the blade. During transport of the saw the whole blade should be guarded.

12.12. It should be possible to stop the machine quickly by means of a device such as a handle or a trip-bar. Saws driven by an internal-combustion engine must have a device that automatically prevents the blade from running when the engine is ticking over.

12.13. The saw should be inspected at regular intervals when in use to ensure that the blade is rigidly attached and is

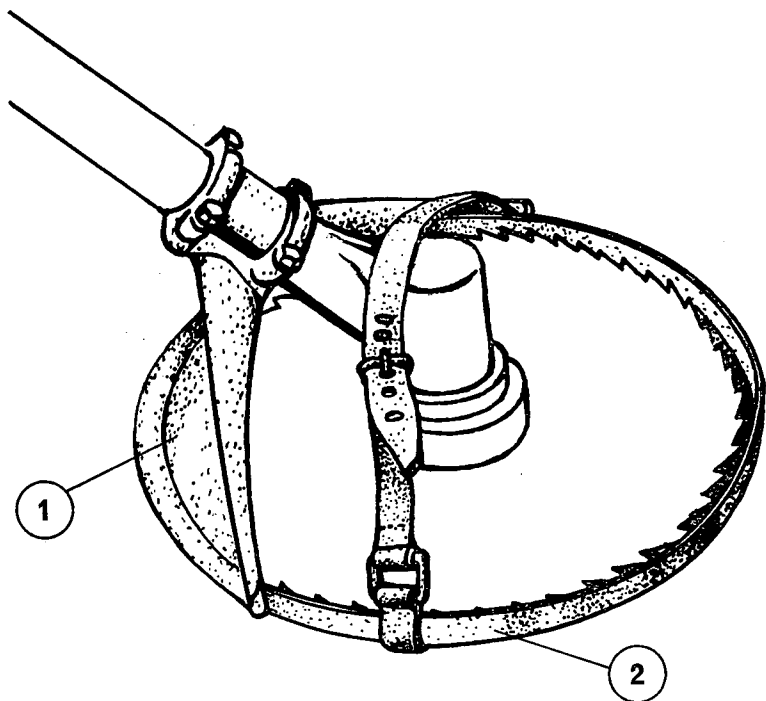


Fig. 36. Brush-cutting saw.

1. Shield behind the blade. 2. Guard to be attached when the saw is not in use.

free from cracks. The coupling must be kept properly adjusted. No cleaning, adjustment or other work should be done around the blade while the saw is in motion.

12.14. Only blades intended for brush-cutting should be used and they should be kept sharp, properly set and perfectly circular.

12.15. Care is needed with fuel. Spilled fuel is easily ignited by a spark, e.g. when starting the motor. The motor must not be run indoors, for the exhaust gases are poisonous.

### ROTARY LAWN-MOWERS

12.16. A great many rotary lawn-mowers are now used for cutting grass around homes and in parks. They have proved to be dangerous machines and have caused a large number of injuries. Generally the accidents have occurred when the operator has taken hold of the lower edge of the hood and had his fingers cut by the rotating knife, or when the machine has slipped backwards on a slope and run over the operator's foot or in some other way brought him into contact with the knife. Another unpleasant habit of the machine is to shoot out stones hit by the whirling knife, occasionally followed by a broken knife. These objects can be thrown off directly or rebound at high speed, causing nasty injuries if anybody is hit. A properly guarded machine with the hood reaching sufficiently below the level of the knife to a distance of about  $\frac{3}{8}$  in (1 cm) from the ground retains flying objects and protects the knife.

12.17. The following rules should be observed:

- (1) Do not attempt to move the knife unless the cable to the spark plug is removed. Otherwise the motor may start.
- (2) Do not leave the machine with the motor running.
- (3) Keep hands and feet away from the knife while the motor is running.
- (4) Never permit a child to operate the machine. Keep children at a distance to avoid their being hit by flying objects.

12.18. Rotary lawn-mowers provided with cutting devices suitably guarded to avoid the hazards mentioned above are available and should be preferred.

### CENTRIFUGES

12.19. Accidents with centrifuges have occurred when persons have attempted to brake and stop the rotating drum by hand, adjust the material in the drum while in motion, or slipped and got a hand inside the drum. In such cases the material in the drum, particularly clothing, has trapped the hand and injured the arm.

12.20. In order to prevent accidents a centrifuge should be supplied with a lid fitted with an interlocking device that prevents the machine from being started while the lid is open and the lid from being opened before the drum has come to a stop.

12.21. It is essential that the drum should not be run at higher speeds than that indicated by the manufacturer and the brake should be kept in proper adjustment. Nothing but the brake should be used for stopping the drum.

### VENTILATING FANS

12.22. Ventilating fans have high speeds, and the fan blades are almost as dangerous as rotating knives. If a hand or finger comes into contact with the blades serious injuries will result. If a blower or a ventilator is so situated that the blades are within reach of the floor or a platform or are easily accessible, they should be entirely enclosed, preferably by stout wire netting. The mesh should be small enough to prevent fingers from coming into contact with the blades, and no opening should exist between the protection and the ring around the blades. Radiator fans on internal combustion engines are sometimes so situated that they constitute a danger for persons attending the engine and should be protected. Sometimes a sheet-iron ring mounted around the circumference of the fan and extending at least 1 in (25 mm) in front of the blades, is sufficient for practical purposes. If necessary, the nip-point between belt and pulley should be guarded.

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## 13. TRACTORS

13.1. A tractor is one of the most important machines on a farm and it is also one of the most dangerous if it is not carefully handled. A large proportion of accidents on farms are due to tractors.

13.2. No person should drive a tractor until he has been fully instructed by a competent person. No children should at any time be allowed to drive or even ride on a tractor. Nor should any other person ride on a tractor unless steps are taken to ensure his safety, including the provision of a seat. Many persons have been severely injured or even killed through slipping off the drawbar or other unsuitable foothold on a tractor or a drawn vehicle.

### RISKS

13.3. The most common accident is that due to the tractor overturning either sideways or backwards. About half of such accidents are fatal.

#### *Overturning Sideways.*

13.4. The stability of tractors depends, among other things, on the position of the centre of gravity and on the wheel-base. Some implements mounted on the tractor, e.g. loading gear, may raise the height of the centre of gravity and increase the risk of overturning sideways. A raised bucket can easily cause the tractor to tilt if a wheel is passing over a stone or drops into a rut.

13.5. In unfavourable driving conditions a tractor can overturn sideways quite easily. Among causes are underestimating the risk, mistakes in judging the terrain (e.g. slopes, ditch sides, stones and stumps), turning too fast and using the brakes on drawn vehicles at soft spots in the ground.



13.6. Many tractor drivers use too narrow a headland close to ditches and steep places when ploughing. Further, if the soil is wet and churned up, the tractor does not easily follow the steering. One of the wheels may sink down at the edge, causing the tractor to overturn. To avoid accidents, the headland should be sufficiently wide and never less than 25 ft (8 m).

13.7. If a tractor is hauling a heavy vehicle or a machine which cannot be adequately braked downhill, the vehicle or the machine will press against the tractor, causing it to slide sideways and overturn. It is most advisable to put the tractor into low gear *before* going downhill. Brakes should always be used on drawn vehicles or machines. The control of these brakes should be so arranged that the driver does not have to turn around to operate them. It is obvious that when brakes are used the driver has his attention directed forward, and the control of the tractor should not be disturbed by his having to turn round to reach a brake lever.

13.8. When the differential lock is engaged, the steering wheel has little turning effect on the tractor, and accidents have happened when the driver has forgotten to disengage the lock and the tractor has run into a ditch and overturned. If the lock is hard to disengage, the driver must be prepared to disengage the clutch in good time.

#### *Overturning Backwards.*

13.9. Overturning backwards can occur unexpectedly and is rapid. In some cases complete overturning is possible in half a second. The driver hardly has any chance of stopping the rearing in time to prevent overturning.

13.10. A tractor's motor power is transmitted to give a high torque on the axle shaft, i.e. a high pulling force. If the tractor meets too high resistance when pulling, it will rear. This, of course, is only possible if the back wheels have enough hold on the ground, otherwise one of them will slip.

13.11. A common cause of rearing is hitching a load too high, e.g. at the attachment point for the top link. The load will

lift the front end of the tractor. Even if the load is not heavy, the towed vehicle may be blocked by a tree, a corner of a building or in some other way, and so overturn the tractor. High hitching is thus dangerous. A point as low as possible should be used, always lower than the back wheel shaft. It should not be assumed, however, that low hitching will always give safety against rearing. Haulage chains should never be fastened around the axle.

13.12. If the back wheels of a tractor stick in a hole, no attempt should be made to get them out by jamming the wheels with blocks of wood or sticks, because when the tractor is started up such scotches may be forced into the ground and it may rear. Even if this method succeeds in getting the tractor out of the hole, the scotches may be thrown by the wheels towards the driver and injure him.

13.13. A two-wheel tractor trailer is more or less unbalanced and part of the trailer's weight is transferred to the back wheels of the tractor. This is a great advantage since the tractor can exert a high drawbar pull. Nevertheless, the load applied to the drawbar will lighten the front of the tractor and thus increase the risk of rearing if no measures are taken to prevent it. The trailer must, therefore, be hitched with a device that gives positive security in this respect. Several effective devices have been developed, e.g. the drawbar reaching to 2-8 in (5-20 cm) beyond the back of the back wheels or fastened under the tractor in front of the back axle.

13.14. One cause of rearing is too hasty engagement of the clutch, especially when going uphill; the back wheels are jammed on the ground. In this case the tractor should be backed. Other causes are crossing a ditch or running against a stone. Removing stones from the ground with a tractor is very dangerous unless it is backed. Rearing and overturning have also occurred in attempts to pull up ditched vehicles.

13.15. There are a number of books and pamphlets containing rules for safe tractor operation. Driving a tractor is often so complicated and includes so many dangerous or unexpected situations that even the most experienced and capable driver may

fail to avoid the hazards and so meet with an accident. A short set of safety rules is given at the end of this chapter.

#### SAFETY FRAME OR CAB

13.16. A safety device giving the driver sufficient protection when a tractor overturns sideways or backwards has been developed and has been in use in various countries for some years. After much experience it was found that the best way to achieve safety was to furnish the tractor with a protective frame or cab (figs. 37 and 38). Where the climatic conditions require a cab it should be preferred.

13.17. A protective frame or cab should have sufficient strength and be adequately fixed to the tractor so as to provide satisfactory protection for the driver and any passenger inside if the tractor overturns sideways or backwards.

13.18. Whenever possible, access to the driver's seat should be provided on both sides of the tractor. If necessary, there should be steps and handles in order to facilitate getting on and off.

13.19. The cab or frame must be constructed so as to make it easy for the driver and the passenger to get out if the tractor has overturned sideways or reared. Means of exit should be easy to open from inside the cab.

13.20. A cab on a tractor which is used for driving on frozen lakes or waterways should have the cab roof so arranged that it can be easily opened or removed from the inside. The roof should be kept open when driving on ice.

13.21. A cab or frame must, of course, be so designed that it does not prevent the usual machines, implements, trailers, etc., from being attached to the tractor. It must be spacious enough for the driver to have satisfactory freedom of movement when driving and when handling machines, implements, trailers, etc. The driver should have adequate free space at each side of the steering-wheel.

13.22. A suitable seat should be arranged for at least one passenger. Easily accessible handholds should be provided.

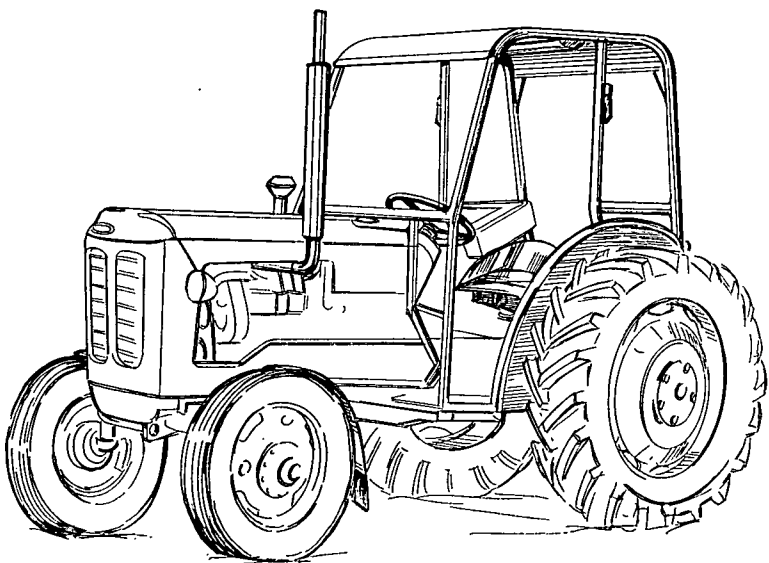


Fig. 37. Tractor fitted with a protective frame.

The frame can easily be converted into an enclosed cab by fitting it with prefabricated panels.

13.23. A cab should be provided with windows that give the driver a clear view. The window panes should be made of safety glass. Doors, windows that open and all other movable parts should be of sound construction. Further, the windscreen should be provided with an electric wiper and the cab with direction indicators. The cab should be draughtproof, but there should be provision for adequate ventilation.

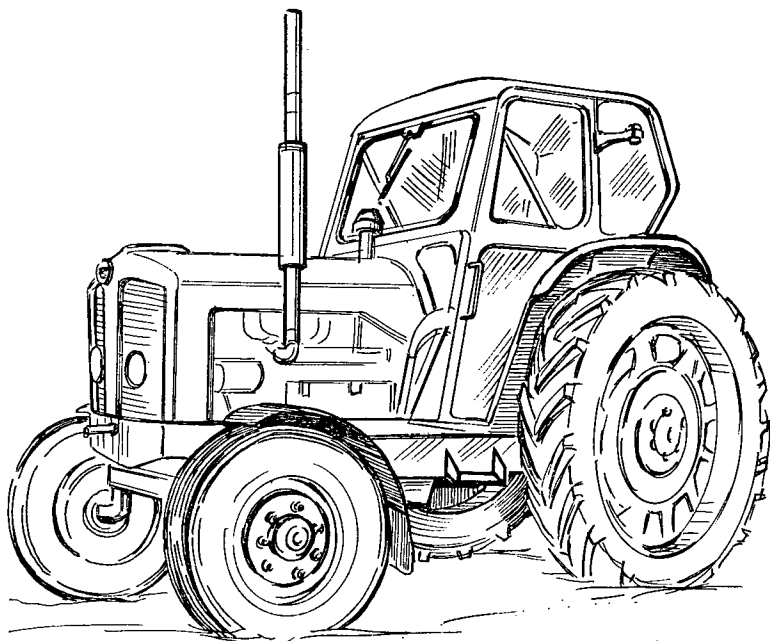


Fig. 38. Tractor fitted with a protective cab.

The cab can be partially dismantled so as to be entirely open in summertime. The exhaust pipe ends at a level higher than the roof of the cab.

13.24. The driver's cab on an agricultural tractor should be designed to enable him to carry out his work efficiently. As a rule, it should be equipped with an opening at the back whose width is at least 40 in (1 m) and extend at the most about 12 in (30 cm) behind the driver's seat so that the control levers on a machine which is attached to the tractor can be easily operated.

### POWER TAKE-OFF

13.25. The power take-off, i.e. the primary transmission gear of the tractor, is used to drive machines that accompany the tractor and also stationary machines. A splined shaft of the tractor is used for transmitting power to a machine, this splined shaft being the "power take-off" and the shaft of the other machine to which it is coupled being the power take-off shaft. This arrangement for transmitting power is known as a power line.

13.26. Power lines have caused many accidents. Uneven splined shafts and universal joints may catch clothing and pull the person around the shaft at a high speed. Severe injuries, sometimes fatal, are a common result of such accidents. It is astonishing to see how many persons pay little heed to or even realise this danger. Unguarded power lines are a menace not only to the driver and operators of the machines or implements, but also to other people and children who may come into contact with them.

13.27. A power line should never be started unless it is completely covered. The tractor should be equipped with a guard, and the driven machine or implement with guards for that part of the power line forming a part of it. The guard should be strong enough to carry a person stepping on it. As it is often used as a step it should be able to carry 260 lb (120 kg). The guard generally used for many years, i.e. the U-shaped shield, has proved to be unsatisfactory. If in place and in good condition it is sufficient, but it is not convenient to attach and furthermore is too easily damaged.

13.28. The guard shown in figure 39 is of a more reliable type. It wholly encloses the shaft, is firmly fixed to the shaft with ball bearings and is locked with chains at both ends that prevent it from sticking to the shaft, rotating with it and catching clothing. The guard is so constructed that, together with the shield over the power take-off on the tractor and the shield over the power take-off shaft of the machine or implement, it satisfactorily protects shafts and clutches at pivot angles up to 45° on each end and in both directions. As the guard is fixed to the shaft it is always in

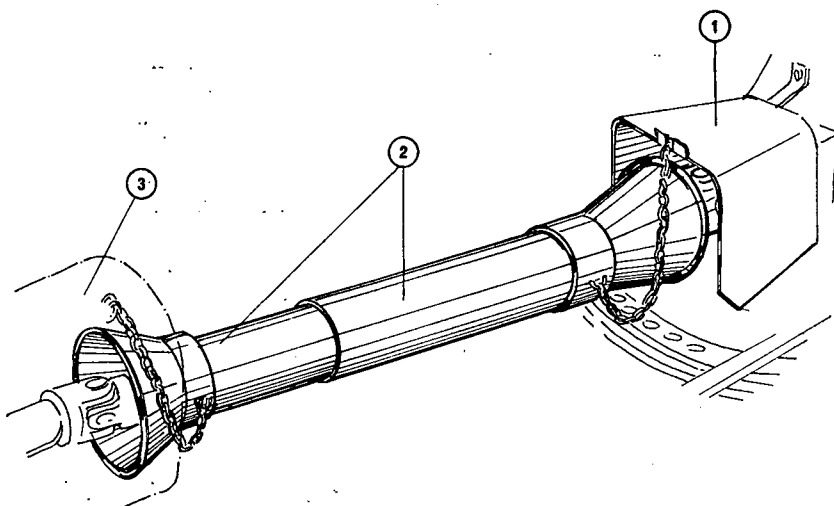


Fig. 39. Guard for power take-off shaft.

A telescopic steel pipe wholly encloses the shaft. 1. Fixed guard on tractor end. 2. Sliding cylindrical shaft guard locked by chains to prevent it from rotating with the shaft. 3. Fixed guard on end to which implement is hitched.

place, and when the shaft is connected to the power take-off on a tractor the only thing needed is to hook up the chain to the take-off guard; for that purpose a hole should be made in the guard.

### BELT PULLEY

13.29. The most dangerous point of the belt-drive, i.e. the space between the pulley and the in-running part of the belt-drive, should be protected with a nip-guard. The guard should be adjustable so that it can be set to fit all belt directions in question and be so constructed that a belt cannot be put on the pulley unless

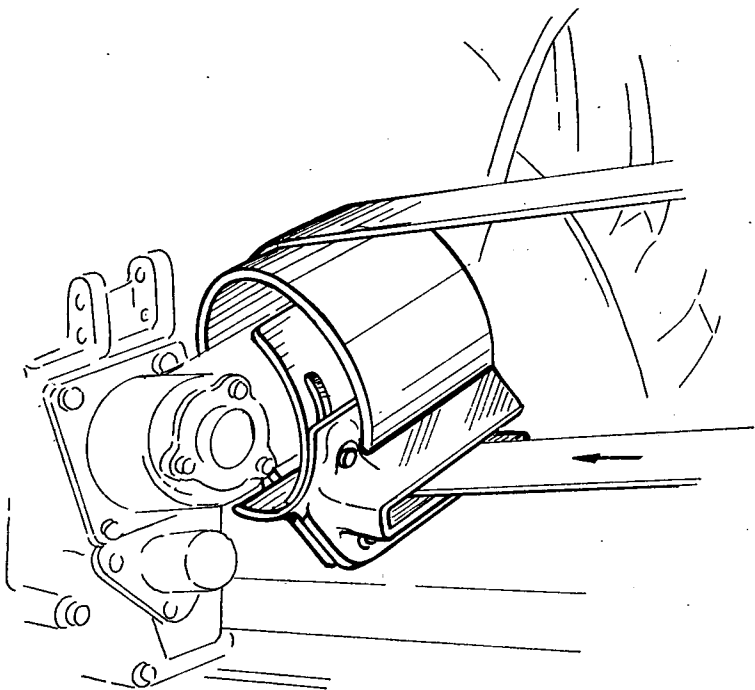


Fig. 40. Adjustable nip-point guard for belt pulley.

The belt cannot be put on the pulley unless the guard is in the right position.

the guard is in the right position (fig. 40). If the pulley is placed on the side of the tractor a shield guarding the nip-point can be used. If a belt pulley is so placed that a person is liable to step on it, a plate sufficiently strong to carry him should be fitted over the pulley. The belt from a tractor pulley has such speed and power that it should not be left unguarded. Rail guards on both sides over the entire length should be provided even though nip-point guards are fitted.



### MUDGUARDS

13.30. The back wheels on tractors have caused accidents when drivers or other persons have been caught by them and severely or fatally injured. Iron wheels are the most dangerous, but spikes and rubber tires have also seized clothing, squeezed legs or pulled persons around the wheels. To prevent such accidents and also to prevent the driver and driver's seat from being spattered with mud, tractors should be equipped with mudguards for the back wheels. They should extend beyond the full width of the wheels and sufficiently far forward to protect the driver's feet.

### EXHAUST PIPE

13.31. The exhaust pipe from the engine should be vertical and discharge at least 40 in (1 m) above the driver's seat. If the tractor is provided with a cab, the exhaust pipe should discharge above the roof of the cab (fig. 38). A low-discharging exhaust may cause the exhaust gases to accumulate in the cab when the engine is running. With a low exhaust there is also the risk of igniting straw or other combustible material on the ground.

### DRIVER'S SEAT

13.32. Many tractors are not provided with satisfactory seats. It is, therefore, important to pay attention to seating requirements. Seats of good quality, i.e. with back-rest, adjustable spring and vibration dampers, can be obtained (fig. 41).

### TRACTORS IN ROAD TRAFFIC

13.33. All necessary precautions should be taken when entering a road, and the driver should always observe the traffic signs. Tractors must be fitted with all the equipment required for driving them on a road, e.g. lights in front and at the back, reflectors, brakes, horn, windshield wipers, rear-view mirror and

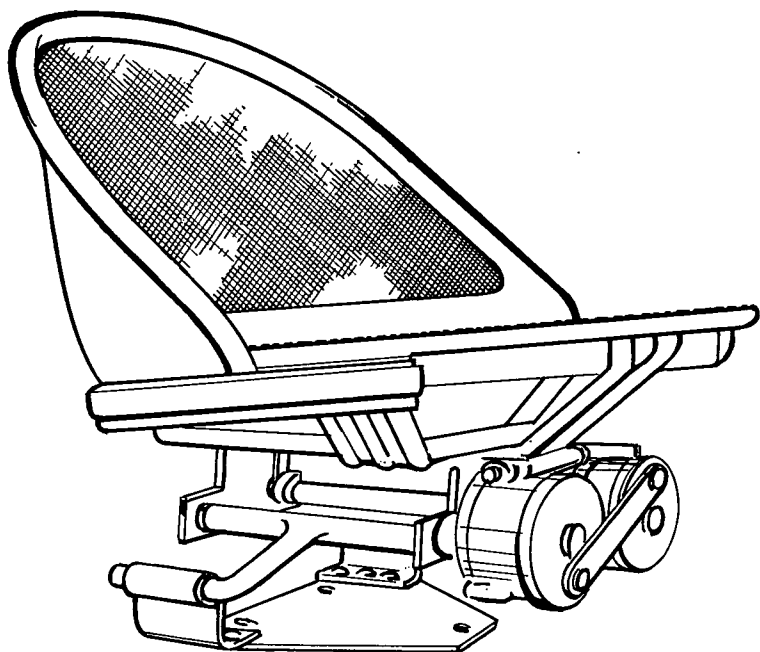


Fig. 41. Adjustable seat for tractor driver.

direction indicators, as usually prescribed in national regulations. All the rules of the road should be strictly observed. Traffic on the road should not be obstructed by a tractor and its trailer. If necessary, it should be driven to the side and other vehicles allowed to pass. The driver should be particularly watchful at unguarded level crossings. Dangerous implements fitted on tractors should be properly guarded (fig. 42).

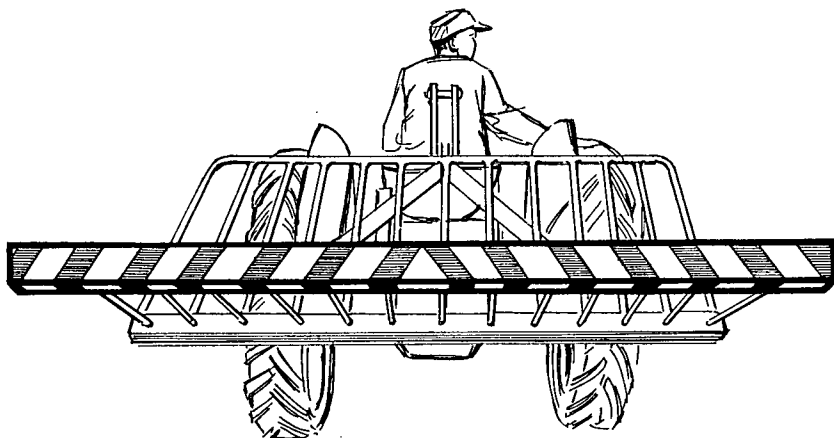


Fig. 42. Guard protecting the points of a fork-lift when not in use. The guard should also be used on a loaded fork.

## FIRE HAZARDS

13.34. As has been seen in Chapter 9, all internal combustion engines are a fire hazard on farms, and this is particularly true of tractors. The chief danger is from the exhaust igniting nearby combustible material. This usually occurs when the engine is heavily loaded and the throttle is changed rapidly. The best protection is a spark arrester. As a general rule, tractors should not be taken into buildings other than properly constructed garages (see Chapter 7), and a tractor not fitted with a spark arrester should never be driven inside a building that is not of fire-resistant construction or come too close to any flammable material.

13.35. A spark arrester works like a cyclone. The exhaust gases are whirled around inside it and the sparks are thrown towards the sides and burnt out or destroyed by being dashed against the internal surfaces. They leave the exhaust pipes as tiny harmless particles. The spark arrester does not, however, give protection against flames, which can still come out of the exhaust pipe. For this reason the discharge should not be allowed to approach within 40 in (1 m) of any combustible material.

13.36. A silencer often looks like a spark arrester but has little value in that capacity. One should, therefore, make sure that what is fitted on the tractor really is a spark arrester. Furthermore, a spark arrester should be tested and approved by a competent person or authority.

13.37. Arresters are made for specified sizes and types of engines and should not be used on engines for which they are not made.

13.38. A spark arrester can be ineffective by reason of corrosion or damage. It should be examined at regular intervals. A simple way to examine it is to shake it: if a noise is heard, something is loose and the arrester should be changed.

13.39. A tractor used in stationary work should always have a spark arrester and be placed at least 20 ft (6 m) from a building or any combustible material.

13.40. The electrical equipment on a tractor may cause fires if not properly maintained. Worn or damaged cables may cause short-circuits. As many conductors are under tension all the time, the risk can exist even if the engine is not running. It is good practice to provide the electrical system with a switch placed as close to the battery as practicable. The system can then be switched off when the engine is not used. If something is wrong when the tractor is working it is easier to switch off the current than to remove the battery cable.

13.41. If the tractor is not kept clean, and chaff or dust is allowed to remain on hot parts of the engine, it can become incandescent. The same thing can happen if straw or hay comes

into contact with the exhaust pipe. Appropriate maintenance and care will prevent fires.

13.42. When the fuel tank is filled fuel may be spilled onto the engine. If petrol is used it evaporates; its vapour is highly flammable and can be easily ignited. Spilt fuel should, therefore, be carefully dried up and the engine should not be started until a few minutes have passed. Tractors should never be refuelled while the engine is running, or is hot, or in the presence of flames, open lights or lighted cigarettes, either inside or near a building.

### SAFETY RULES FOR TRACTOR DRIVERS

13.43. It is advisable to have safety rules for tractor drivers and post them in suitable places and give each driver a copy to learn and remember. The following rules may serve as a guide:

(1) Before cranking the engine be sure the gear lever is in neutral. Otherwise the tractor will start!

(2) When hitching, use the proper coupling. An automatic pick-up hitch can be used for two-wheeled trailers and manure spreaders with small tractors. Hitch as low as practicable when pulling heavy loads.

(3) Engage the clutch carefully in order to prevent the tractor from rearing when pulling a heavy load or going up a hill.

(4) Watch out for risks ahead such as holes, ruts, obstacles, slopes, weak edges and ditch sides that may cause the tractor to overturn.

(5) Keep the tractor at speeds slow enough to ensure safety, especially over rough ground or near ditches. Reduce speed before turning or applying brakes. Use wide headland when ploughing, not less than 25 ft (8 m) for mounted ploughs and 33 ft (10 m) for drawn ploughs.

(6) Change to low gear before going down steep hills or banks, especially if the tractor is pulling a heavy load.

(7) Watch out for the risk of overturning when driving a tractor with a high load, e.g. a filled dredger.

(8) Use as wide a wheel track as practicable especially when driving the tractor in risky conditions, e.g. with loaders mounted or on rugged and steep terrain.

(9) Do not put planks, poles or similar objects in front of the back wheels to force the tractor out of a hole.

(10) Keep the brakes correctly adjusted. When driving on highways, to and from fields or in any other transport work, be sure that both wheels are equally braked when the brakes are applied.

(11) Never let anybody ride on the drawbar of the tractor or the drawn implement and do not let any person ride on the tractor unless he has a safe seat.

(12) Never start a power take-off shaft unless all power line guards are in place.

(13) Never dismount from the tractor when it is in motion.

(14) Be careful when hitching implements. Avoid standing between the tractor and the implement. If practicable use an iron hook or some other suitable equipment to handle the drawbar.

(15) Do not use a belt pulley unless it has a guard for the nip-point between the pulley and the framework of the vehicle. Use only belts with smooth surfaces and smooth joints. Fit a guard on both sides of the entire belt line. Do not put on or remove a belt from a pulley while it is in motion.

(16) Never run the engine in a closed garage, repair shop or other closed room.

(17) Make sure that the exhaust gases are discharged so as not to trouble you or any other person.

(18) Maintain the tractor in good condition and keep it clean. Inspect the tractor at regular intervals and be particular about electrical equipment.

(19) Never refuel the tractor close to a building or while the engine is running or is still hot. Avoid spilling fuel on the tractor, but if that happens, dry up the fuel, or wait until it has evaporated, before starting the engine.

(20) If the engine is overheated be careful to avoid scalding when removing the radiator cap.

(21) Use a reliable spark arrester and inspect it at regular intervals. Do not mistake the silencer for a spark arrester.

(22) Do not keep the tractor in a room which does not comply with existing regulations or standards for a garage.

(23) Keep children away from the tractor.

## **14. OTHER VEHICLES**

14.1. A great number of accidents have occurred during transport of persons on farm vehicles to or from the job. Most of these accidents could undoubtedly have been avoided if people had been acquainted with the hazards and had taken elementary precautions. Farm vehicles should be of solid construction, and if they are to be used on public roads should comply with all the official traffic regulations. Possible causes of accidents are faulty construction, defective brakes or lights, careless driving, overloading, unsafe methods of carrying persons or loads, inadequate brakes and poor maintenance. The risk of a tractor overturning when hauling loaded vehicles has been dealt with in the previous chapter.

### **FLOORS AND SIDES**

14.2. Sides and tailboards must be securely hinged and locked. The locking device should be easy and safe to handle but must not be able to open by itself. The corners of the platform and boards need to be rounded in order to limit injury or damage in case of a collision. If stanchions are used they must be of substantial construction and not have any sharp points. Stanchions that are to be removed or laid down for unloading the vehicle should be equipped with a locking device that can be released from a safe place, preferably from behind the vehicle.

### **SEATS**

14.3. Vehicles on which the driver or any other person has to travel should have a safe and convenient seat for each person. The seat should be comfortable and provide sufficient protection in an emergency stop or other unexpected movement of the



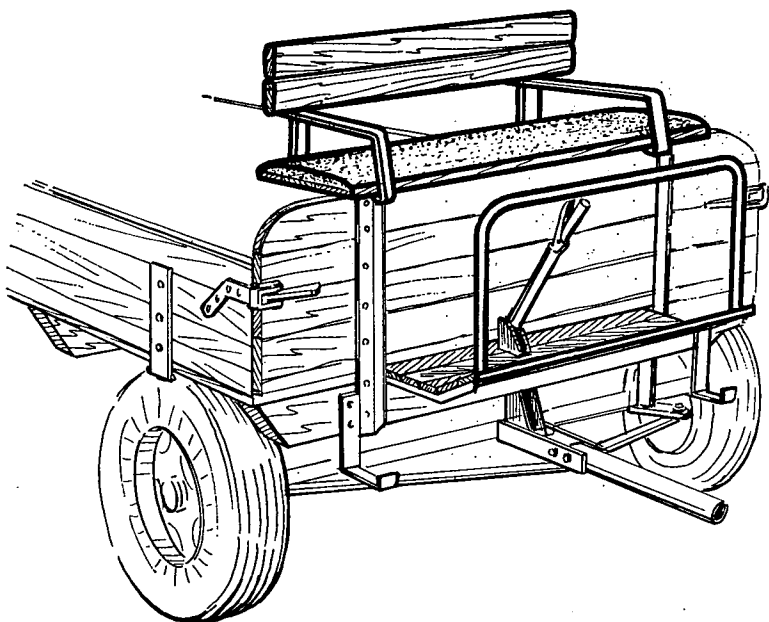


Fig. 43. The driver's seat on a horse-driven vehicle: back-rest, cushion, foot-board with bar guard and steps.

vehicle. Protection can be given by a back-rest, bar guard, foot-board and, if required, side-rests (fig. 43). Steps and hand-grips may be needed for safe climbing on and off.

### BRAKES

14.4. In some countries the traffic regulations require brakes to be provided on hauled vehicles if they are over a certain weight or if more than one is being hauled at the same time. This safety rule is based on rules for traffic on public roads. Farm vehicles,

however, are used on much inferior roads, on wet slippery grass, and on clay surfaces where the factor of safety is much lower than on public roads. It is, therefore, inadvisable to dispense with brakes merely because a vehicle does not require brakes under the traffic regulations. All farm vehicles over a certain weight, say half a ton, should be provided with brakes.

14.5. As far as practicable, the brakes of hauled vehicles should be controlled by the driver from the tractor seat but should be independent of the tractor's brake system. The controls should be so arranged that the driver does not have to turn round when operating the brakes.

14.6 If a four-wheeled vehicle is provided with two-wheel brakes, they should be fitted to the front wheels, for brakes on the rear wheels only can cause the back part of the vehicle to slide sideways.

14.7. All brake levers on hauled vehicles should have a ratchet device, or otherwise be so made as to prevent the brakes from becoming disengaged.

14.8. Over-run devices for the automatic operation of brakes are not always reliable and should not be used.

14.9. All vehicles should be equipped with mechanical parking brakes that will securely hold the vehicle even on slopes. These brakes should always be applied before vehicles are uncoupled. If there are no such brakes the vehicles should be blocked by chocks or other effective means.

### DRAWBARS

14.10. The drawbar on a vehicle should be properly designed and of sound construction. The coupling device must not come loose through shocks or vibrations during travel, and should withstand the considerable strains to which it is subjected (fig. 44). It should be inspected at regular intervals and not be used if considerably worn or if showing cracks. It is of advantage, especially with heavy vehicles, to use drawbars with rotary axle joints because then overturning of one of the vehicles will not affect the other.

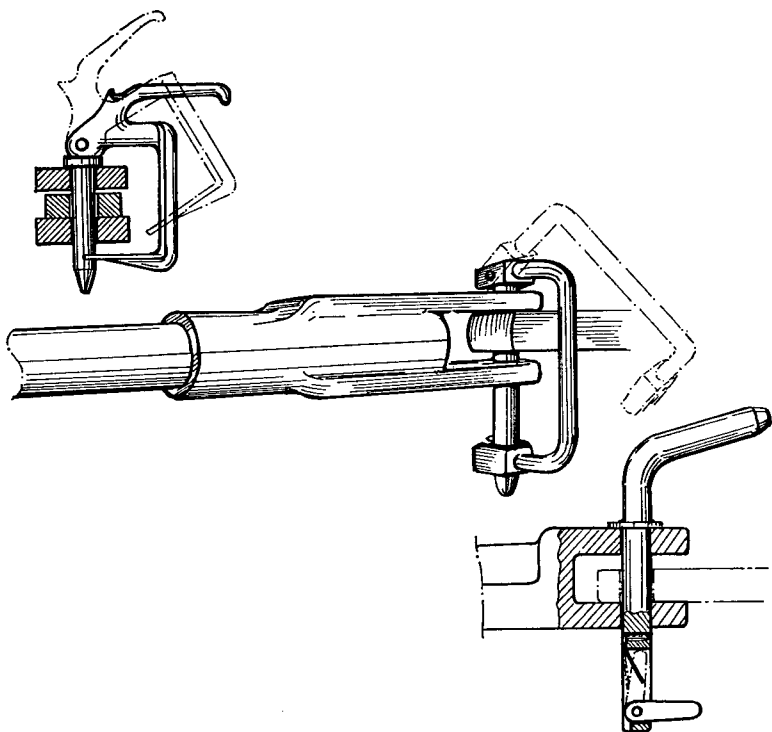


Fig. 44. Three designs for couplings.

Top and centre: the locking device is held in the closed position by springs. Bottom: a coupling pin with a stop held in the locked position by a spring.

14.11. Drawbars on two-wheeled vehicles can be supplied with a jack or other support to be used when parking the vehicle. The support should be adjustable to any height required and have a base sufficiently wide to prevent it sinking in soft ground. If practicable, it should be so constructed and situated that it can be operated from the driver's seat during hitching or unhitching of

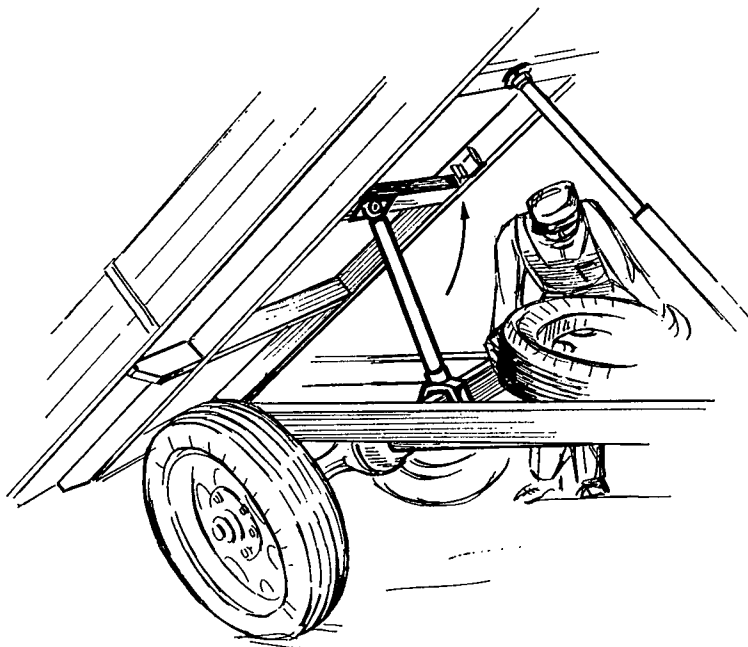


Fig. 45. A rotatable support for a raised dump-truck platform.

the vehicle. Measures may be needed to prevent inadvertent tipping up of the drawn vehicle.

### DUMP TRUCKS

14.12. As dump trucks or trailers have caused many severe accidents when the hydraulic system has failed while persons are leaning under the lifter platform, such trucks or trailers must have a device for securely blocking the platform in a raised position

(fig. 45). No person should lean on or step under a raised platform unless it has been securely blocked.

### OPERATION OF VEHICLES

14.13. No person should ride on a drawbar or stand or sit on any other unsafe place, jump off or onto a vehicle while it is in motion or climb from one vehicle to another.

14.14. When they are being loaded and unloaded, vehicles should be blocked by means of brakes or in some other way. If this cannot reasonably be done, e.g. when loading hay, grain, etc., in a field, a warning should be shouted before the vehicle is started up. Inadvertent movements of draught animals should be avoided by suitable precautions, for example by keeping them reined in, holding the bridle, or unharnessing them.

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## **15. FIXED HOISTING AND TRANSPORT APPLIANCES**

### **HOISTING APPLIANCES**

15.1. All parts of hoisting appliances such as cranes and winches must obviously be of sound material, good construction and adequate strength, and be maintained in safe working order. They should, of course, comply with any applicable national regulations or standards.

15.2. All load-bearing parts should be designed with a sufficient safety factor, i.e. the number of times the breaking strength exceeds the maximum safe load. As a guide, a safety factor of five may be recommended for hooks, steel wire and other parts made of steel. A factor for wooden construction cannot be fixed, for the kind of wood and its condition are important matters that have to be taken into consideration; the ratio should therefore be determined according to recognised rules and by competent persons.

15.3. Hoisting appliances should, if practicable, be so arranged that the load stops and cannot fall by its own weight when the operator lets go of the control.

15.4. All parts of the hoisting and transport appliances, including pulley wheels and traversing gears, should be easily accessible for inspection and lubrication. If necessary, fixed ladders and platforms should be provided. As the ladders sometimes have to be quite high they should be provided with a cage or similar device to guard against the danger of persons falling off. The platforms should be provided with railings and toe-boards.

15.5. Many fires have been started by the bearings of hoisting appliances becoming overheated. This has occurred mostly when ordinary bearings have been used and placed where they

cannot be seen. Only ball or roller bearings should be used, but they must be well lubricated or they may start fires too.

15.6. Farm people often install and use hoisting appliances without the necessary knowledge and experience. Only competent persons should be entrusted with their installation and operation.

15.7. Fixed appliances should be so installed that they cannot be displaced by the load, by vibrations, etc., that the operator is not exposed to danger from loads, ropes or drums, and that the operator can either see over the zone of operations or exchange signals with all loading and unloading points.

#### *Inspection and Testing.*

15.8. Before it is taken into operation, every fixed appliance should be inspected, and if necessary tested, by an officially recognised body or person. When in use it should be inspected and tested at regular intervals not exceeding fourteen months.

#### *Marking of Safe Working Load.*

15.9. To avoid the overloading of hoisting appliances, the maximum safe load should be legibly and durably marked at a conspicuous place (fig. 46). Even loose gear such as hooks, chains and shackles should be marked.

#### *Drums and Pulley Blocks.*

15.10. Hoisting drums should have a diameter not less than thirty times the diameter of the wire rope, and be provided with a flange on each side large enough to prevent the rope from leaving the drum. The diameter of the sheaves of pulley blocks measured at the outer circumference of the sheave should not be less than twenty times—for hand-operated winches sixteen times—the diameter of the rope. If the diameters stated above are not provided, the wires will be overstrained and damaged by too much bending. This reduces the strength and life of the wire.

15.11. The sheaves and housing of blocks should be so constructed that the rope cannot become caught between the wheel and the sides of the block. As fingers may be crushed where

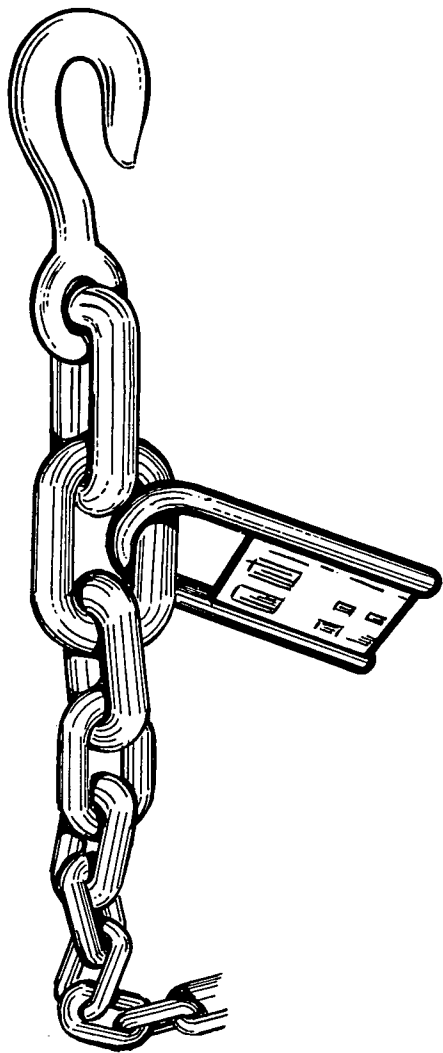


Fig. 48. Chain and hook with maximum safe load marked on a tab.  
A good-quality chain is always marked by the manufacturer.



wires pass over pulleys in the block, a nip-guard should be fitted at the danger points (fig. 47).

*Brakes.*

15.12. Brakes should act smoothly and be easily adjustable.

*Loose Gear.*

15.13. When not in use, loose gear such as chains, wire ropes and fibre ropes should be stored under cover in clean, dry, well-ventilated places where it is protected against corrosion.

*Wire Ropes.*

15.14. Wire ropes for hoisting and transport equipment should be made of sound steel wire and have an effective breaking strength of five times the greatest anticipated load. They should not consist of pieces joined together, or have any knots or kinks in them.

15.15. Good care of wire ropes will promote safety and reduce working costs. They should be treated at regular intervals with suitable lubricants free from acid or alkali to keep them pliable and prevent rusting. The fastenings should be examined at regular intervals to see whether they are in a sound condition; clips or clamps should be tightened if they show any signs of loosening.

*Fibre Ropes.*

15.16. Fibre ropes should be of high-grade Manilla or other fibre of equivalent quality. Before being put into use and at suitable intervals while in use they should be examined for defects such as abrasions, broken fibres, cuts, fraying, internal wear and deterioration of fibre. Blocks for fibre ropes must have no sharp or rough edges or undue projections, and the pulleys must have grooves at least as wide as the diameter of the rope and free from roughness.

*Chains.*

15.17. If chains used for hoisting have been stretched or show excessive wear, cracks or other evident defects, they should be

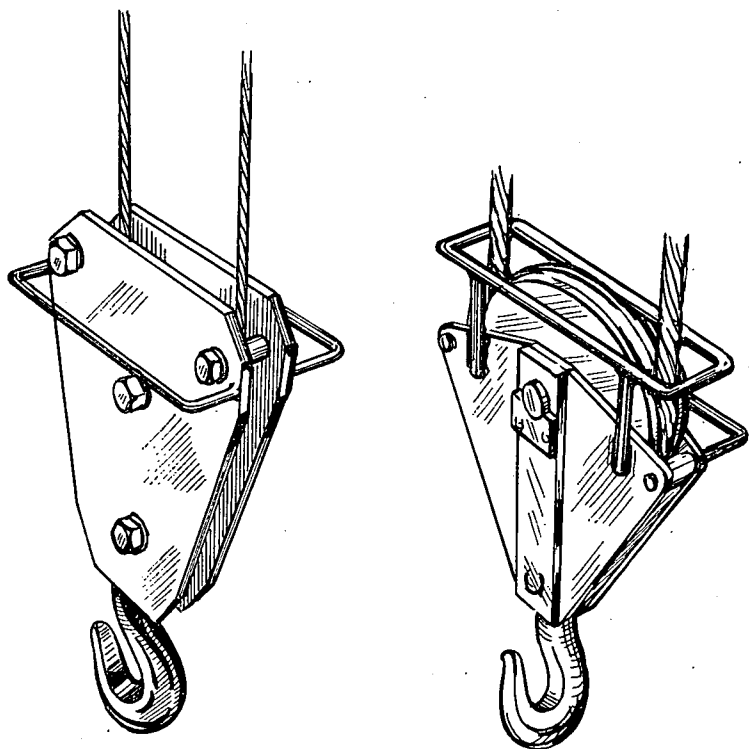


Fig. 47. Nip-point guards on pulley blocks.

Left: a properly constructed block, preventing a hand that has taken hold of the wire rope from reaching the nip-point. Hand grips fitted to the block facilitate work. Right: Old blocks can be made safer to work with by fitting them with a nip-point guard made of iron rods.

withdrawn from use. They should be repaired only by a properly qualified person. Joining broken chains by wiring links together or inserting bolts between links, etc., is dangerous. Poor welding can damage the material in chains and hooks and make them dangerous to use.

15.18. Chains should not be subjected to violent treatment by hammering them, dropping them from a height, applying shock loads, etc., and they should not be knotted or twisted.

15.19. Chains and their rings, hooks, shackles and swivels should be examined for defects such as stretch, wear and cracks at frequent intervals. When individual links show such defects they should be cut out and replaced.

#### *Hand-operated Winches.*

15.20. As a general rule the maximum effort to be applied by any one person at the handle or handles of hand-operated winches should not exceed 22 lb (10 kg) when the maximum safe working load is being lifted.

15.21. Hand-operated winches have caused many accidents, some of them fatal, when the operator has released his hold on the handle. The load has then turned the handle at high speed, and the operator has been struck and severely injured, or the handle has flown off at a high speed and has hit someone. These accidents can easily occur if the winch is not equipped with a ratchet wheel and a locking pawl, or if it has no brake and the operator has to lower the load with a releasing pawl. Even when a winch has been equipped with both locking pawl and brake, similar accidents have happened because these appliances have not been kept in good condition or the operator has lost control of the machine. Hand-operated winches not supplied with pawls should never be used.

15.22. If a winch is intended for both hoisting and lowering, it should be equipped with a securely constructed and mounted pawl and a braking device capable of holding one-and-a-half times the maximum load and allowing the load to be lowered smoothly. If these devices are kept in good order the winch will be reasonably safe. Experience has proved, however, that they often fail for the reasons mentioned above. It is therefore advisable to use a self-locking device, i.e. one which is automatically locked when the handle is not cranked, so that the handle has to be cranked in the reverse direction for lowering the load. When acquiring a new winch the owner should see that it is equipped with such a device.

*Operating Precautions.*

15.23. It has already been mentioned that hoisting appliances should be operated only by competent persons. Care should be taken that the appliances cannot be set in motion by unauthorised persons. A fundamental precaution is not to overload an appliance. Loads should be securely attached and raised and lowered smoothly without sudden jerks. The driver of a crane or hoist, or the signalman, should see that no person is under a suspended load at any time, or comes into danger when the load is slowed down or moved sideways. Persons should not ride on hoisting appliances; they are not constructed for such a purpose. Any person who neglects this rule runs a serious risk of injury.

### CONVEYORS

15.24. Many serious injuries have occurred when persons have come into contact with the nip-point between belt and pulley on belt conveyors, for example when removing stones, straw or other objects. Nip-guards should be provided to prevent such accidents. The belt and pulleys should also be guarded on the sides to prevent danger from contact with them.

*Slat Conveyors.*

15.25. A slat conveyor presents a hazard at the ends. When travelling round the sprockets the slats open and close and can pinch fingers or catch clothing. The ends should therefore be covered. There may also be the risk of shearing between them and the conveyor frame.

*Toothed Conveyors.*

15.26. Conveyors provided with tines or teeth should be adequately protected at the bottom reversing points so that there will be no risk of shearing or pinching between the protruding parts in motion and the conveyor frame. If the sides of the conveyor

do not shield the tines and teeth during the return travel, it is advisable to protect the dangerous space with railings so as to prevent inadvertent contact. If a conveyor, especially a vertical sack conveyor, passes through the floors of a building, the returning part should be entirely enclosed from top to bottom so as to protect persons from being crushed between the carrier and the floor or other adjacent parts of the building or objects.

### *Extension Conveyors.*

15.27. Extension conveyors have sometimes fallen because the locking device has not been reliable and has been released by the vibrations of the conveyor or has been inadvertently moved by someone standing nearby. The conveyor must be equipped with a locking device that securely holds the conveying unit in position.

### *Screw Conveyors.*

15.28. Screw conveyors are particularly dangerous. The conveyor troughs should therefore be completely covered. Removable sections of the cover or covers of inspection openings should be interlocked so that the screws stop when the covers are open. Transportable screw conveyors with the feed end of the screw uncovered are often used in agriculture. These conveyors have caused accidents at the point where the screw enters the housing. Furthermore, if the screw end is unguarded, it may catch clothing. A screw conveyor should have a protective cage around the uncovered part of the screw, and the end of the housing should be widened like a funnel or other steps taken to eliminate the hazard. In work with damp grain, or when the elevator is started with a screw filled with corn, the motor can easily be overloaded and overheated. The motor should therefore have an overload circuit breaker. Whenever practicable, screw conveyors should be fed through a trough covered by a grating. Foreign bodies, such as string and straw, should be removed only while the conveyor is at rest.

*Bucket Elevators.*

15.29. Bucket elevators should be totally enclosed. Covers for openings in the enclosure should never be open for taking samples, cleaning, etc., while the elevator is in motion.

15.30. A bucket elevator with an endless belt carrying the buckets can cause fire if the belt slips. This can happen if the elevator is overloaded; for instance, when damp grain is transported a bucket may become stuck in the housing, or the belt may run on one side and rub against the housing. The resulting friction creates heat, which can rapidly start a fire. Much the same can happen with cabin elevators when the belt driving the elevator slips. To prevent fire an elevator should be constantly watched and carefully maintained. Belts should be taut. Feeding should be so regulated that no overloading occurs. Experience has proved, however, that special fire prevention devices are needed. Besides the motor control, there should be a device that automatically stops the elevator if the bucket belt slips. If more than one bucket belt is used, there should be such a safety device for each belt.

15.31. Accidents have occurred when a person has been cleaning a bucket elevator and the elevator has unexpectedly been started. It is advisable to equip the covers for openings in the housing with electric contacts that prevent starting when the covers are open, or with a main power control or switch that can be locked in the off position. In the latter case the only key to the locking device should be carried by a responsible person.

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## **16. HAND TOOLS, IMPLEMENTS AND LADDERS**

### **TOOLS AND IMPLEMENTS**

16.1. While hand tools and implements do not cause a large proportion of accidents resulting in death or permanent disablement on farms, they do cause considerable numbers of accidents resulting in temporary disablement. When they are purchased, therefore, it is of great importance that reliable ones should be selected for the work for which they will be used. A tool or implement of suitable and safe design (figs. 48 and 49) and good quality not only increases safety, but facilitates work and is cheaper in the long run. Tools and implements are generally standardised, and experience has shown that it should not be necessary to acquire many types.

16.2. Portable power-driven tools should be constructed without projections on any exposed revolving or reciprocating part.

16.3. Common occurrences with tools are eye injuries due to flying splinters of metal, cuts from knives, scythes and axes, fractures from slipping or defective wrenches, severe bruises from flying tool-heads not securely fastened to handles, and septic wounds.

16.4. Tools with broken handles, loose heads, dull edges or other such defects should not be used (figs. 50 and 51). Defective and unsuitable tools not only cause accidents but also impede the work. A knife should not be used as a screwdriver, a wrench as a hammer, pliers instead of a wrench, or a file as a lever to prise something open.

16.5. Accidents can also be caused by such unsafe practices as throwing tools from one person to another, carrying sharp tools such as chisels in pockets and leaving scythes, saws, sharp-pointed

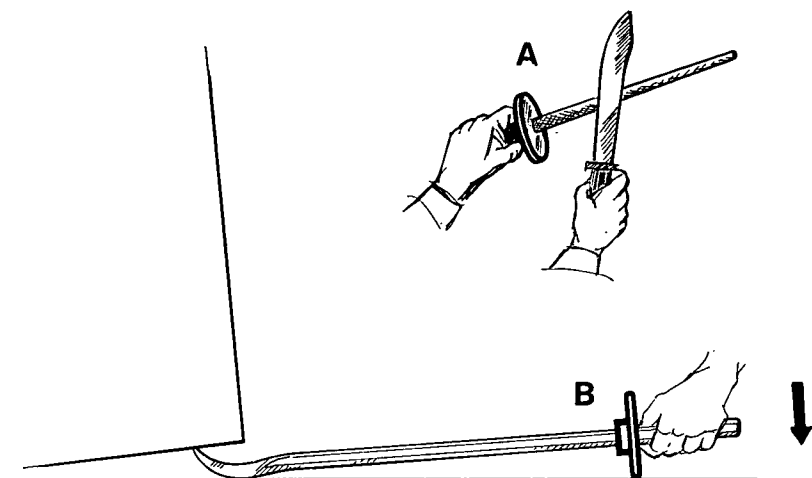


Fig. 48. Guards on tools to prevent hand injuries.

A. On the handle of a honer. B. On a pinch bar.

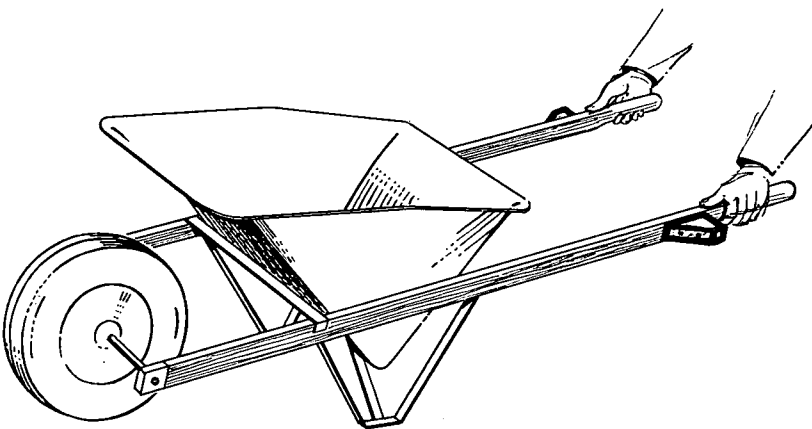
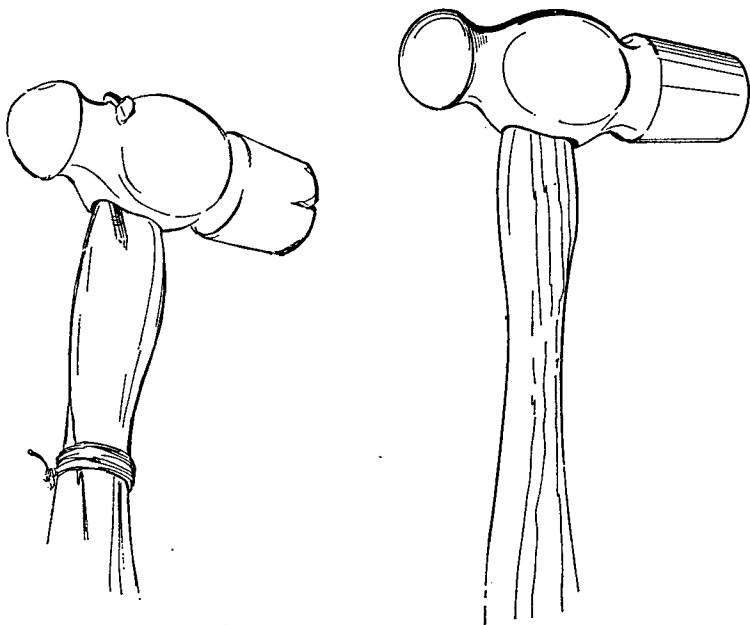


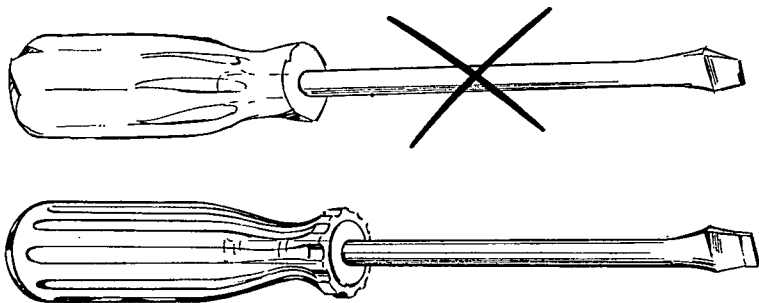
Fig. 49. Knuckle guards fitted to the handles of a wheelbarrow.





**Fig. 50. Two hammers.**

A hammer like the one on the left, with a worn and broken shaft, badly fastened head, damaged head surface or other defects, should never be used. Right: hammer in good condition.



**Fig. 51. Screwdriver bits.**

A screwdriver with a dull and rounded bit and sloping bit sides slips easily (above). Parallel bit sides and a sharp, square-edged bit give a better hold on the screw (below).

tools and hammers lying on the ground or so placed or stored that persons can be injured by them.

16.6. When protection from flying particles is required workers should wear safety goggles. (See Chapter 24.)

16.7. All tools and implements should be kept in good order in permanent depots where they can be easily found and are conveniently available for the work in which they are to be used (fig. 52).

16.8. The farmer should make sure that tools and implements are maintained in safe condition and when in use are carefully handled.

16.9. Carrying or transporting tools or implements in a safe way should be a habit (fig. 53). If workers and their tools are being carried on a vehicle, care should be taken to see that the tools are so placed that they are not likely to cause injury to anyone.

### LADDERS

16.10. Accidents with ladders are all too frequent. Some are due to poor or makeshift construction, some to lack of care and maintenance and some to improper or careless use.

16.11. All metal, wooden or other ladders should be of sound material, good construction and adequate strength for the purpose for which they are intended (fig. 54) and should be properly maintained. A wooden ladder should be made of sound, straight-grained wood free from knots. For preservation, oil or transparent preservative only should be used; paint is not good as a preservative and will hide defects. Portable ladders should be provided with non-slip shoes, spikes, hooks or other devices to prevent slipping. Whenever hooks can be used they should be preferred because they give the best protection against slipping. Double ladders should have a device that prevents the two sides from slipping apart.

16.12. No ladder should be used which has only one upright, a missing or defective rung, or any rung which depends for its

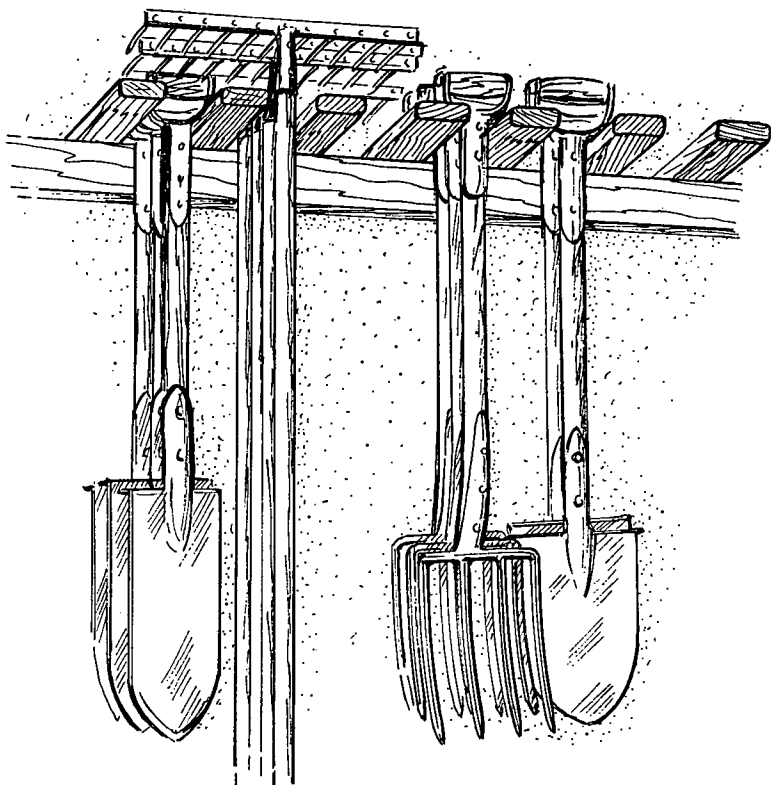


Fig. 52. A storage rack for agricultural implements.

support on nails, spikes, screws, or other similar fixing. Wooden rungs should have no knots in them.

16.13. Where practicable, ladders, whether fixed or portable, should rise, or be provided with an adequate handhold, to a height of 40 in (1 m) above the top landing place so as to afford

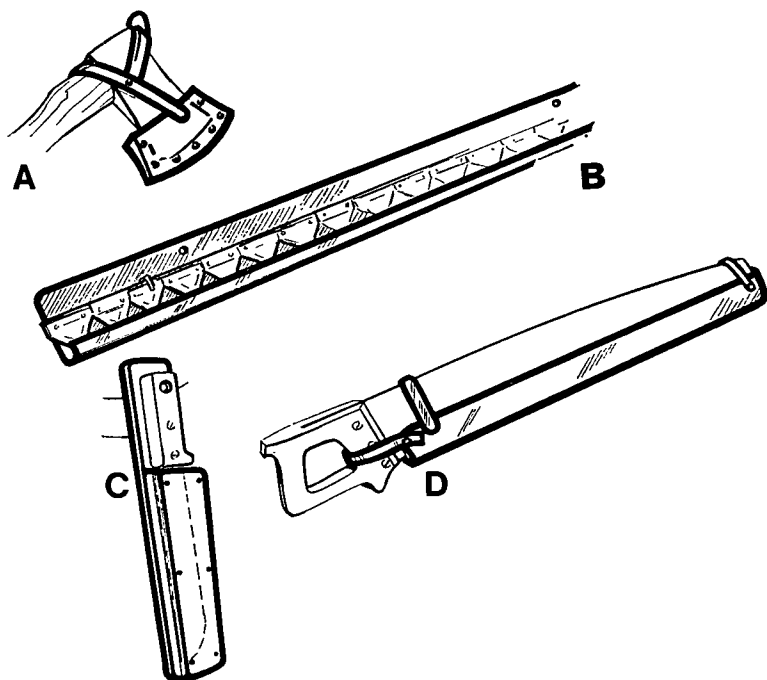


Fig. 53. Guards for the transport of sharp-edged or pointed tools.

A. Axes. B. Cutter blades. C. Knives. D. Hand-saws.

support to persons stepping on or off them, but no rungs of a fixed ladder should extend above the top landing. Alternatively, adequate supports and handholds should be provided at the landing place itself.

16.14. Portable ladders should, as far as practicable, be stored where they will not be exposed to the weather and where there is good ventilation and no excessive heat or damp.

16.15. All ladders should be inspected at suitable intervals. If any dangerous defect is found the ladder should be immediately

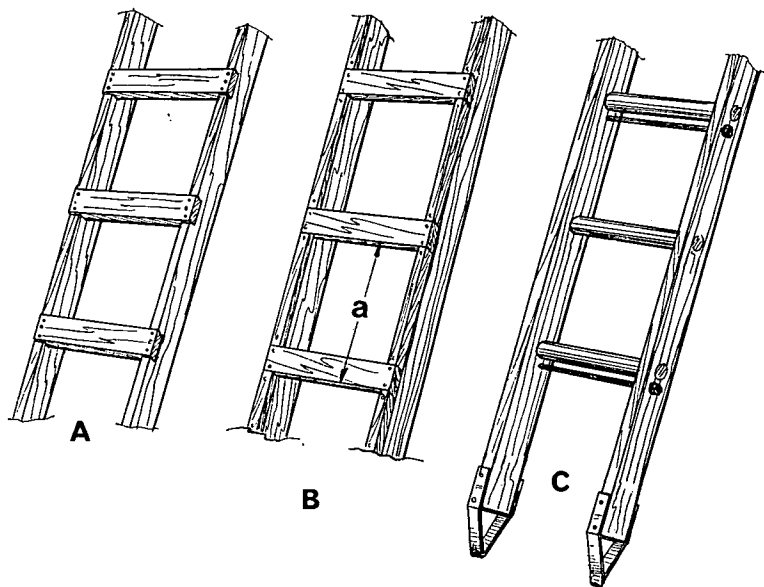


Fig. 54. Ladders of conventional construction.

A. Cleats set into the uprights. B. Cleats fixed onto the uprights with filler blocks between them. C. Ladder with rungs and bolts to keep the uprights together; a bolt is usually inserted at every fourth or fifth rung. (a) = 12 to 16 in (30 to 40 cm).

repaired or its use prevented until it is repaired; if it is irreparable, it should be immediately destroyed. If a defective portable ladder is just put aside with the intention of repairing it later, someone who is unaware or heedless of the defect may use the ladder and have an accident.

16.16. Fixed ladders should be so installed that the distance from the front of the rungs to the nearest fixed object on the climbing side of the ladder is at least 30 in (75 cm) and the distance from the back of the rungs to the nearest fixed object is at least 6 in (15 cm).

16.17. Here are a few simple rules for using ladders.

- (1) Do not use a ladder that is too short. See that the ladder has secure footing.
  - (2) Do not use loose or otherwise unsafe objects as a base.
  - (3) Never place a ladder in front of a closed door unless the door is locked or otherwise securely guarded.
  - (4) Do not use a ladder near bare electric wiring.
  - (5) As far as possible use both hands on the rungs when climbing or descending.
  - (6) Avoid carrying heavy objects on ladders but use a rope or block and tackle to lift them.
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## 17. ANIMALS

### GENERAL PRECAUTIONS

17.1. Livestock is another cause of many accidents on farms, due mainly to kicking, biting and butting. Farm animals are not usually vicious by nature; it is when they are frightened by being teased or surprised, or when they are ill-treated, that they become ill-tempered. They can also cause accidental injury by tossing their heads or treading on feet. Further, the characters of animals differ and it is important to know the character of each and to treat it accordingly. Consequently, it is always necessary to be cautious when handling animals.

17.2. In some cases animals have been improperly treated and cannot be made to behave safely. They are then a permanent danger and should be destroyed: this is the case with a breed with a hereditary tendency to viciousness. Generally speaking, however, animals should be treated kindly and should not be teased. They should not be kept isolated but should learn to become accustomed to the presence of men.

17.3. When an animal is being led, it should not be held by a rope wrapped around the wrist because of the risk of the handler being dragged along the ground if the animal bolts or becomes excited. The rope should be so held that it can be immediately released. An animal should never be led by a person riding a bicycle.

17.4. People should always give a gentle warning when approaching animals, and, if possible, should approach them from the side, otherwise they may take fright. This is particularly important if an animal has been stabled and inactive or isolated for some time. If it is not too nervous, its neck or back can

be stroked. A nervous animal behaves best when handled by someone in whom it has confidence.

17.5. Young animals, particularly foals, are unpredictable in their movements. Children should not be permitted to be near them, and should never be allowed to play with them.

17.6. Young animals should be brought up in calm surroundings. They should be gently and firmly handled, and as far as reasonably practicable by trained persons capable of managing them. This will prevent development of ill-temper.

17.7. Care should be taken not to irritate females during periods of heat, gestation and suckling. Mother animals are sensitive and they and their young should be approached and handled with special caution, for they are suspicious and naturally on the defensive.

### HORSES

17.8. Horses, like other animals, should be treated kindly. They should be properly and firmly trained and taught to obey and respect commands. For instance, a horse drawing a vehicle should under no circumstances be permitted to start until the driver is seated, has the reins firmly in hand and has given his command. The harness should be kept properly adjusted and free from defects. A loose or ill-fitting harness is uncomfortable and irritates the horse, and leads to sore shoulders which can make it dangerous to handle if they are not promptly attended to.

17.9. When a man is putting on or taking off bridles, halters or harnesses, the horse should be tied up. The man should keep clear of the head and feet and allow himself ample room to get away if necessary. Many serious injuries have resulted from horses tossing their heads or striking out with their hoofs in an effort to get free. Hitching or unhitching should be done quickly.

17.10. Loose reins thrown over the seat of a cart or across the horse's back or on the ground may cause an accident if the horse takes fright and runs away. The reins should be held or at least kept within reach. If a hitched horse is left alone, it



should be tied to a stout pole or the like. When driving, a person should never loop the reins around his body. Because of such practices, many drivers have been dragged along the ground and injured.

17.11. A person leading a horse should walk beside it, not in front of it.

17.12. Biters and kickers are dangerous and should be clearly identified by warning notices. Biters should be fitted with muzzles outside the stable. Kickers should be stabled indoors in such a way that they are not a danger to passing people or animals.

### BULLS

17.13. Bulls must always be considered dangerous. It is a delusion to believe that any bull can be trusted. Even if one has been placid and tractable for years and never shown signs of aggressiveness, he may for some unknown reason suddenly lose his temper and attack without warning. A bull should always be handled with great care, and no one should ever neglect to safeguard himself against occasional aggression. As strength is often needed to manage bulls, only robust, properly trained persons between 18 and 60 years of age should be permitted to handle them.

17.14. Horns should be removed or at least have the points cut off and rounded. The best time to dehorn is when the animals are calves. The most effective means is caustic potash or a similar substance, but caustic potash is dangerous (corrosive) and should be kept in a metal container away from children. There are electrical appliances for dehorning that are safer than chemicals.

17.15. As a rule, a bull over ten months old should be fitted with a strong nose-ring of copper or other non-corrosive material for safety and convenience of handling. The ring and retaining screw should generally be of the same material to avoid galvanic corrosion, but the combination copper/brass can be used. The ring should be regularly examined and changed when necessary.

A spare ring should always be available. Beef bulls, however, are not usually fitted with rings; extra precautions should therefore be taken when handling them. Stud bulls should always be fitted with rings.

17.16. A bull should be stalled in a bull box. The place should be well ventilated, well lit, protected from extremes of heat and cold and have clean dry bedding. It should be large enough for the bull to exercise, and have a floor rough enough to prevent man or animal from slipping. For persons attending the bull, means of escape should be provided such as gaps or baffles across corners. The door of a bull's box should be secured against being lifted off and against the risk of the bull pushing it open (fig. 55). The box should be so arranged that the bull can be fed and captured from the outside. No person should enter the box unless the bull is secured by a yoke or other means.

17.17. If the bull is tethered in a stall, he should be tied with a strong neck chain or neck strap short enough to prevent him from moving his head too freely. A wall should be permitted only on one side of the bull; it should be at least 20 in (50 cm) from the bull's shoulder. The bull should never be tied by the nose-ring.

17.18. Jerky movements of the nose-ring hurt the bull. Rigid leading poles should therefore not be used unless necessary for managing the animal. A rope hooked to the ring and a flexible staff for the man leading the bull are often sufficient (fig. 56). If a second man is at hand it is good practice to let one man walk at each side of the bull, the second man having a rope attached either to the bull's halter or to the nose-ring (fig. 57). However, all dealings with a bull call for the utmost alertness and prudence and a leading pole or staff is usually required. The bull should never be let out without a halter, and the rope should be attached to it. If a bull is vicious, he should be provided with blinkers before being taken out.

17.19. When a bull is at large in a herd, the fences and gates should be inspected to make sure that the animals cannot

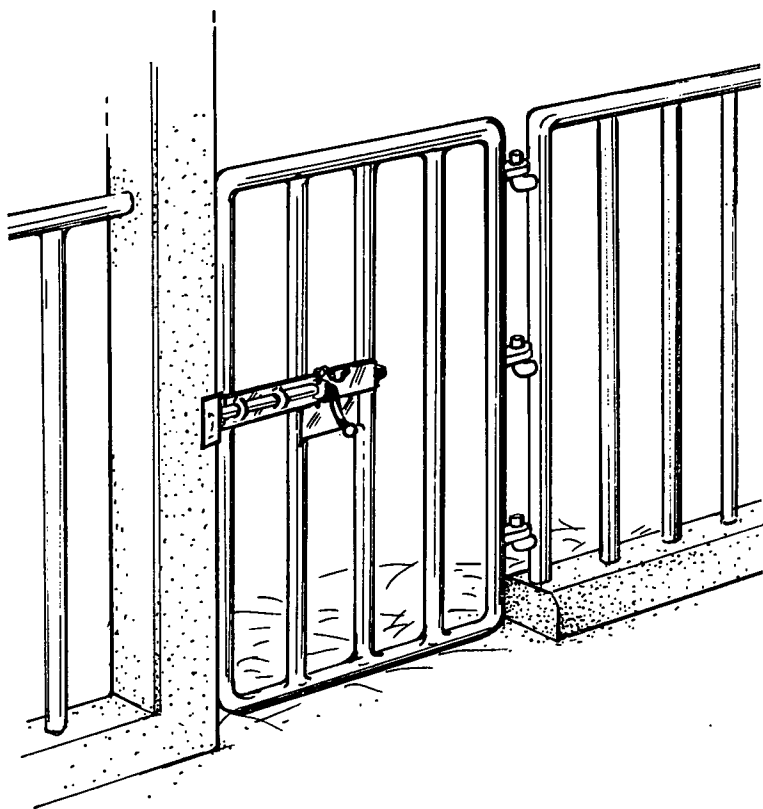


Fig. 55. Door of a bull's box.

Door of a bull's box secured to prevent it from being lifted off or opened by the bull.

find their way out. A person should not try to separate a bull from a herd of cows single-handed; help should be near at hand in case of emergency. If a bull has attacked a person he may be frightened away from his victim by a loud noise, e.g. the crack-



Fig. 56. Bull's nose-ring and leading staff.

The staff should have an eye through which the bull's nose-ring can be passed.

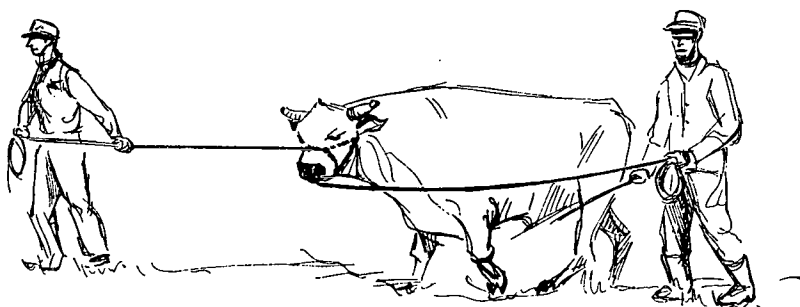


Fig. 57. Leading a bull.

A safe way of leading a bull is to let a second man walk on the other side of the animal with a rope attached to the halter. Some people attach the rope to the nose-ring.

ing of a whip or two poles banged together. A frightened bull may hurl himself against a wall; no one should therefore go between a bull and a wall or he may be crushed against the wall.

17.20. Tethering a bull should be done as fast as possible. When a bull is tethered on a grazing ground the iron stake should be knocked in before the bull is led to the place, or the bull should be tied up or held by a second person until the stake is knocked in.

17.21. Cows as well as bulls should be serviced in strong pens so made that the animal can be held from the outside. Tying up an animal to a wall should be avoided because of the risk that the persons tending it will be crushed against the wall. If the pen is in a building, there should be suitable exits through which persons present can escape if a bull becomes wild.

### ANIMAL-BORNE DISEASES

17.22. Several diseases can be transmitted to man by animals. These diseases, known as zoonoses, include brucellosis (e.g. Bang's disease), anthrax, tularaemia and rabies. They will be dealt with fully in the Guide to Health in Agriculture which is to be published as a companion volume to the present Guide, and only a few general precautions will be indicated here.

17.23. Many of the diseases can be prevented by a safe water supply for men and animals, the proper disposal of human and animal waste without the possibility of contamination of the water supply, and the use of insecticides and pesticides.

17.24. Careful cleaning and disinfection of contaminated premises following the removal of diseased animals is one of the cardinal principles of disease eradication.

17.25. Cleaning must precede disinfection. Manure, bedding, litter, cobwebs, dust and all other refuse should be removed to a place inaccessible to livestock, and burned or thoroughly soaked with disinfectant. Stalls, walls, mangers, troughs and other parts of buildings which have housed diseased animals should be thoroughly washed with hot water and soap or washing soda. Rotten wood may have to be torn out and burnt.

17.26. Cattle should be tested at suitable intervals for diseases communicable to human beings.

17.27. Water, soap, disinfectants and towels should be provided at places where animals that are, or are suspected of being, infected are kept.

17.28. Persons handling animals that are, or are suspected of being, infected should disinfect their hands and top clothing

after every occasion of contact with the animals, and persons with skin injuries should not handle such animals at all.

17.29. Anyone who has itching or burning patches of skin or painful blisters should consult a physician without delay to see whether he is infected with anthrax.

17.30. Persons assisting in foaling, calving, farrowing and lambing should wear rubber gloves and take any other suitable precautions against infection.

17.31. Carcasses of animals slaughtered because of internal disease should be handled and disposed of in conformity with official regulations.

### WILD ANIMALS

#### *Snakes.*

17.32. In certain regions, where there are poisonous snakes, high boots or leggings should be worn and snakebite kits carried. Persons should always watch where they step, special care being needed in places where snakes might hide, such as in or under timber stacks. Certain poisonous snakes to be found in trees attack persons walking underneath, and hard hats should be worn as protection against them. Normally, however, a snake will not attack unless it is touched, trodden on or cornered. Anyone who is bitten should remain calm and remember that few people die from bites of even the most poisonous snakes because the snake is seldom able to inject a full dose of venom. The bitten limb should be immobilised, the bite washed thoroughly and a slightly constricting bandage applied. If available, an antidote should be injected as soon as possible and the sufferer hospitalised or put to bed.

#### *Other Animals.*

17.33. In remote places certain large animals can sometimes be dangerous. It might be useful to equip crews working in danger zones with firearms as protection against sudden attacks from them.

## INSECTS, ETC.

17.34. Spiders, ticks and many kinds of insects, such as flies, mosquitoes and wasps, can be a considerable nuisance and even dangerous. They should be kept in check by insecticides and repellents, especially in the vicinity of areas where workers are concentrated, such as nurseries or workshops.

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## 18. DANGEROUS SUBSTANCES

18.1. The dangerous substances that farm workers are most likely to come into contact with are chemical fertilisers, pesticides, weed-killers, corrosive and flammable liquids and explosives. There are also liquefied and compressed gases, some risks of which have been dealt with in Chapter 5 and some in Chapter 19.

18.2. In addition to substances that are toxic, flammable or explosive, there are others that are injurious when in the form of powder or dust; among these are cereals and legumes. Grain dust, for example, may explode in the presence of a flame, or it may harm the lungs or infect the eyes. Chemical fertilisers are now used in very large quantities; some of the nitrates and phosphates, as well as lime products, are skin irritants.

18.3. Substances that are used in comparatively small quantities, but are extremely dangerous, are poisons for exterminating vermin such as rats, and for treating seed grain.

18.4. Clothing and other equipment affording protection against these various substances are described in Chapter 24.

18.5. This chapter deals only with the safety precautions for (a) toxic substances; (b) oxidising substances; and (c) flammable liquids. Commercial explosives are dealt with in Chapter 20.

### TOXIC SUBSTANCES

18.6. One of the most important factors affecting the health of the agricultural worker today is the increasing use of toxic substances in agricultural operations. The field of agricultural chemicals is complex and ever-changing. Many of these chemicals are hazardous but, if proper precautions are taken when handling them, they can be used safely. Any toxic chemical



should be carefully handled at all stages—from the time it is brought onto the premises until the empty containers have been safely disposed of.

18.7. Toxic substances should be stored separately from other materials and, in particular, away from food and feeding stuffs; the storeplace should be kept locked. If stored in containers other than those provided by the manufacturer they should be clearly labelled "POISON" with the name of the substance and marked with a danger symbol as shown in figure 58; they must also be kept away from children, animals and the water supply.

18.8. Empty containers are dangerous if left accessible to people (especially children) or animals. In order to prevent the danger of poisoning workers and members of their families, it is important that all containers and bags which have contained pesticides and other dangerous substances should be destroyed. They must never be washed out in rivers, streams or ponds. Any advice or instructions given by the manufacturers should be strictly followed.

18.9. Geographical regions, soil types, weather conditions and many other factors may affect the use of chemicals on agricultural crops; these important factors must be taken into account.

18.10. All workers should be warned of the dangers associated with the substances they use. In fact, the education of workers in the inherent dangers of these substances and the ways in which they can enter the body is essential in the prevention of poisoning.

18.11. Toxic substances may be absorbed in three ways—by ingestion (through the mouth), through the skin and by inhalation. The first is usually the result of accidental circumstances; the second is a potential hazard frequently encountered in actual practice and the third is the most common cause of acute and chronic poisoning.

### *Ingestion.*

18.12. Ingestion may result from many sources such as contaminated food, tobacco or beverages, from putting fingers or

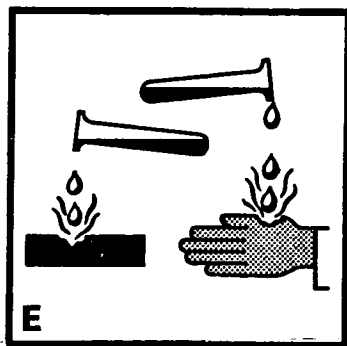
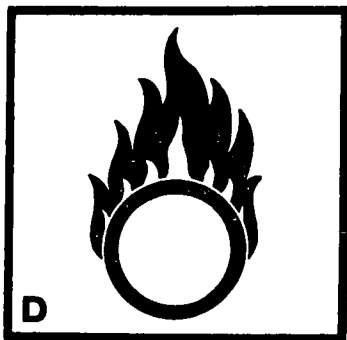
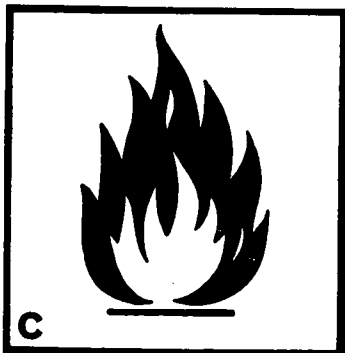
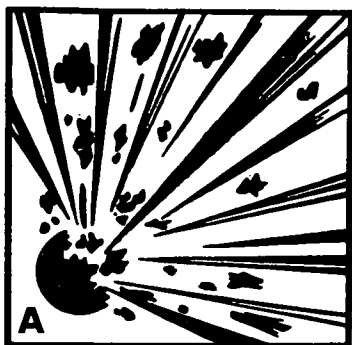


Fig. 58. ILO danger symbols.

- A. Danger of explosion.
- B. Danger of poisoning.
- C. Danger of ignition.
- D. Oxidising agent.
- E. Danger of corrosion.

other contaminated objects into the mouth or from licking the lips. A particular risk is connected with cereal seeds which have been treated with pesticides. In some cases workers have used such seeds for preparing foodstuffs and have been poisoned. Another risk is the contamination of foodstuffs and drinking water during spraying operations.

18.13. In order to prevent poisoning by ingestion, a worker must never eat, drink or smoke until he has removed all his protective clothing, washed his hands and face and left the area of operation in which he might be in contact with any toxic substance or with any protective clothing that has been worn when using the substance.

#### *Absorption through the Skin.*

18.14. The prevention of absorption through the skin consists in avoiding, as far as possible, contact between the chemical and the skin due to accidental spilling, contamination of clothing or immersion of the hands. In the actual application of chemicals the most serious hazard is that the spray operator may be drenched because of sudden changes in the wind or carelessness in operation. Such risks can be largely avoided by providing the worker with adequate protective clothing (rubber gloves, overalls, hoods) and by giving him proper training in safe working procedures and strict instructions on the necessity of wearing his protective clothing throughout the dangerous operation. Protective clothing varies according to the job to be done.

18.15. Suitable washing facilities (including showers whenever possible), with soap, clean towels and clean water should be provided for workers in places of employment where there is a risk of poisoning.

18.16. If contamination occurs all clothing must be removed at once and the skin washed with clean water.

18.17. All working clothes must be washed and changed at least once a week and gloves washed and inspected at the end of each day.

*Inhalation.*

18.18. Dangerous chemicals used in agriculture may present a respiratory hazard in the form of a cloud of dust, liquid droplets or vapours. Sometimes these have an immediate effect on the respiratory tract, but they may have delayed action. In the prevention of poisoning by inhalation, safe working conditions constitute the most important safeguard. It is therefore imperative that meticulous attention should be given to all aspects of safety.

18.19. Possibly the greatest hazard of all arises from the spraying of chemicals. As a general rule spraying should never be carried out when there is a strong wind, because of the danger of drifting. Before work begins the machine should be checked to ensure that it will spray at the correct rate and that all joints are leakproof. Care should also be taken to see that all the necessary protective clothing fits well and is in good condition.

18.20. The risk of poisoning through inhalation is greater when work is carried on in a confined space, such as a greenhouse or hothouse.

18.21. It is important to use the right type of respirator and dust mask for protection against the hazard involved.

18.22. Workers who handle toxic chemicals should be trained in the use of protective equipment and recommended appliances, and be conversant with the first-aid measures required in an emergency.

18.23. It is of the utmost importance to study the information furnished and take the precautionary and protective measures recommended by the manufacturers of the chemicals.

### OXIDISING SUBSTANCES

18.24. Increasing use is being made of some chemical compounds in agriculture, particularly fertilisers and weed-killers that are flammable or supporters of combustion. Suppliers of chemicals should provide special instructions for their use, and the workers should be fully instructed, if there are any dangers. Oxidising substances should be clearly marked as shown in figure 58.

18.25. Fertilisers and other chemical substances should be stored in a dry room. The sacks or containers should preferably be on skids or a platform and kept away from walls and any combustible material. Different kinds of fertilisers or chemicals should not be stacked together.

*Potassium Nitrate.*

18.26. Potassium nitrate, sometimes referred to as nitre or saltpetre, easily promotes the combustion of other materials since as it gives off oxygen when heated, thereby increasing the intensity of any fire in its vicinity. Bags in which nitrates are shipped tend to absorb humidity and to become saturated with nitrate solution; on drying they are highly flammable. For this reason it is recommended that nitrates should be transferred from bags or wooden barrels to incombustible bins for storing and that the bags or barrels should be thoroughly washed. Paper bags which have contained saltpetre should be burned.

*Sodium Chlorate.*

18.27. Chlorate compounds are sometimes used as weed-killers. It is not always realised that they are oxidising agents which, although they do not burn themselves, create optimum conditions for fire or explosion when in contact with combustible materials. During hot weather large numbers of fires have resulted from the use of sodium chlorate solutions on dry grass and weeds. When spread on the ground they may remain on the surface, especially in dry weather. Ignition may then be caused by the sun, sparks or fabrication. Dried weeds treated with the solution may be ignited by a person walking on them. It is advisable to spread the solution on a rainy day, for the rain will soak it into the ground. Fires have been reported in buildings and other properties where such solutions have been spilled. A personal hazard has arisen when people's clothing has become saturated while they have been engaged in a process that has involved the use of solutions. Clothing that has been splashed with a solution should be washed before being used again.

Sodium chlorate should be stored only in metal containers. As this chemical is dangerous its use should be avoided as far as possible.

*Quicklime.*

18.28. Calcium oxide, more commonly known as quicklime or unslaked lime, reacts vigorously when in contact with water or exposed to damp, generating enough heat to ignite paper, wood, sacks or other combustible material. Bags or barrels of calcium oxide should therefore be placed on skids in a dry fire-resistant storeplace.

FLAMMABLE LIQUIDS

19.29. The flash point of a liquid is the lowest temperature at which it gives off enough vapour to form a flammable mixture with air and produce a flame when a source of ignition is brought close to the surface. Other properties are also factors in determining the hazards of flammable liquids, but the flash point is the principal one. The hazard increases as the flash point becomes lower. The significance of this property becomes more apparent when liquids of different flash points are compared. Kerosene has a flash point of approximately 46°C (115°F) and at ordinary temperatures does not give off dangerous quantities of vapour likely to cause a fire. On the other hand petrol gives off vapour at a rate sufficient to cause flammable mixtures with air at temperatures even below 0°F (—17°C).

18.30. Flammable liquids are usually divided into three classes, according to their flash point, by national regulations or by rules made by insurance companies, fire-protection organisations or standards associations. Different countries have adopted different classifications of flammable liquids. In the United Kingdom, for example, under the petroleum legislation liquids are considered to have a low flash point if they give off flammable vapour at a temperature of less than 34°C (90°F).

18.31. Liquefied petroleum gas (marketed under various names: LP gas, gasol, etc.) is petroleum gas compressed into

liquid. It is distributed and stored as liquid under pressure but is converted into gas upon release of the pressure, and is used as a gas. Liquefied petroleum gas is as dangerous as any other flammable liquid.

18.32. Careless handling or inappropriate storage of flammable liquids may cause a serious fire or an explosion. The most volatile liquids such as petrol, methyl alcohol and kerosene are naturally the most dangerous. No fire, flame, open light or any other agency likely to ignite flammable liquids or the vapour should be in any area or room in which these liquids are being used or stored. Such sources of ignition may be dangerous even though they are at some distance from the flammable liquid, because the vapours given off are usually heavier than air and spread unnoticed along the floor or ground. A small quantity of vapour can cause an explosion and a fire.

18.33. Static electricity may easily form in equipment used for flammable liquids. A static spark can be created by pouring petrol from one container to another and can ignite the vapour. To prevent sparking, a metal contact between the container or the appliances used should always be maintained in the case of metal equipment, e.g. between the metal nozzle of a pump hose and the mouth of the petrol tank. Except in very small quantities, petrol should never be transferred from one container to another near or inside a building, and no flammable liquid or gas-burning machine or equipment should be refuelled while it is in operation.

18.34. Accidental mixtures of highly flammable liquids and fuel oil may change the flash point of the oil sufficiently to make it hazardous in ordinary use.

### *Storage.*

18.35. Flammable liquids should be stored only in well-ventilated places and kept in suitable containers. Storage facilities for flammable liquids, whether in large or in small quantities, should comply with official or other recognised standards.

18.36. The quantity of flammable liquid in a building should be kept as small as practicable having regard to the work being

carried on. The liquid should be kept in closed metal cans, preferably safety cans, marked as indicated in figure 58. Large quantities of highly flammable liquids, e.g. in steel drums and tanks, should be stored outdoors and at a distance from buildings specified in safety regulations or otherwise prescribed by the competent authority. Above-ground storage tanks for petrol should be at least 80 ft (25 m) from any building, but underground tanks should be preferred. Stationary above-ground tanks should be grounded to lead off static electricity and protected against lightning. It is advisable to dig a ditch around the tank to prevent a flow of liquid if a leak should occur.

18.37. Large quantities of kerosene or diesel fuel should be stored only in accordance with national regulations or recognised standards. All containers should be clearly marked to avoid mistakes when the containers are filled and the liquids are used.

18.38. Cylinders or tanks for liquefied petroleum gases should be installed in accordance with national regulations. If small cylinders are allowed to be stored inside buildings, the store-place should be well ventilated. Only weldless solid-drawn copper tubes should be used in the installation and, if hoses are necessary, only hoses of material resistant to the liquid. Ordinary rubber is not resistant.

18.39. Many explosions and fires have been caused by leaks in poor installations, when the gas has accumulated in the room and been ignited by a person turning on the electric light or striking a match. Normally the gas distributor installs the equipment, but in any case a competent person should do it. The installation must be in accordance with regulations in force or recognised standards.

18.40. If a leak is suspected a flame should never be used to check the equipment. A leak can be located by painting the equipment with soapsuds.

18.41. The manufacturers' instructions for the operation of equipment using burning gases or flammable liquids should be carefully observed.



## 19. CONSTRUCTION, MAINTENANCE AND REPAIRS

19.1. Farmers often do their own building and repairing with the assistance of the people on the farm. The larger farms usually have special workshops such as a smithy, a machine shop and a carpenter's shop, sometimes equipped with machinery and welding appliances.

19.2. Workshops should be adequately lighted, ventilated and heated and equipped with electric wall sockets, suitably placed for portable lamps and power-driven portable tools.

19.3. Appropriate precautions as described in Chapter 3 should be taken against excessive contact voltages.

19.4. Washing facilities should be available in or near the workshop.

19.5. A carpenter's shop may have a high fire risk. Defective or unsuitable heating appliances may easily cause a fire. The workshop should be separated from any adjacent rooms by a fire-resistant wall.

19.6. Some general precautions with machinery are discussed in Chapter 8.

### METALWORKING MACHINES

#### *Lathes.*

19.7. If a lathe is not handled properly it is a dangerous machine. Injuries have been caused by contact with projections on chucks or faceplates or on work in the stock, attempting to remove chips by hand, and flying metal chips. To avoid dangerous contact a simple shield can be installed around the chuck or faceplate. Coiled chips should be removed by a hooked rod provided with a shield for the hand, and small chips by using a brush. Compressed air should not be used to remove chips from a lathe

or drill table, nor should the bare hand. To save the eyes from flying chips, goggles or other eye protection should be used, especially when cast iron or other brittle material is worked. Long worked stock material extending beyond the chuck may be a hazard if bent by centrifugal force; it should therefore be properly guided.

### *Drills.*

19.8. Insecurely clamped or supported work is one of the prevalent causes of accidents with drills, for the tool sometimes sticks to the work and spins it—with possible injury to the operator. A dull tool increases this risk. Such accidents will not occur if the equipment is kept in good order and the work is properly secured against spinning.

### *Grinding-wheels.*

19.9. An abrasive wheel or grinding-wheel is operated at a very high speed. If the wheel breaks or parts of it are thrown off, the pieces fly out with violent force and usually cause severe injury to the operator or damage to the workshop. Breaking abrasive wheels are responsible for many injuries every year.

19.10. An abrasive wheel of good quality, properly handled and correctly mounted in a grinding machine constructed in accordance with recognised standards, can as a rule be considered safe. As it is difficult to see whether a wheel in a machine has defects, is subject to severe strains, or is otherwise liable to break, it is almost impossible to foresee whether its use involves particular dangers.

19.11. The chief causes of abrasive wheels breaking are incorrect set-up, not using a work-rest or having an improperly adjusted work-rest, defective wheel guards, excessive wheel speed, applying work to a cold wheel too soon, vibrations, wrong size of flanges or flanges of unequal diameter, wheel out of balance and incorrect alignment of the wheel.

19.12. Before mounting a wheel, one must make sure that the speed specified by the manufacturer corresponds with the speed

of the machine. The wheel can be tested by tapping it gently with a wooden screwdriver handle or the like. A clear, metallic sound indicates that it is in good condition. A wheel should not be forced onto the spindle because force may damage or crack it. A regular, straight wheel should be mounted between two flanges of equal diameter not less than one-third the diameter of the wheel, and both flanges should be recessed on the side next to the wheel. Washers of elastic material should be inserted between the flanges and the wheel. The spindle and nut should hold the wheel firmly but not too tightly. After mounting, the wheel should be tested by running it at full speed for one minute, during which time nobody should stand in line with it.

19.13. The machine should be provided with a guard to retain the pieces of the wheel if it should break in operation (fig. 59). The guard should not expose more of the wheel than is necessary for the work. It should be made of steel or other equally tough material and be sufficiently strong to withstand the force of a wheel breaking. A wheel should never be run without such a guard.

19.14. Many wheels have been broken or operators' hands crushed because work has become wedged between the work-rest and the wheel when the distance between the two is too great. The work-rest should be properly adjusted and securely clamped not more than  $\frac{1}{12}$  in (2 mm) from the wheel. Grinding wheels should not be allowed to stand partly immersed in water, for the water-soaked part may throw the wheel out of balance. Abrasive wheel operators should wear suitable goggles or screens to protect their eyes against flying fragments (fig. 59).

### *Grindstones.*

19.15. Grindstones are made from natural sandstone. The material is soft and will not stand the strains of any great peripheral speed. Many grindstones used in farm work have shattered, causing injury and even death through being operated at too high speeds. Grindstones should not, as a rule, be run at speeds greatly in excess of those obtainable when they are operated by hand.

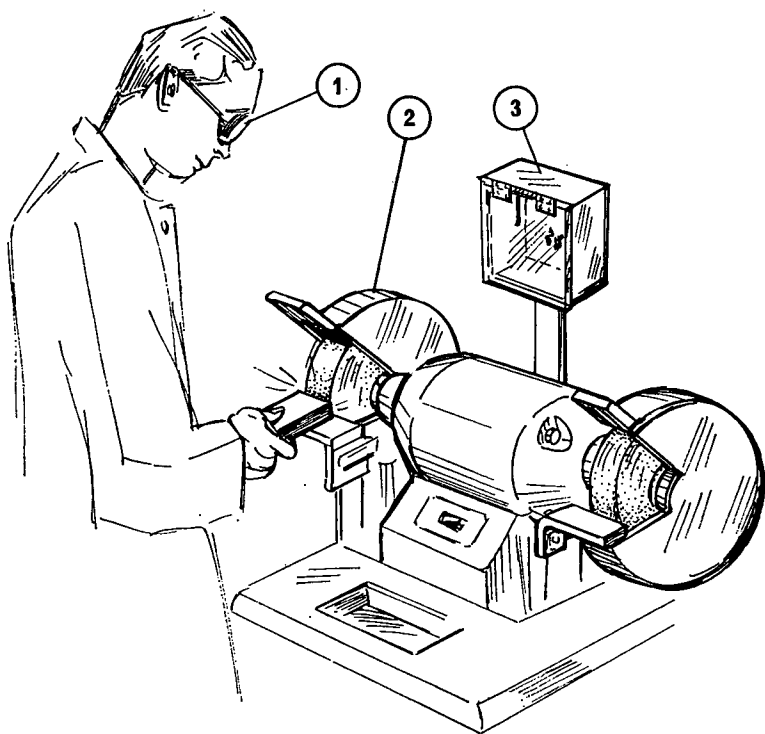


Fig. 59. Operating a grinding-wheel.

1. Safety goggles. 2. Grinding-wheel guard. 3. Box with lid on the front to protect goggles from dirt and damage when not in use.

They should be perfectly circular and should be mounted and maintained in good balance and well centred. They should not be left partially immersed in water, for this unbalances them.

## WOODWORKING MACHINES

*Circular Saws.*

19.16. The circular saw is one of the most dangerous machines in use, continually causing serious injuries or even death. There are two main types of accident: contact by the operator or his helper with the saw blade, and kick-backs. A kick-back occurs when a workpiece or a splinter is seized by the teeth on the back or the top of the blade and is thrown forward. The object can have a speed of some 90 miles (150 km) an hour, and will kill or severely injure anyone in its way.

19.17. For up-sawing, circular saws should have a riving-knife. The riving-knife should be made of good quality saw-blade steel. It should be slightly thinner than the cut but thicker than the blade; its curvature should follow that of the blade; it should be rigidly mounted and adjusted not more than  $\frac{1}{8}$  in (3 mm) from the blade and with the top about  $\frac{3}{16}$  in (5 mm) below the top of the blade.

19.18. The hood should cover the part of the saw-blade projecting above the workpiece when the saw is cutting. It should be easy and safe to move up and down to fit different thicknesses of work and be moved down while the saw is running idle so that the whole blade above the table is covered. The cover can also be made adjustable to the thickness and size of the work. Suitable guards of recognised construction are made and may be obtained from the manufacturers (fig. 60).

19.19. On small saws the hood may be attached to the riving-knife, if the knife is constructed to hold the cover rigidly so that it will not wobble and strike against the saw-blade.

19.20. Kick-back is prevented if the riving-knife and the hood are properly constructed, mounted and adjusted as described above.

19.21. When firewood is being sawn, the wood should be fed to the saw with a device that keeps the hands away from the blade. The device should return automatically to its position of rest, and when it is not in use the blade should be completely

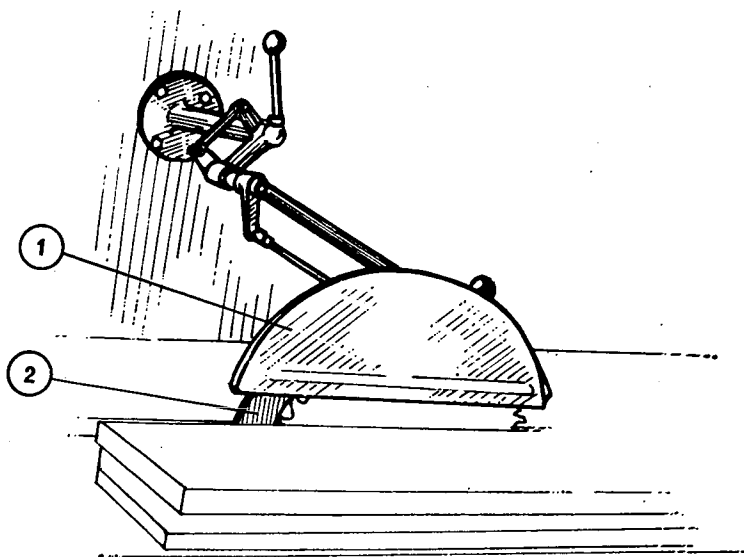


Fig. 60. A properly guarded circular saw.

1. Guard. 2. Riving-knife.

enclosed. Protective devices should not obstruct the view of the cut.

19.22. Contact with the saw is most frequent when the operator's hand slips off the workpiece while he is pushing it into the saw or tries to clean the table with his hands while the blade is running. It is very dangerous to touch the side of a running blade as the blade is apt to push the hand from its centre and towards the teeth. Helpers are injured by coming into contact with the blade while removing scrap or finished pieces. Contact with the saw-blade can be prevented by fitting the proper types of riving-knife and hood guard, and by using push-sticks.

19.23. The part of the saw-blade underneath the table should be effectively guarded. Where this safety requirement has been neglected, persons have been injured, e.g. when removing chips.

19.24. Hands should not be near the saw-blade. The workpiece should be pushed close to the blade with a push-stick so as to keep it out of the line of the cut.

19.25. A cross-cut saw should not be used for ripping or a ripsaw for cross-cutting. Using the wrong saw makes the work harder, but a cross-cut saw used for ripping is particularly liable to cause kick-backs.

19.26. The saw-blades should be kept in good and sharp condition with well-rounded gullets; sharp angles in the gullets start cracks. Blades with cracks should be discarded, for cracks may cause fragments to fly off from the blade. Repairing by brazing or welding makes the blade unsafe to use and should not be done.

#### *Band-saws.*

19.27. Injuries from band-saws are less frequent than those from circular saws, but they are not uncommon. It is not only hands coming into contact with the saw band that have caused injuries. Ends of broken bands on unguarded machines have been thrown out and severely injured the operator, and bands that have slipped off the upper wheel have fallen round the operator's legs.

19.28. The saw should be entirely enclosed except for the point of operation (fig. 61). An adjustable guard should be provided at this point covering the saw band at the front and on both sides, and be set as low as the work permits.

#### *Planers.*

19.29. Overhand planers are dangerous machines. Injuries arise from hands and fingers coming in contact with the knives, particularly when short pieces are being worked; in particular, kick-backs come easily and unexpectedly.

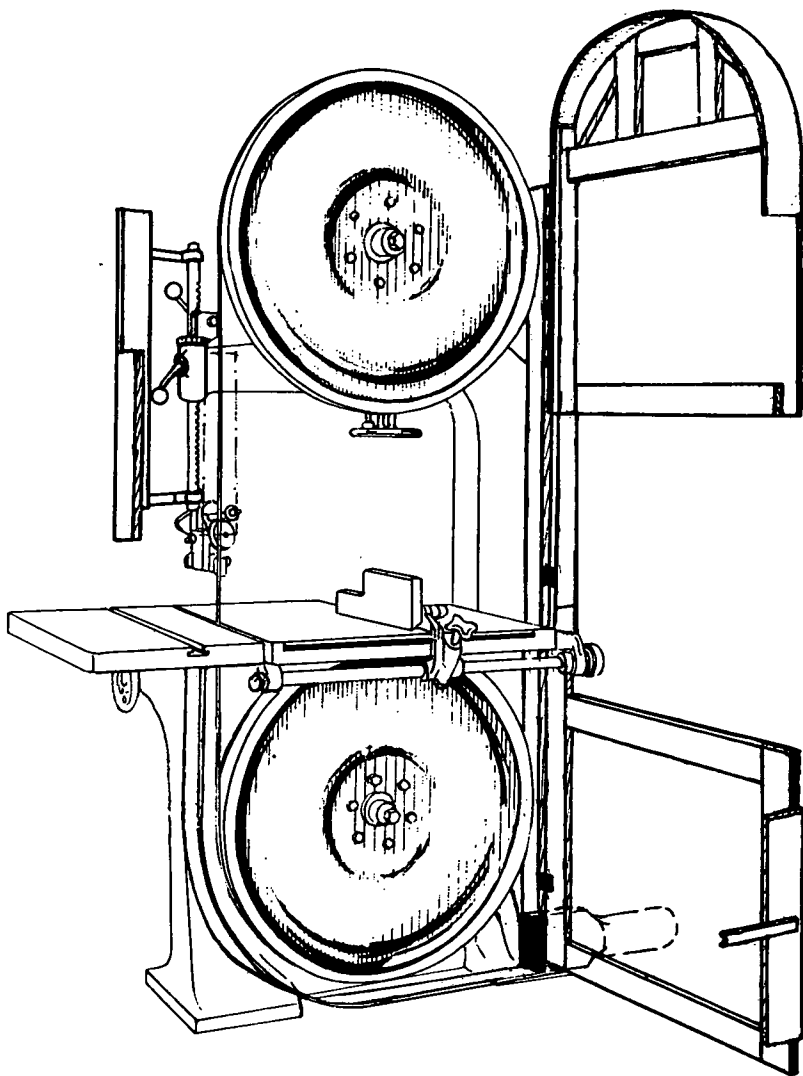


Fig. 61. Band-saw with wheel guard opened.



19.30. Cylindrical cutting heads do not cut hands as severely as square heads and should, therefore, always be used. A telescoping or other guard over the table opening should always cover the part of the cutting head not in use. As the guards must be convenient to work with, they should not be improvised, but must be of a standard design (fig. 62).

19.31. Accidents have happened when people passing by a planer have come into contact with the cutting head, not realising it was in motion. The machine should not be left unattended while in motion.

### *Combined Machines.*

19.32. Some farms have combined machines such as a circular saw with a planer, an abrasive wheel or a drill on the same shaft. Such machines can be very dangerous, since a saw-blade, for example, may be running idle while grinding is being done on the abrasive wheel. The machine should be provided with guards enclosing the part which is not in use while the other is working.

19.33. Other combined machines include a circular saw with a planer and a shaper, or similar combinations, each tool running on its own shaft. The saw and the planer should be guarded as described above. For the shaper, fabricated guards of recognised construction are often difficult to obtain, but a skilful craftsman can make guards himself suitable for his work; they must, however, be so constructed that fingers cannot accidentally come into contact with cutting tools. A shaper should never be used without guards. A combined machine of the last-mentioned type should be so arranged that only one of the machines can be run at a time.

## FORGES

19.34. The chimney from a permanent forge should be large enough and high enough to carry off the smoke and gases. Above the forge a suitable hood that efficiently prevents smoke from coming out into the shop should be fitted. No combustible material should be allowed near the forge or near the place where

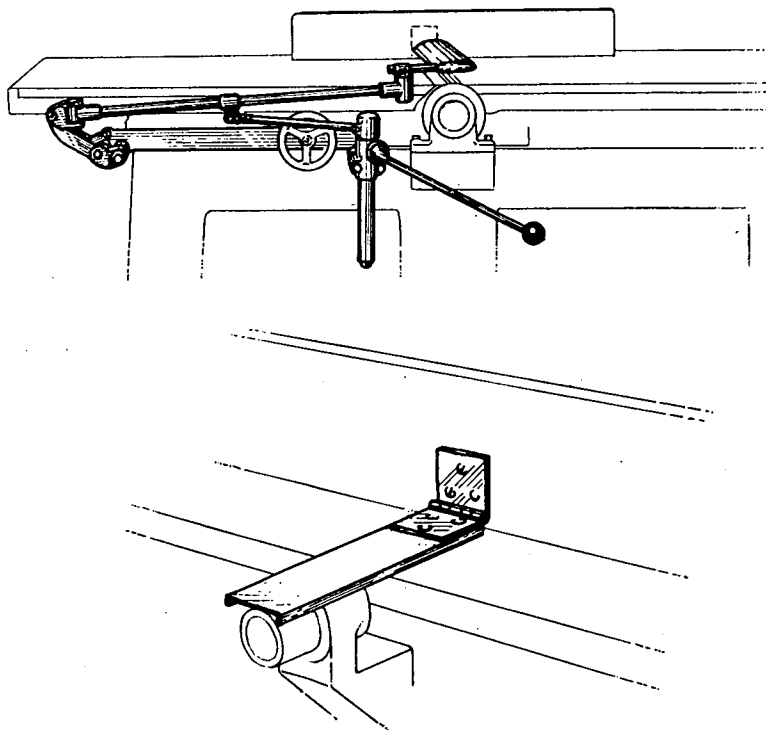


Fig. 62. Guards for overhand planer.

Above: guard for planer blade. Below: guard at the back of the machine for the part of the cutting head which is not in use.

forging work is done, and no fire in a forge should be left without supervision. A portable forge should not be placed within 20 yards (15 m) of a farm building or combustible material.

## WELDING AND CUTTING

19.35. Welding and cutting on farms are generally done with gas purchased in cylinders, the contents, acetylene or oxygen, being marked on each cylinder.

19.36. When a cylinder is not connected for use, the cap protecting the outlet valve should be kept on the valve. Cylinders should be handled carefully. Misuse or mishandling may result in explosion. Tampering with safety devices such as valves on cylinders may cause serious accidents.

19.37. If a cylinder is overheated, e.g. in a fire, it will explode and may cause considerable damage to buildings and injury to persons. The best way to keep cylinders is to have them mounted on a special cylinder truck. Trucks are usually available commercially. Cylinders on trucks are convenient to move to welding places, and can easily be taken out in case of fire. If a cylinder is not too hot to hold there is no danger in moving it.

19.38. The truck with cylinders should, when not in use, be stored indoors, near a door so that it can quickly be taken out in case of fire (fig. 63). A warning should be posted on the building close to the door clearly indicating that there are cylinders inside. Such notices can be obtained from the gas supplier.

19.39. No flame or excessive heat should be allowed to come into contact with any part of a gas cylinder.

19.40. The valve of the oxygen cylinder must not be lubricated, nor must the cylinder be so placed that oil or grease can get onto the cylinder or fittings. If oil or grease comes in contact with oxygen it will ignite and perhaps cause an explosion.

19.41. Welders must be sure to have the hoses properly connected, open the cylinder valves slowly, and test the connections for leaks with soapy water or leak-test solution. No leak should be permitted, for it involves danger of fire and injury.

19.42. A torch flame has a very high temperature and will quickly ignite combustible material if it is too close. There is a risk of ignition up to one yard (1 m) from the torch. In addition, the workpiece may be heated sufficiently to ignite material near

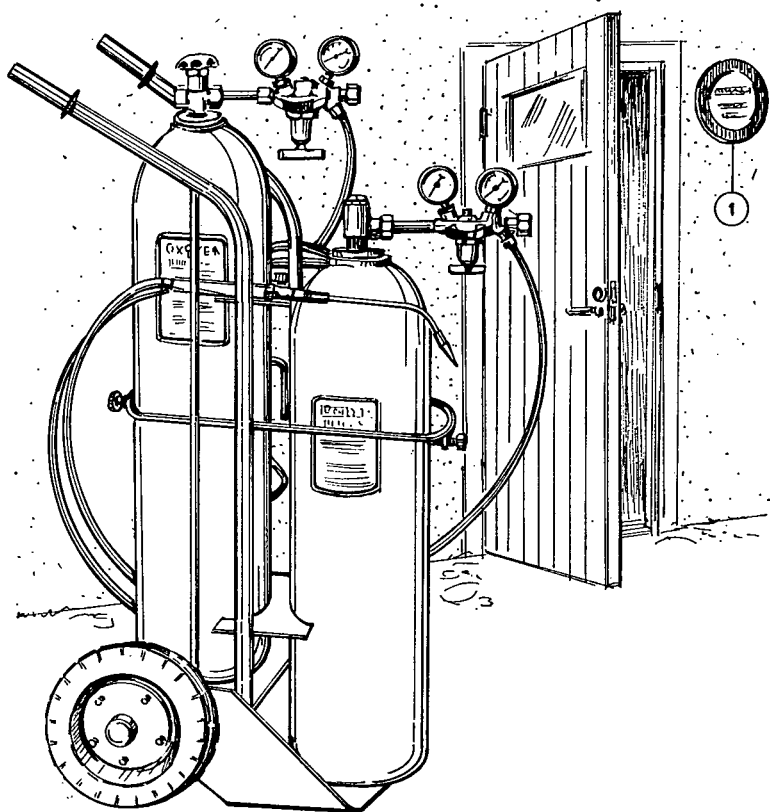


Fig. 63. Truck-mounted welding equipment.

1. Sign indicating the presence of the cylinders. It should be placed so that it will not be covered by the door when it is open.

the welding point. A pipe-line, for example, may conduct the heat and ignite combustible material some distance away.

19.43. A serious fire hazard arises from the sparks or hot slag thrown out from the point of welding or cutting. If they

reach material such as chaff, wood wool, greasy cloths or flammable liquids a fire may quickly start. Sparks and slag usually fall near the point of work, but sometimes they fall some distance away. Cases are known where sparks have been thrown 25 yards (20 m) and started a fire. It is easy to prevent such accidents by using suitable screens, e.g. sheet steel or tarpaulin.

19.44. Welding and cutting work should as far as possible be carried out in fire-resistant surroundings. It is usually practicable to arrange such surroundings in the forge shop. The floor around a welding space must have non-combustible covering, e.g. earth or cement, and the place must be kept free from flammable material. The risk of fire is then very small.

19.45. The fire hazard is considerably higher when welding or cutting is carried on in places where adequate precautions are difficult to take or are not taken. Repair work on buildings or machines has in such cases caused many fires and considerable loss of property. It is therefore advisable to take the trouble to move the work to the forge shop or outdoors. Welding or cutting inside farm buildings should not be permitted. Outdoors, such work should not be done within 20 yards (15 m) of any farm building or combustible material.

19.46. If it is not possible to move the work out of doors, some other means of repairing, e.g. bolt jointing or hack-saw cutting, may be tried. When a new machine or other equipment is installed, it is advisable to watch the installer so that welding or cutting is not done inside any of the farm buildings. However, it is not always possible to avoid welding or cutting inside a building. The work may be permitted if adequate measures are taken to prevent fire, e.g. surrounding the place with sheet steel or wet covers, providing effective fire-extinguishing appliances and maintaining close supervision.

19.47. A fire-extinguisher should always be at hand when welding or cutting is being done.

19.48. Since the light from the torch flame has a harmful effect on the eyes, they must be protected by goggles consisting of outer shaded lenses and inner clear glass lenses. When cleaning

welds, the welder can raise the outer lenses, and the inner lenses will protect him from flying slag particles.

19.49. Electric-arc welders require a special helmet or face shield with a light-filtering window. Not only the eyes but also the face must be protected against the strong ultra-violet radiation produced. Other persons, too, must be protected from the rays from the electric arc, which have a very high and harmful intensity. Looking directly into an electric arc may cause permanent eye injury, and hence adequate screening should be provided around all workplaces in which electric welding is to be carried out, in order to ensure full protection against injury by radiation from the welding arc for all persons working or passing by.

19.50. During welding operations certain gases or fumes are given off. When clear carbon steel is welded in well-ventilated areas under ordinary conditions no health hazard will arise, but for welding in small confined areas, e.g. a space screened on all sides, adequate ventilation must be provided. If the steel is coated with tar, paint, lead or zinc, toxic fumes are generated and must be prevented from concentrating around the welder.

19.51. Drums and other closed containers which have held petrol, kerosene, pitch, sulphuric acid or other flammable liquids or substances producing flammable gases are very dangerous if heat from a welding torch is applied to the shell. The remains may be very flammable even if the container has been stored empty with an open bung for a considerable time. An explosion can occur in a 40-gallon (200-litre) drum which contains two table-spoons (60 ml) of petrol. Many violent explosions, causing deaths or severe injuries, have occurred when empty containers have exploded. Welding or cutting on a drum or other closed container should be avoided on farms. If it is done, the container must first be cleaned thoroughly by applying steam to it for at least one hour, and then filled with water to within 1-1½ in (2-4 cm) of the place where the work is to be done. No open flame or other source of ignition should be in the vicinity of the container during these preparations. When applying the torch to the shell,

the welder should stand at the side of the container because it is the ends that fly out if the container bursts.

### THAWING PIPES

19.52. The safest method of thawing frozen pipes is to use hot water or steam. It takes some time, but there is no risk of overheating or damage to the pipes being treated. A quicker way is to use electricity. As high current intensity must be used, there is a risk of overheating and fire. Only a qualified electrician should be permitted to do such work since he alone is able to monitor the heating carefully with instruments. After the work is finished, however, the heated installation should be inspected and watched for possible overheating in hidden places. It should be forbidden to use any type of torch, open fire or radiant electrical element because of the risk of igniting combustible material.

19.53. Pipe-lines and fittings of a boiler must be carefully thawed before firing the boiler; otherwise an explosion may occur.

### SCAFFOLDING

19.54. The timber for scaffolding should be sound, reasonably straight-grained and free from defects. Round timber should be barked to enable the quality to be judged. Scaffold planks can be tested by placing them on supports spaced at distances equal to the anticipated span about 12 in (30 cm) above ground and loading them to twice the maximum load to be carried.

19.55. A scaffold should be built and supervised by a competent person. The nailed joints are important for its structural stability and should be carefully made. The joints for bearing members should be reinforced by means of cleats nailed below them.

19.56. Platforms should be provided with guardrails and toe-boards.

19.57. Stairs, ladders or other safe and convenient means of access to platforms should be provided.

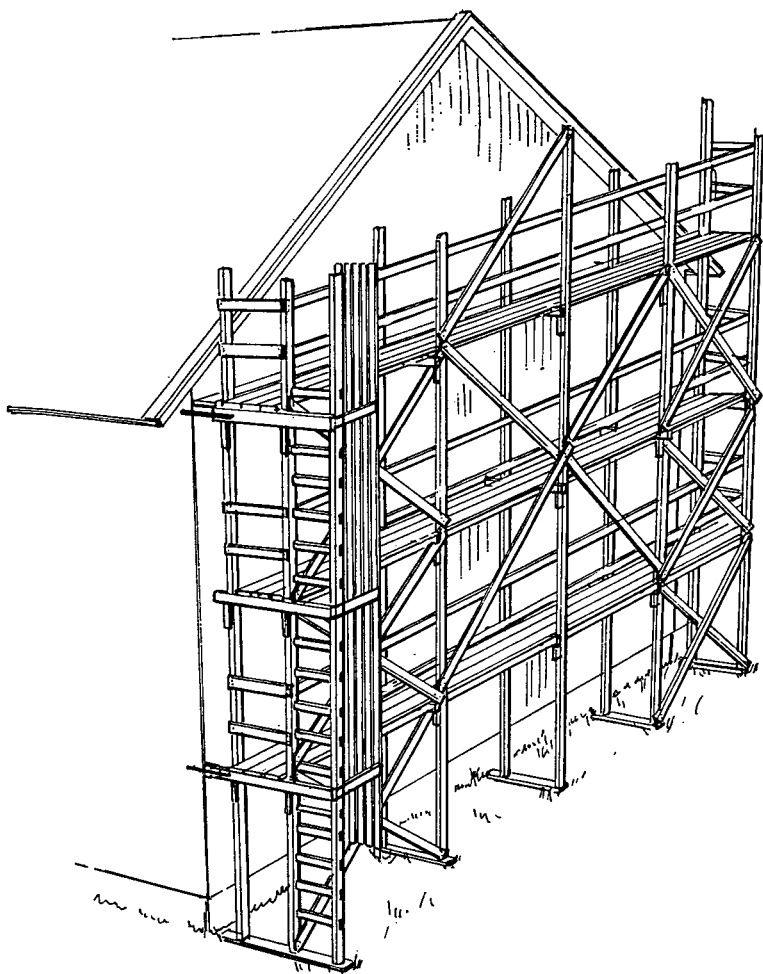


Fig. 64. Scaffolding of sound construction.  
Fencing is provided for platforms.



19.58. Scaffolds should be well anchored to the building or otherwise secured against falling, even under exceptional conditions, such as storms (fig. 64).

### WORK ON ROOFS

19.59. Roofs and chimneys require inspection and maintenance. Steep roofs on high buildings constitute a hazard of falls causing serious injuries or death. A rail or similar device at the eaves is a good protection against slipping off the roof, and is also useful for preventing snow and ice from sliding and falling down on persons or animals. For better safety, a person working on a roof should use a lifeline which should be long enough to permit freedom of action but as short as possible to avoid a severe jolt in case of a fall (fig. 65). Further information on safety belts will be found in Chapter 24 on personal protective equipment.

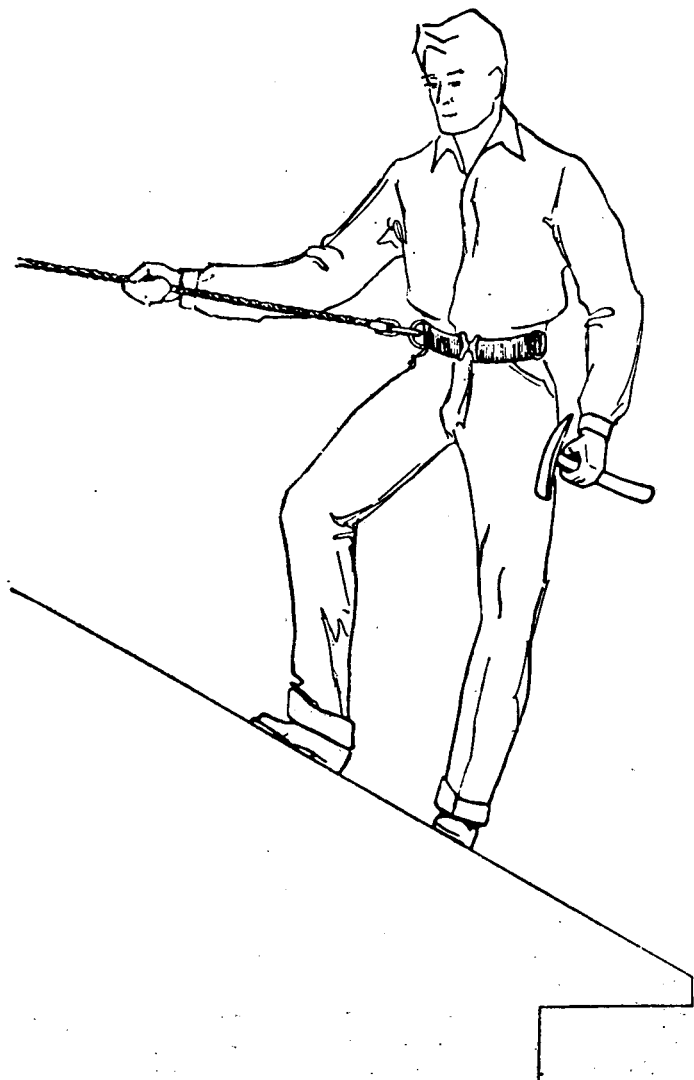
19.60. Fragile roofs, for example asbestos-cement roofs, are dangerous to step on. Many persons have fallen through such roofs and been killed. Cat ladders or crawling boards should be provided for the use of persons having to work on or cross them. A permanent warning notice should be kept on any building with a roof constructed of fragile material.

19.61. If work on roofs has to be done near overhead electric lines, the current should, if practicable, be cut off for the duration of the work.

### EXCAVATIONS AND WELLS

19.62. Many fatal accidents occur every year through workers being buried or crushed during excavation work. Most of these accidents are due to the caving in of the sides of trenches in which timbering or shoring has not been provided. Persons working in trenches often have to work in a bent position and can consequently be easily trapped although the depth of the excavation may be only about half the height of the average person.

19.63. The sides of any excavation or trench more than 4 ft (1.2 m) deep should be shored with timber or other suitable



**Fig. 65. Safety in roof-climbing.**

**If no other precaution is taken to prevent falls from roofs, a rope securely attached to a chimney or other reliable support should be used.**

material to prevent a fall or dislodgment of sand, earth, rock or other material forming the sides of the excavation.

19.64. The sides of an excavation may appear to be safe and unlikely to collapse, but appearances are often deceptive. There is always the danger of hidden loose pockets of sand, earth, rock or rubble caving in without warning. Land which has been worked and re-excavated land are often very treacherous and liable to collapse. To keep the pressure on the sides of a trench or other excavation to a minimum all excavated material should be thrown at least 40 in (1 m) from the edges, and no loads should be placed near it.

19.65. When wells are being dug every precaution against caving in of the sides should be taken, for there is no escape in case of accident. Concrete linings are sometimes inserted in sectional lengths one after another. In such cases shoring is not necessary, provided that the depth of side exposed does not exceed 40 in (1 m) at any time.

19.66. If a well has to be cleaned out, care should be taken that it is properly ventilated before any person enters. There is often a lack of oxygen or the presence of marsh gas or carbon monoxide to be reckoned with. No person should be allowed to smoke while working in a well; to do so may reduce the oxygen level below the safe limit or perhaps cause an explosion of a methane and air mixture. In many cases workers have been overcome by the bad air when working in wells. Under no circumstances should an internal combustion engine be used close to a well in which a person is working or about to work, because of the danger of the exhaust fumes from the motor entering the well. It is sometimes claimed that it is safe to enter a well in which a lighted candle continues to burn. The lighted candle test, however, is useless for the detection of carbon monoxide and should never be used for this purpose.

19.67. The following safety precautions are recommended for work in a well:

- (1) Before anyone enters, clear it of any gases that may be present

by blowing in a plentiful supply of air. The air in the well should then be tested.

- (2) Continue to blow air into the well while anyone is in it.
- (3) Any person entering the well should wear a safety belt attached to a lifeline secured to the top of the well. A man should be posted at the top to pull him out if he becomes ill or for any other reason is unable to climb out.
- (4) Any worker who gets a headache or feels giddy should leave the well at once.

## 20. BLASTING

### GENERAL PRECAUTIONS

20.1. The use of explosives involves considerable hazards and the safety problems to be solved are complicated. Unfortunately many people handling explosives or working with them are not acquainted with the hazards, although they believe they are, and for that reason many severe accidents occur every year.

20.2. This chapter gives some rules for the use of explosives in agricultural work. These rules are by no means comprehensive, for the subject is too extensive to be covered in a few pages. However, they set out the essential precautions applicable to blasting in agriculture and should be known by everybody concerned with it. They are without prejudice to any precautions laid down in national laws, regulations or recognised standards that have to be observed. Regulations concerning transport, storage and use of explosives and detonators are made to protect people and property against accident and damage. Usually only persons holding a permit may possess explosives and only a qualified person holding a blasting permit should be allowed to handle and use them. Appropriate warning should be provided on receptacles containing explosives as well as at places where explosives are stored (fig. 58).

### TRANSPORT, STORAGE AND HANDLING OF EXPLOSIVES

#### *Transport.*

20.3. Vehicles in which explosives are carried should be lined with wood and covered with cloth or tarpaulin. No smoking should be allowed and no passengers carried. Detonators and explosives should be kept in separate packages during transport.

The vehicle should fly a red flag or carry some other approved indicator. Tools or other articles should not be carried with explosives. When carrying the explosives from the vehicle to a storeplace or place of use, workers should not put them in their pockets, but should use special bags or containers. The packages or containers should be handled gently.

#### *Storage.*

20.4. Most countries have strict regulations regarding the storage of explosives and it is usually necessary to obtain a licence for the purpose from some government department. Explosives should be stored in a dry, well-ventilated and reasonably cool place at a safe distance from occupied buildings or areas. No stove or open light should be permitted in the room. Explosives should be securely locked up to prevent unauthorised persons getting at them. Explosives should not be stored together with activators or primers, and no flammable material should be kept in the storeplace. Dynamite should not be left where livestock can get at it, for they may eat it, with fatal results.

#### *Handling.*

20.5. Explosives should be kept in containers. The containers should be protected from jolts, kept closed when not in use, and opened only with non-sparking tools. Explosives should be kept away from open flames, sparks and excessive heat, and should not be handled during electrical storms.

### DRILLING AND LOADING BOREHOLES

20.6. A borehole should not be made near another borehole if it is not positively known that the first hole is unloaded. If there are explosives left in the hole the drill may come into contact with them directly or indirectly through cracks in the rock and cause detonation. The minimum distance from one hole to another should be 6 in (15 cm), and no old hole or socket should be drilled or deepened.

20.7. All holes should be cleaned out and left to cool before loading. All persons other than the loader should be kept at a safe distance. Holes must be loaded carefully with all due precautions by competent persons. Unqualified persons should have no part in loading operations. There should be no smoking.

20.8. Tamping should be done with soft material such as loam, sand or clay mixed with water, or with water cartridges. Tamping bars should be made of wood or other suitable non-sparking material. Unfortunately, people sometimes use a drill or an iron bar for tamping, which is very hazardous, for the explosives may be ignited. Care must be taken not to kink or damage fuses when tamping; the flame in the fuse may jump and considerably shorten the burning time, or else be blocked and cause a misfire.

## FIRING

### *Firing with a Fuse.*

20.9. The fuse should be handled carefully. Oil, kerosene or similar solvents, heat, sharp bends and cracks, are among influences affecting the burning speed and may cause accidents as a result of premature firing, delayed firing or misfiring. Fuses must be capped and prepared at a safe distance from other persons. The detonators and capped fuses should be kept at least 30 ft (9 m) from the explosives box or other container. To ensure that the end of the fuse is dry a short piece should be cut off. Fuse caps that have been soaked in water should not be used, even if they have dried out. The fuse should be cut squarely across, and inserted into the blasting cap so that it will be properly seated against the charge in the cap. The cap should only be crimped to the fuse with a special cap crimper. Other tools will flatten or otherwise ineffectively crimp it. Workers should never crimp caps with their teeth. The fuse must be long enough—at least 40 in (1 m)—to give the blaster enough time to reach a place of safety after lighting it. Standing behind a tree is not effective

cover since it offers poor protection from ricochetting or falling material.

*Electric Firing.*

20.10. This requires proper knowledge of the material and equipment used and special apparatus for testing the circuit and for firing. Blasting machines of approved types should be used. Dry cells for batteries are not reliable because of the uncertainty of the extent of charge, and of the voltage drop when a load is applied. They are therefore dangerous and should not be used. Connecting the wires directly to an electric power line is also dangerous and should never be done. If a thunderstorm approaches blasters should discontinue electric firing and move to a safe place away from the explosives, because lightning may cause a premature blast. The same thing can happen if a radio transmitter is used in the vicinity, since radio frequency currents can be induced in the firing line and may set off the charge.

*Protection of the Vicinity.*

20.11. A blast, even a small one, may throw rocks, soil, etc., a considerable distance. Look-outs equipped with red flags must be posted to ensure that the blast area is kept clear. The person firing the shot must make sure that the danger area is definitely clear of persons and animals, and he should give an agreed signal or warning before firing. Heavy blasting mats should be placed in front of or over the blast to prevent flying fragments from hitting nearby buildings or other easily damaged constructions or objects.

*After Firing.*

20.12. Whatever the method of firing, an inspection should be made to determine whether all the charges have exploded. After firing with electricity the leads should be disconnected from the blasting machine or other source of power and be short-circuited. A search for wires and unexploded cartridges should then be made by the person in charge of the blasting operations. The search should be unhurried and thorough.



20.13. No one should return to the face after a blast until sufficient time has elapsed to allow the smoke, dust and fumes to clear away. Obscured vision may cause accidents, and the fumes contain toxic gases.

20.14. A misfire or a burning hole should not be approached until one hour has passed so that there is no likelihood of its exploding. A missed hole is very dangerous. It should never be abandoned. Only an experienced man should be allowed to investigate and deal with it. Misfires should be disposed of only as prescribed in national laws and regulations or by the competent authority.

#### MUDBLASTS

20.15. Boulders are often blasted by laying cartridges on top of them and covering them with 3-4 in (7-10 cm) of mud. The cartridges should be in close contact with each other, and the covering should be free from rocks or other material, which might constitute a hazard by flying off. Mudblasts should not be used near buildings, because the blast cannot be covered by blasting mats, which would be projected by the shot. For mud-blasting, the same precautions should be taken as for blasting in shotholes (warning signs, guarding the area, etc.).

#### BLASTING TREE STUMPS

20.16. Dynamite is sometimes used to blast out or split tree stumps. The hazards are similar to those described above and the same precautions must be taken. As material can be thrown long distances care should be taken that all persons and animals are beyond the range of flying objects.

#### DISPOSAL OF EXPLOSIVES

20.17. If there is no further need for explosives, fuses or detonators, or they have deteriorated from any cause, they should be destroyed so that they cannot fall into the wrong hands,

especially those of children. The method of disposal must conform to the requirements of national laws and regulations or of the competent authority. If an experienced or competent person is not available on the farm, or there is any question about the safety of the destructive methods, a competent person or the supplier of the material should be consulted.

20.18. Detonators can be safely destroyed by crimping them to a fuse and exploding them at a safe distance.

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## **21. FIRE-FIGHTING**

### **GENERAL PRECAUTIONS**

21.1. As has been seen in other chapters, common fire hazards include defective chimneys, poor housekeeping, badly maintained and hence overheated machines; defective, poorly insulated or overloaded electric wiring; careless use of flammable substances; open lights or flames; lack of lightning protection; portable heaters placed near combustible material; spontaneous combustion from moist hay or crops or from chemicals such as quicklime and sodium chlorate; and the use of tractors or motor vehicles inside buildings where they may set fire to dust, chaff or other combustible materials.

21.2. It has also been seen that fire hazards can be substantially reduced by the adoption of a number of safety rules. The first is that the buildings should as far as possible be constructed of fire-resistant material and designed so that fire cannot spread either horizontally or vertically through wall openings, floor openings, elevator shafts or ventilating ducts. Buildings and stacks of hay, crops, wood or any other combustible material should be spaced sufficiently far apart to prevent the spread of fire from one to another.

21.3. Detailed fire precautions are explained in the earlier sections of the manual. Inspections should be made to discover whether any fire risks have developed or are developing. Farmers are recommended to seek the advice of their local fire brigade and their insurers on points connected with fire prevention.

### **FIRE-FIGHTING EQUIPMENT**

21.4. Fire-fighting and first-aid equipment should be kept available near farm buildings and rickyards and on vehicles and

machines so that any outbreak of fire may be attacked without delay pending the arrival of the fire brigade, which should always be called immediately a fire is discovered (fig. 66). Fire-fighting equipment, and especially extinguishers, should be of types conforming to the requirements of the competent authority or to national standards. Unless the equipment is maintained in good condition it may be useless when a fire occurs. Frequent inspection and regular maintenance are necessary.

21.5. The danger of fire is greatest at harvest time and during threshing. Extinguishers in good working order should at all times be carried on machines and vehicles.

21.6. Water is the most efficient extinguishing agent for use on most fires that are likely to occur on farms. Water buckets, soda-acid and water (gas pressure) extinguishers and portable pumps are the most suitable items of first-aid fire-fighting equipment for the protection of farm buildings and rickyards. Where piped water is available at sufficient pressure, hose reels should be provided. Buckets and portable pumps can be replenished from butts, tanks, or taps installed nearby.

21.7. Every motor vehicle, and out of doors every stationary engine, should be equipped with a foam fire extinguisher. Combines should also carry beaters. Foam extinguishers should be provided for liquid fuel stores and for plant and equipment using oil such as grass and grain driers and heating systems.

21.8. Beaters can be usefully employed in controlling fires in growing crops, in heather and bracken and in plantations. They are easily made by binding the green branches of hazel, elder, birch or almost any other tree around a handle cut from a thicker branch. Other types of beaters can be made by fixing wire netting, sacking or canvas to broomsticks.

21.9. Soda-acid and foam extinguishers require protection against temperatures below 5°C (40°F), and all extinguishers containing water require protection against frost.

21.10. Carbon tetrachloride extinguishers, extinguishers using other halogenated hydrocarbons, and methyl bromide extinguishers should not be used indoors because of the toxic vapours



Fig. 66. A fire-fighter in action.

that they generate. Some extinguishing liquids set up dangerous reactions with the materials on which they are sprayed and some cause skin injuries. The manufacturer's instructions should be carefully noted.

#### *Flammable Liquid Fires.*

21.11. Flammable liquid fires are not easy to extinguish. Quick and effective action is needed. Portable fire-extinguishers suitable for use against flammable liquid fires, e.g. foam, carbon dioxide or dry chemical types, should be kept in a handy place and in condition for instant use. Everybody on the farm should know how to use them. If the fire can be put out before it is beyond control damage can be kept to a minimum.

21.12. Small isolated fires, e.g. on floors, can often be put out by using sand or a rug rapidly applied. Water is generally not effective. It may spread the burning liquid and make control of the fire more difficult. However, a fine spray of water, e.g. from a spray nozzle, can be used in controlling a small flammable liquid fire. Water can also be used to keep tanks or other containers cool when there is a fire close to them and thus prevent over-pressure in the container and possibly an explosion, or to keep the surroundings cool while a fire that can be extinguished is burning itself out.

#### *Electrical Equipment Fires.*

21.13. Portable soda-acid, foam or water extinguishers should not be used for fires on live electrical equipment since the current passes along the spray to reach the person holding the extinguisher. Carbon dioxide extinguishers, dry powder extinguishers or other equivalent equipment must be used.

### WATER SUPPLIES

21.14. Inadequate supplies of water for fire-fighting have too often been the cause of widespread and unnecessarily expensive

damage. There must be water immediately at hand to confine farm fires to their place of origin. To help the fire brigade, all sources of supply should be developed extensively—natural and artificial alike.

21.15. The ideal is, of course, to have an adequate mains supply, but in many areas this is not possible. Even when mains are laid, other sources should not be neglected because the capacity of the mains may not be sufficient for fighting major outbreaks. There should be a water supply, natural or artificial, of at least 800 cubic feet or about 5,000 gallons (25 m<sup>3</sup>). This should be situated not more than 500 ft (175 m), and preferably not more than 300 ft (95 m), from farm buildings and rickyards. Where there are ponds or streams they should be kept free of rubbish and reeds, and they should be available for fire-fighting equipment. Sites sufficiently firm to carry large pumps should be provided close enough to enable short suction hoses to be used. Natural water supplies can be improved by digging deep pools near river banks, by damming streams or by providing sumps.

21.16. If natural supplies already available near farm buildings or rickyards cannot be depended upon for at least 5,000 gallons at all times of the year, this amount should be provided artificially, either by digging ponds where conditions are suitable or by installing static water tanks. Where open static water is undesirable from the point of view of farm hygiene (e.g. on farms housing tuberculin-tested cows) tanks may be sunk in the ground and provided with covers.

21.17. It may be necessary to protect the water supply against freezing in winter; frost-free plugs may have to be provided in ponds.

### FIRE ALARM SYSTEMS

21.18. An efficient fire alarm system should be installed in farm buildings with fire risks. Acoustic alarm systems such as bells or sirens should be distinctive in sound and pitch from

any other acoustic devices, and should not be used for any other purpose than that of sounding fire alarms or calling fire drills.

21.19. It is useful to post up the position of the nearest telephone and the telephone number of the fire brigade at convenient places.

### INSTRUCTION AND TRAINING

21.20. The personnel should be trained and instructed in the action that they should take in case of fire. Most fires can be extinguished or at least prevented from spreading if tackled in the early stages by workers who know what action to take. The time spent on training workers in fire protection practice and fire-fighting is well worth while. They should know where the fire-fighting equipment is situated and how to use it. The local fire brigade is often very willing to give the necessary training.

### FOREST AND FIELD FIRES

21.21. Beaters as described above can be used. Water supplies are often too far away to be readily available. The direction of the wind should be taken into account and efforts should be directed from the lee side of the fire. If the fire cannot be extinguished immediately it may be necessary to prevent it from spreading by ploughing a firebreak.

### RESCUING ANIMALS

21.22. A fire in or near a stable or cattle shed may require immediate action in order to save the animals. Such buildings should be planned and laid out to provide for the easy evacuation of animals. The exit doors must be of sufficient width for two animals to pass through at the same time and must open outwards. There should be at least two exits, since this increases the chance of finding one opening free from smoke or flames. Arrangements should be made to release the animals easily. There are various types of fastenings, which can be rapidly released for one



animal or a group of animals by a single motion of the hand. There should be a fenced area in which the animals can be placed so that they are under control.

21.23. Horses are more sensitive than cattle and more difficult to handle in case of fire. It may be necessary to cover their eyes to get them moving when there are sparks and flames nearby. An agitated horse can be more easily handled if the halter strap is put on the nose so that it slips through the attachment ring in the halter.

21.24. Cows can be driven out of cowsheds by using an electric pusher of the kind used in slaughterhouses. Cows which are difficult to manage can be handled with nose tongs.

21.25. Smaller animals are easier to rescue and special means of handling are not usually required. Pigs can be driven out with the help of a stick, but large pigs may require a pusher or a snout rope. Fowls should not be chased out of the fowl-house because they are apt to fly back. It is best to put them into sacks and carry them to a place where they cannot fly back.

21.26. All animals usually like to get back into their shelters, so when evacuated in case of fire they should be put where they cannot return to the burning building or to any place where they would be a hindrance to the fire-fighters.

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## **22. ERGONOMICS**

### **THE IMPORTANCE OF POSTURE**

22.1. Medical investigations have shown that certain diseased conditions of muscles and joints are due to unsuitable working postures. It has also been proved that work can be made easier and less tiring by adopting a good posture and good practices.

22.2. Everybody knows that it is tiring to hold an arm stretched horizontally. Fatigue and pain will be felt in a few minutes. Keeping the arm moving, however, will afford relief, for in a moving arm the tension is continually changing, and the motion in the muscles—dynamic work—speeds up the flow of blood. Working standing is sometimes more fatiguing than working sitting but is often necessary in farm work. Strain is reduced by standing with the legs wide apart and with the knees and ankles relaxed. Postures that require bending or twisting of the body should be avoided. If possible the work should be arranged so that the worker can sit for a short period once in a while to rest his legs and prevent the development of varicose veins due to sluggish circulation of the blood. After long spells of work in a sitting position some movement is desirable in rest periods.

22.3. Often the work need not be done standing, but often also tradition and prejudice are opposed to sitting.

### **MANUAL OPERATIONS**

22.4. Manual labour includes some basic operations that everybody should learn to perform correctly in order to save time

and energy. Among them are lifting, carrying, pulling, pushing, cutting and throwing.

22.5. In *lifting* work the muscles of the legs, arms, abdomen and back are used. If the wrong method is employed, for example lifting with the back bent and legs straight, not only the muscles but also the spine may be injured. When a load is lifted with the back bent and legs straight the load on the spine is fifteen times as much as it is with the knees bent and the head and back straight. This applies to all lifting, including the lifting of wheelbarrow shafts before wheeling (fig. 67). Lowering goods to the floor or the ground is essentially the reverse of lifting, and the same rule should be followed.

22.6. When a load, for example a sack, is *carried* on the back the body should be as upright and straight as possible and the load should be so placed as to ensure a good balance. When a load is carried in front, the body should be straight and bent slightly backwards. The load should be held underneath, and be kept close to the body. Short steps facilitate carrying.

22.7. When a load is *pulled* or *pushed* the heavier the load the more the body should lean. The arms and the leg behind the body should be in as straight a line with it as possible.

22.8. In the light of what has just been said it will easily be seen that, wherever practicable, mechanical appliances should be provided and used for the lifting and carrying of material and articles. A well-planned system of handling will reduce the workload, lessen the risk of accidents and improve productivity. Devices such as dolly ladders can be used for raising and lowering goods. A good practice is to have the floor or platform for loading or unloading at the same level as the vehicle floor.

### *Workers Needing Special Protection.*

22.9. Farms are places of work for very large numbers of children, adolescents, women and old people. Farmers should realise that these workers are more liable to suffer the consequences of handling heavy loads than men in the prime of life. Conse-

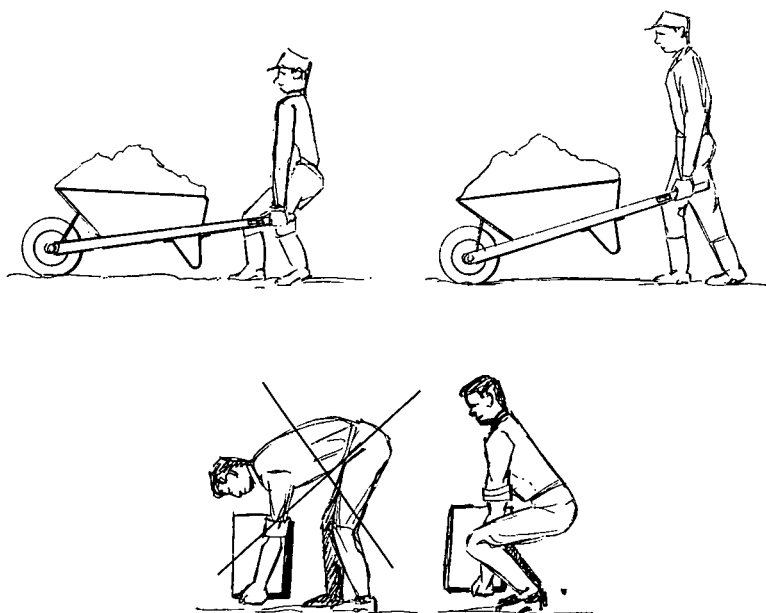


Fig. 67. Good lifting practices.

Above: For lifting a wheelbarrow, the knees should be bent and the back and neck kept as near vertical as possible. Below: the correct way to lift a load is to squat down with the feet well apart and the back straight, pick up the load holding it close to the body, and gradually straighten the legs. The method illustrated on the left should never be used, as it places undue strain on the back muscles.

quently, everything possible should be done to adapt their work to their capacities and to prevent them from handling heavy loads.

### IMPROVING UNCOMFORTABLE POSTURES

22.10. In farm work many jobs are done leaning forward, squatting or kneeling. Squatting or kneeling should be preferred

to leaning. Although squatting strains the thigh muscles, it is easier to move forward in a squatting position than on one's knees. Kneeling is more suitable for work in one and the same place, but if protection for the knees were provided it would probably be commoner than it is now.

22.11. Many uncomfortable working postures could be avoided or at least made less uncomfortable if more rational tools and implements were employed, and people were trained to use them in the right way.

22.12. Problems of posture arise in almost all farm work. It pays to study these problems and make any necessary corrections whenever this can reasonably be done. Not only the design and condition of tools and implements but also those of walkways, transport lanes, stairs and ladders are of importance, for bad design or maintenance often leads to incorrect postures. Farm machines are often inconvenient to operate but can sometimes be improved to make work easier. The operator should not be forced to assume postures that unnecessarily strain his muscles.

#### DISEASES AND MORBID CONDITIONS CAUSED BY INCORRECT WORKING PRACTICES

22.13. Occupational diseases or morbid conditions in farm work are caused in various ways. Infections and diseases acquired from animals are mentioned in Chapter 17. Some conditions result from overstrain, work in which the body is subjected to asymmetrical stresses, pressure against certain parts of the body in incorrect working postures, vibrations, etc.; they include backache, sprains and tenosynovitis.

22.14. Work involving considerable lifting and carrying can harm the back, causing lumbago. Injuries may arise because of continuous heavy work or momentary overstrain.

22.15. Repeated movements of the same joint can cause tenosynovitis at the joint. The disease is sometimes located at the wrist, but severe strains in a leg or a foot may cause a similar condition in the Achilles tendon. The inflammation gives rise

to sharp pain in the muscles, which sometimes swell. The trouble generally passes off after a period of rest. Tenosynovitis sometimes occurs during work like woodcutting, beet-lifting, peat-digging, loading and milking by hand. Experienced workers are not as easily affected as inexperienced ones. The trouble can be avoided by good working postures and practices that spread the strain among different groups of muscles.

22.16. If work involves crawling or squatting, certain nerves of the crotch muscles can be injured. This occurs during the trimming and lifting of beets and similar work. The trouble usually arises after a worker has been working for some time, and normally begins as numbness and pricking in the feet and the crotch when he rises from a kneeling or squatting position. When these symptoms occur, work should stop. Knee protection lessens the danger.

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## **23. SOME OTHER PRECAUTIONS**

### **HOUSEKEEPING**

23.1. Poor housekeeping is often a cause of accidents, fires and damage to equipment and stores. All working places, store-places, yards and walkways should be free of dirt and refuse.

23.2. Rubbish should be removed daily and deposited in a safe place to prevent fire.

23.3. Loose gear and equipment should not be left lying around in workplaces and passageways when not in use.

23.4. Places in buildings and yards that have been made slippery by rain, ice, snow, grease, oil, etc., can be made safe by strewing sand, ashes, sawdust, salt or other materials if they cannot be properly cleaned up.

### **STORAGE OF GOODS**

23.5. Badly stacked goods and materials are often dangerous to people and animals. Falling, rolling, slipping or sliding goods are sources of accidents leading to severe injuries and sometimes to death. As many storeplaces are outdoors, they can be dangerous to anybody on the farm, particularly children. The danger of a leaning woodstack, for example, is often neglected, but a child, when playing, may stumble against it and cause it to collapse.

23.6. Goods should be stored in such a way that they will not fall or otherwise constitute a danger. Sacks, baled material and boxes should be properly overlapped. Material should be so piled that the piles will not interfere with the lighting or the operation of machines or other equipment, obstruct passageways or traffic lanes or prevent the use of fire-fighting equipment.

23.7. Material should be piled on firm foundations not liable to settle. When goods are stored inside a building care should be taken that the floors are not overloaded. Material should not be stored against partitions or walls of buildings unless they are known to be strong enough to withstand the pressure. Material should not be stacked to a height that will render the pile unstable.

23.8. When heavy bagged material is stacked the mouths of the bags should be placed upwards, the first four bags of each layer should be tied together to prevent the others from slipping, and the pile should be stepped back by one bag at every fifth layer.

23.9. In order to avoid overheating and to ensure stability, lumber should be piled on supports above the ground, with horizontal or slightly inclined layers separated by tiepieces the ends of which will not project into gangways or walkways.

23.10. Silos have been discussed in Chapter 6, and the personal protective equipment needed when various kinds of dangerous substances are handled will be dealt with in Chapter 24.

### BURNING STRAW

23.11. If burning of straw is permitted it should not be done within 250 ft (75 m) of any building or place where flammable material is stored, or 130 ft (40 m) from standing corn or wood. Account should be taken of the direction of the wind, and no burning should take place in a high wind.

23.12. The burning of straw in connection with stationary threshing in the open has caused many fires in fields, woods and buildings. Damage has been caused by sparks or fire spreading along the ground, particularly when the wind has turned. In order to protect the thresher the pipe by which the straw is blown should be at least 130 ft (40 m) long and its discharge end inclined upwards with the opening at least 40 in. (1 m) above ground. The pipe will then be at a safe distance from the pile to prevent the fire from entering it.



23.13. Burning straw remaining on the ground after combine harvesting is hazardous because the fire may spread so rapidly that it cannot be kept under control. Adequate precautions must be taken. No machine should be left on the field where straw is burning. The field must be open or safely bounded; spreading of the fire can be prevented by ploughing a 40 in (1 m) firebreak around the field or by keeping a 33 ft (10 m) wide space around the field free from straw and high stubble. Protective burning can also be done. A safer method, however, is to rake the straw into lines or piles before burning.

23.14. Burning straw must be kept under satisfactory control and be watched until all fire is extinguished, particularly in the neighbourhood of buildings, woods or other flammable areas. Adequate fire-extinguishing equipment should be available, e.g. water supply, spades and clods of earth. Straw should not be burned near roads because the smoke decreases the visibility for traffic.

#### BURNING WASTE

23.15. Waste and rubbish should preferably be burned in incinerators situated in a safe place. When waste or rubbish is burned in the open, no fires should be started within 40 ft (12 m) of any building or combustible material.

#### FIREARMS

23.16. Firearms are often used on farms for shooting rabbits and other pests. They need to be handled with caution. Here are a few elementary safety rules:

(1) Only firearms in perfect condition and working order should be used.

(2) Firearms should be loaded only with the ammunition designed for them.

(3) Buckshot should be kept separate from other cartridges.

(4) Guns should not be loaded until they are about to be used.

(5) Loaded guns should not be carried in vehicles or on ground on which the person carrying them is liable to trip, stumble, fall or become entangled in obstacles.

(6) Shots should not be fired if any person can be endangered either by a direct hit or by a ricochet.

### POULTRY INCUBATORS AND REARERS

23.17. Poultry incubators and rearers may be heated by coal, gas, oil or electricity. They all need to be handled with care. On coal-fired incubators and rearers the draught and the dampers should work properly, cinders should be removed daily, and the grate door should be closed at night. Oil-fired incubators and rearers should not be lit when they are hot, and never with petrol or paraffin, which might explode. The main risk with gas-fired incubators and rearers is leakage of gas. With electric incubators and rearers it is important to maintain the insulation intact by protecting it against wear and tear. Pulls on the leads to the lamps can be avoided by suspending them from chains or rods.

23.18. With all types of incubators and rearers it is advisable to keep flammable material at a safe distance, keep fire-extinguishing equipment handy (portable extinguishers, pails of water or sand, etc.), and avoid makeshift repairs. All incubators and rearers should be inspected before the farm workers retire for the night.

### ARTIFICIAL RIPENING OF FRUIT

23.19. In some regions unripe fruits such as oranges, lemons and bananas are treated to make them look ripe. This is done by changing the colour of the skin with the help of unsaturated hydrocarbons such as acetylene and ethylene. Unless proper precautions are taken the process is extremely dangerous when acetylene is used, for it easily explodes. Many countries have strict regula-

tions governing the production and use of acetylene. If there are none the competent authority should be notified before any equipment for generating it or using it is installed. The necessary precautions are too elaborate to be described here.

#### SHELTER FROM THUNDERSTORMS

23.20. During a thunderstorm persons should not remain in the open if it is possible to obtain shelter. If a building is not provided with a lightning conductor it is safer to keep away from fireplaces, stoves or other metal. If in the open, people should not shelter under isolated trees or near wire fences on hilltops or in open fields. Shelter may safely be sought in a cave, at the foot of a cliff or in a valley. If no shelter is available, it is best to lie down in a low spot. Persons in vehicles or on tractors with a cab should remain where they are; the tractor cab is a Faraday cage and thus affords protection.

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## **24. PERSONAL PROTECTIVE EQUIPMENT**

24.1. Personal protective equipment includes all devices or garments of various kinds which protect the wearer against injury or disease. Generally, personal protective equipment is counted as a second line of defence; however, in some work of a special nature, as in agriculture, when making the work safe is impossible or impracticable, the safety of persons engaged in it may depend on personal protective equipment.

24.2. Every effort should be made to eliminate the need for such equipment by removing the hazards of equipment and processes by other means such as built-in safety, guards, fencing and interlocks. When personal protective equipment has to be worn in agricultural operations the primary responsibility for selection of the proper types rests with the employer. When necessary he should consult an occupational safety and health specialist to ensure that the equipment provides adequate protection with reasonable comfort. There are many makes of protective equipment on the market; some are excellent in design and performance, while others are of inferior quality and inadequate as protection. All protective clothing and personal protective equipment should at least conform to any national standards that may be applicable.

24.3. In selecting the proper type of equipment for a given risk attention should be paid to the environmental working conditions as well as to the degree of protection necessary. A detailed survey of the risks involved in all operations of an agricultural undertaking should be made by a competent person before the various types of equipment needed are chosen. An effort should be made to keep the number of models to a minimum, since variety adds to the difficulty and expense of replacement and repair.

Experience has shown that unsuitable equipment not only gives poor protection but will discourage the worker from wearing it.

24.4. The circumstances in which personal protective equipment should be worn should be decided with due regard to the working and environmental conditions. It is advisable to draw up appropriate rules which must be strictly enforced. Although it is a mistake to enforce the use of equipment when there is no need for it, it is a greater mistake to make rules and not to enforce them.

#### INSTRUCTION OF WORKERS

24.5. The proper use of personal protective equipment is vital to the safety of the workers. They should therefore be thoroughly instructed in its purpose, use and limitations, and should be convinced of the benefits of using it. In view of the particular nature of agricultural operations and the ignorance of many agricultural workers it is very important that the workers should be instructed by a competent person. The wrong use of equipment may not only reduce protection and cause discomfort to the wearer but may also discourage the worker from wearing any protective equipment at all. It is also essential that supervisory personnel should know what equipment should be used and in what circumstances.

#### CONTROL OF PERSONAL PROTECTIVE EQUIPMENT

24.6. It is advisable to have all personal protective equipment cared for by a responsible person. Regular inspection, cleaning, sterilising and repair of the equipment are essential. This will ensure that it is kept in good condition and that track is kept of each item. Workers should be in no doubt as to what equipment has to be worn and where and when to wear it.

#### HEAD PROTECTION

24.7. Equipment for protecting the head may be divided into two groups. Firstly, there are hard hats for protection against

falling objects such as rocks, branches and tools (on building sites), and traffic accidents. The second group includes equipment for protection against sun and rain and splashes of insecticides, herbicides and fertilisers.

24.8. The materials most widely used for hard hats are plastic, fibreglass and aluminium alloy. The shell of the hat should have adequate resistance to impact, fire and moisture, and should be of electrically insulating material. The hard shell of the hat is supported by a cradle or a hammock which serves as a cushion against blows. The headband and the cradle should be adjusted to fit snugly with an air space of about  $\frac{1}{2}$  in (1.5 cm). Hard hats should have a brim to keep rain off the neck. The brim should be kept narrow at the sides, or persons operating machines such as drills and power saws might suffer ear damage from the noise. Hard hats are comparatively light in weight and are cooler than conventional hats on account of the space left around the head which allows the circulation of air.

24.9. When protection against impact or bumping is not required, workers may wear broad-brimmed hats made of light material and of light colours. This is particularly advisable when workers are employed in the sun or in hot weather.

24.10. Hats worn by workers engaged in handling or using pesticides or toxic substances should be cleaned at the end of each shift.

## EYE AND FACE PROTECTION

### *Types and Applications*

24.11. Agricultural operations, as well as mining and industrial ones, expose the eyes to a variety of hazards, some of which can be eliminated at the source by shields or screens on equipment. Many eye injuries, however, especially in agriculture, are caused by flying particles, leaves, dust, splashes of toxic or irritating liquids, and harmful radiations. All these accidents are preventable by well-known and relatively inexpensive means.

24.12. Agricultural workers should wear adequate eye protection when engaged in any of the following operations:

- (a) reaping grain crops with sickles;
- (b) handling chaff;
- (c) feeding threshers;
- (d) weeding rice, sugar cane or tobacco;
- (e) knocking chestnuts off trees;
- (f) breaking, hulling or scutching flax and hemp;
- (g) collecting mulberry leaves;
- (h) pruning vines and fruit trees;
- (i) clipping and trimming thorn hedges;
- (j) cutting or splitting wood;
- (k) breaking or splitting stone;
- (l) mixing dangerous substances.

24.13. Protective equipment for the eyes and face in agricultural operations consists of goggles and shields or screens.

24.14. Goggles should offer complete protection to the eyes, from whatever direction the risk is likely to come. They should sit well on the face, should be comfortable and fit as close to the eyes as possible, but without touching the eyelashes, in order to give the widest possible angle of vision. They should stand up to rough handling and resist corrosion and heat.

#### *Box-type Goggles.*

24.15. Box-type goggles are worn for light work, such as spraying fertilisers or insecticides. They consist of a one-piece transparent plastic lens or independent lenses fitted into a deep-section frame which may be made of rubber, rigid or pliable plastic, or transparent plastic with ventilation holes. The frame depth should permit the wearing of corrective spectacles with comfort. The goggles should be light in weight and give an unobstructed field of vision.

### *Spectacle-type Goggles.*

24.16. Spectacle-type goggles are worn for light and moderately heavy work. They are fitted with lenses of safety glass or plastic and should also be provided with side shields of metal or plastic when protection against light flying objects from the sides is necessary (fig. 59).

### *Chemical Goggles.*

24.17. Chemical goggles are worn for protection against splashes of harmful liquids. Either they are of the box type, described above, or they consist of separate eyepieces connected by an adjustable shielded chain bridge. Each eyepiece should be designed to give a wide field of vision and should follow the contour of the face. This can be ensured with edges of soft moulded rubber or any other equivalent non-flammable material.

### *Eye-cup Goggles.*

24.18. Eye-cup goggles are worn for heavy grinding, chipping, splitting stone and any other heavy operation which may endanger the eyes. The eye-cups of these goggles should be shaped to fit the contour of the face and they are generally made of perforated metal or heavy plastic, the lenses being of safety glass or plastic. If it is necessary to protect the eye against harmful radiations, each eye-cup should be able to carry filter lenses.

### *Wire-mesh Goggles.*

24.19. Wire-mesh goggles are worn for protection against leaves and light flying particles. The goggles are made of bronze or non-corrosive dull black enamelled wire mesh. The eye-cups are domes and are large enough to cover the orbit of each eye. The bridge-piece is sometimes made so that the goggles can be folded; to some extent, by the nature of their construction, they can be shaped to suit individual wearers. Wire-mesh goggles are specially recommended for agricultural work where fogging is a serious problem.



*Face Shields.*

24.20. Face shields are protectors made of non-flammable transparent material that are hinged on an adjustable headband and can easily be turned up and down in front of the face. They should not be worn for welding or heavy grinding or where there is danger of severe impact. They are light in weight and can be worn for operations such as mixing insecticides or pruning plants.

*Protection for Welding Operations.*

24.21. The purpose of eye protection for welding operations is to protect the worker from ultra-violet and infra-red radiations, intense light, and mechanical injuries such as those caused by molten metal. Accordingly the protective equipment should be fitted with correctly tinted filter lenses and with cover glasses. Welding helmets and welding shields provide protection for the eyes and face under the severe conditions of arc welding. For gas welding or gas cutting, welders' goggles are suitable.

*Care and Maintenance*

24.22. Transparent face shields are usually made of plastic; special care should be taken in cleaning them. Dirt spots on the shields should be removed by rubbing gently with a soft rag moistened with a cleaning solvent such as kerosene or special solvents on the market for this purpose. Afterwards, the visor should be washed with water and rinsed well to remove all traces of oil to which dust or particles of straw might adhere. Care should be taken to keep water away from the fibre, metal or leather parts of the shields.

24.23. Goggles should be cleaned at frequent intervals with warm soapy water, a commercial cleaning solution or a mixture of equal parts of commercial alcohol and water, which will remove grease and oily films from the lenses. If goggles are made of plastic, the procedure for face shields should be followed. If goggles have leather parts, the latter should be washed with

saddle soap, and when they have dried a leather dressing should be applied to prevent them from cracking.

24.24. If goggles are used by more than one person, they should be sterilised before being reissued. No goggles or any other personal protective equipment should be sterilised until after the equipment has been thoroughly cleaned. Goggles with no plastic or rubber parts should be sterilised by immersing them in boiling water or in a steam bath for not less than five minutes.

24.25. Goggles with plastic or rubber parts should be sterilised by exposing them to a moist atmosphere of antiseptic gas, such as formaldehyde, for a period of ten minutes in a gas-tight cabinet. There are many other procedures using various disinfecting and sterilising agents, which are also satisfactory for rubber parts.

24.26. When equipment is sterilised with an irritant such as carbolic acid, to which some persons may be sensitive, the parts of the equipment that come into contact with the skin should be thoroughly rinsed with clear water after sterilisation. When disinfectants smell the odour should be completely removed by rinsing the equipment with water and airing it.

24.27. Gasoline, naphtha, carbon tetrachloride or other solvents used in dry-cleaning should never be used to clean personal protective equipment. Some are toxic and others are highly flammable. They can also damage some materials, particularly rubber.

24.28. Wire-mesh goggles should be cleaned by means of a soft brush. The headband and the frame should be wiped with a rag moistened in a solution of water and commercial alcohol to remove the grease.

## RESPIRATORY PROTECTION

### *Types and Applications*

24.29. When it is not practicable to prevent the emanation of toxic fumes, dust or vapours, or to replace toxic substances by non-toxic ones, respiratory protective equipment should be used

to protect the health of workers exposed to contaminated air. Such equipment should also be used in a workplace with an oxygen-deficient atmosphere. Respiratory protective equipment thus falls into two main categories:

- (a) filtering devices such as mechanical filter respirators or chemical cartridge respirators;
- (b) self-contained breathing apparatus and supplied-air apparatus such as air-line respirators.

Some technical information on respirators is given below as guidance for the purchase of adequate equipment for various conditions.

24.30. Mechanical filter respirators are half-facepieces or facepieces, covering the mouth and nose, and sometimes the eyes also, designed for the wearer to inhale the surrounding air after it has passed through a filter made of some fibrous material that removes the harmful particles by trapping them physically as the air is drawn through the material. The arrangement of the filter should be such as to permit it to be cleaned or replaced easily without leakage of unfiltered air afterwards. All parts that come into contact with the skin should be of non-irritating material. The principal types of mechanical filter respirators are described below:

#### *Dust Respirators.*

24.31. Dust respirators afford protection against particulate matter in the size range above 0.5 micron, including irritating fibrogenic and toxic dusts.

#### *Mist and Fog Respirators.*

24.32. Mist and fog respirators afford protection against atomised liquids in the size range from 5 to 10 microns. These respirators are commonly used for spray painting.

#### *Smoke Respirators.*

24.33. Smoke respirators afford protection against solid particulate matter of organic origin in the size range from 0.001 to

0.3 micron. When the filter is covered with dust so that most of the pores are clogged it becomes unusable and should be replaced. The wearer knows when this occurs by the difficulty of breathing and the taste and smell of the air inhaled.

### *Chemical Cartridge Respirators.*

24.34. Chemical cartridge respirators are half-facepieces with single or twin cartridges mounted on them and containing a chemical to remove gases and vapours. Various chemical filters afford protection against slight concentrations from 0.05 per cent to 0.10 per cent by volume of certain acid gases and organic vapours.

24.35. In agriculture these respirators are used to protect the workers employed in handling, mixing and applying pesticides and fertilisers. It should be remembered, however, that chemical cartridge respirators should not be used for protection against—

- (a) gaseous material which is extremely toxic in very low concentrations;
- (b) exposures to harmful gas that cannot reliably be detected by odour;
- (c) any gas concentrations that are highly irritating to the eyes;
- (d) gases that are not effectively neutralised by chemical filters in any concentration;
- (e) oxygen deficiency.

### *Gas-masks.*

24.36. A gas-mask is a facepiece with a corrugated tube connecting it to a canister containing chemicals. The latter may be filtering, absorbing, neutralising or catalysing materials, affording protection against harmful gases, vapours, smoke and mists in combination with dust. This type of equipment is generally effective for concentrations of toxic gases up to 2 per cent by volume; in the case of the mask for ammonia the limit is 3 per cent.

24.37. In selecting a mechanical filter respirator, a chemical cartridge respirator or a gas-mask it is important to choose the

right type. All respirators and masks should be marked to specify the protection they afford.

24.38. The life of a canister or a cartridge is limited; therefore, unless the canister has an automatic timer, it is desirable to fix a time for its use which is less than half its rated life.

24.39. It should be emphasised that, since the sole function of the filter is to remove toxic gases and vapours from the inhaled air, it is necessary that at least 17 per cent of oxygen should always be present in the air.

#### *Supplied-air Equipment.*

24.40. Supplied-air equipment (hose mask) must be used when the worker is to be protected against atmospheres of higher toxicity than those mentioned above, or when the amount of oxygen in the atmosphere is less than 17 per cent.

24.41. The air for masks should be supplied by blowers rather than compressors. When this is not possible and the air is supplied from a compressed-air system, attention should be paid to possible contamination by oil, water and other vapours, and small particles of dust, fibres, etc.

24.42. The air should therefore first be filtered to ensure that it is clean and dry. If there is a possibility of carbon monoxide being formed in the system, an indicator for this gas should be installed near the inlet for respirable air in order to provide the worker with a warning in case the gas is fed to the airlines.

24.43. If compressed air is supplied at a pressure higher than 25 lb/in<sup>2</sup> (1.75 kg/cm<sup>2</sup>) a pressure-reducing valve should be installed near the point where the facepiece tube is connected to the airline and, as a further precaution in case the pressure-reducing valve fails to function, a relief valve should be installed, pre-set to release at a pressure slightly above the setting of the pressure-reducing valve.

24.44. Another supplied-air apparatus for the protection of respiratory organs is the self-contained breathing apparatus, in which the air is supplied from a tank or cylinder held on the body of the worker by means of straps. It can also be used with a

supply of oxygen, but this requires certain precautions and should only be done under supervision. This type of equipment, while giving more freedom of movement to the worker, is, in fact, much heavier than the hose mask described above. There are many different types of self-contained breathing apparatus on the market.

### *Care and Maintenance*

24.45. After a respirator or mask has been used and before it is stored, it should be cleaned by removing all dirt, grease and perspiration from the facepiece and valves. If respirators are to be used by another person, they should be sterilised by one of the methods for cleaning and sterilising face and eye protectors.

24.46. The facepiece, elastic bands and other elastic fabrics should be washed with soap and warm water, using a soft brush, and rinsed in clear water.

24.47. It should be remembered that plastic parts of respirators must not be treated with concentrated acids or alkalis. It is advisable to sterilise plastic parts of respirators as indicated in paragraph 24.25.

24.48. Mechanical filters may be cleaned by brushing the surface or by tapping. However, since these filters are not expensive, new ones should be inserted each time a respirator is cleaned or sterilised. After a respirator or mask has been cleaned, sterilised and dried, it should be inspected. It should then be put away in a dust-tight box or compartment or in a sealed cellophane or paper bag to keep it in a usable condition.

### HAND AND ARM PROTECTION

24.49. Adequate hand protection is needed in the following agricultural operations:

- (a) weeding with a machete;
- (b) reaping and pulling out weeds by hand;
- (c) clipping thorn hedges;

- (d) pruning trees that have thorns;
- (e) handling, mixing or applying pesticides or fertilisers;
- (f) handling rough or sharp objects;
- (g) assisting animals in labour;
- (h) handling animals that are infected or suspected of being infected;
- (i) working where there is a danger of electric shock;
- (j) planting by hand;
- (k) welding or working where hands are exposed to extreme heat.

24.50. As a general rule gloves or hand pads should not be worn around machinery.

24.51. Most agricultural operations expose the hands to cuts, scratches, burns or bruises, but in selecting gloves or any other protector for the hands and arms it should be remembered that finger movement is essential in all agricultural operations. This makes the hands more difficult to protect than most other parts of the body. At the present time there is a great variety of protective gloves on the market.

24.52. Cotton gloves offer some protection for light jobs, but many operations require stronger and more durable material; leather gauntlets must be provided, for example when hands are exposed to snake bites.

24.53. When handling, spraying or mixing dangerous substances workers should wear long rubber gloves to protect their hands and arms against contact with the substances. Neoprene, vinyl plastic and plastic-coated gloves can also be used for work with substances such as insecticides and fertilisers.

24.54. Asbestos gloves should be used when hands are exposed to extreme heat, as in welding operations.

24.55. Rubber gloves protected by overgloves of leather should be worn by workers engaged in electrical work or where there is a danger of electric shock. The rubber gloves should be inspected and tested by blowing air into them before they are used.

24.56. Leather gloves are not recommended for work with a machete, because when the glove becomes wet from dew or perspiration the machete can slip out of the worker's hand. For weeding or cutting operations with machetes workers should wear light cotton gloves with strips of rubber sewn on the back. Metal staples or wire should not be used to attach the rubber strips because they may injure the hand and damage the glove when they become rusty from dew or perspiration.

### SAFETY BELTS AND HARNESSSES

#### *Types and Applications*

24.57. Certain occupations in agriculture require people to work high above the ground, e.g. on trees, stacks and poles. In these occupations safety belts or harnesses with lifelines should be used. The same applies to work in confined spaces such as wells where there is danger from contaminated air, and workers entering places where there is a risk of their getting buried in loose material (manure pits, cesspools, grain silos or fodder silos) should always be equipped with safety belts attached to lifelines secured outside.

24.58. The lifeline should be long enough to permit freedom of action but it should be tied off as short as the work permits. The line should be attached to the belt by means of a D-shaped ring.

24.59. In the event of a fall, the harness type of belt distributes the shock over the shoulders, back and waist instead of concentrating it at the waistline; this type should, therefore, be used wherever possible.

#### *Care and Maintenance*

24.60. The equipment should be thoroughly inspected before it is used and should be discarded if signs of wear are detected. It should also be cleaned before it is stored. When belts and lifelines are stored care should be taken not to cram them into small spaces where they would kink. They should be kept in open coils.



24.61. Special attention should be paid to the maintenance and cleaning of safety belts and their metal fittings since this equipment is more subject to sudden failure because of hidden defects or apparently unimportant damage.

24.62. Leather safety belts should be cleaned first with a brush to remove the dirt and then washed with a rag dampened with warm water and Castile or saddle soap. The belt should then be left to dry at a temperature no higher than the hand can bear. Dry-cleaning solvents should never be used on leather belts.

24.63. Cotton or linen fabric safety belts should be washed with soap and water and should be dried at moderate heat.

## FOOT AND LEG PROTECTION

### *Types and Applications*

24.64. Operations requiring protection of the feet include—

- (a) working with toxic substances such as pesticides and fertilisers;
- (b) working where there is danger of falling objects;
- (c) working in water, marshy ground or peat bogs;
- (d) mowing and reaping;
- (e) weeding with hoes and machetes;
- (f) working in stables;
- (g) clipping thorn hedges;
- (h) working in manure pits;
- (i) pruning trees that have spikes and thorns;
- (j) steeping hemp;
- (k) working or walking in areas infected with poisonous snakes.

24.65. Footwear for agricultural workers should thus protect their feet against moisture, rough surfaces, sharp objects underfoot, falling objects and snakebite.

24.66. Safety footwear should have stout non-skid soles, and, where there is a danger from falling objects, be reinforced

with steel toe-caps (fig. 68). In forests and on steep slopes workers should wear multi-point calkins on their boots to prevent them from slipping on frozen or slippery wood or ground. The points should be kept sharp.

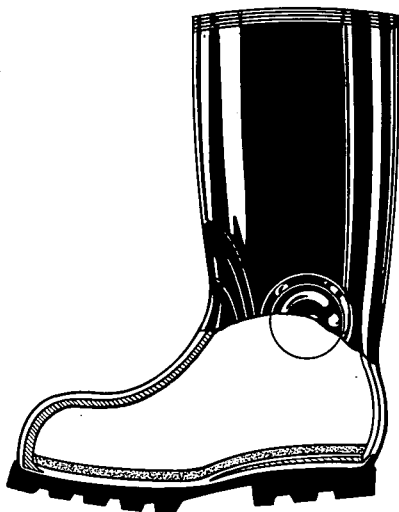


Fig. 68. A commonly used type of safety boot with steel-reinforced toe-caps and insteps.

24.67. In areas infested by poisonous snakes workers should wear protective boots and leggings made of heavy bullhide or similar material.

24.68. Boots and leggings should be worn by workers weeding with hoes or machetes as protection from dust, roots and gravel or a blow from the implement if it slips or bounces.

24.69. When mixing or applying insecticides or any other dangerous substances workers should be provided with rubber or other watertight boots. Such boots are also advisable when

working in water on marshy ground or in peat bogs. The soles should be stout.

24.70. When it is necessary to protect the feet from very heavy impacts, such as in handling logs, big rocks or heavy pieces of machinery, workers should be provided with and use over their ordinary shoes foot-guards designed to afford maximum protection for the entire front of the foot and the instep.

24.71. If protection of the shin is necessary, a combination of foot-guard and shin-guard should be provided. This is advisable when stripping the bark of logs with axes or broadaxes.

24.72. The material used for foot-guards and shin-guards is generally aluminium; however, heavy-duty fibre materials are also used. The guards are attached to the foot and legs by means of straps.

24.73. Knee-pads are useful when work has to be done kneeling for a considerable time.

#### *Care and Maintenance*

24.74. It is advisable to wash leather shoes and boots with Castile or saddle soap and let them dry at room temperature. Once they are clean, some dressing such as castor oil, soya-bean oil or any other commercial dressing should be applied to prolong the life of the leather.

24.75. Workers should be encouraged to clean their shoes and boots thoroughly at the end of a day's work. If the dirt is definitely harmful, footwear should be cleaned immediately after exposure.

24.76. Rubber shoes and boots can easily be washed with water; they should never be dried by exposure to direct sunlight or to any other source of heat.

24.77. Rubber footwear should not as a rule be worn by more than one worker, but if this is unavoidable it should be sterilised before being stored by dipping it into a tub containing a 5 per cent solution of sodium hypochlorite or a 10 per cent solution of sodium thiosulphate for one minute, after which it should be rinsed in cool water.

## WORKING CLOTHES

### *Types and Applications*

24.78. In agriculture, as in any other activity, working clothes should provide adequate protection, comfort and freedom of movement. All work garments, especially in jobs where contamination by dangerous substances is likely to occur, should be simple in design, the trousers and shirts having no cuffs or open pockets where the substances could accumulate. Loose clothing should not be worn around machinery since it may be caught by moving parts.

24.79. Protective clothing for workers engaged in handling, mixing and applying pesticides or any other dangerous substances should have long sleeves and cover as much of the body as possible. All the garments should be washed before they are stored. For a hot, humid environment, clothing should be porous and light in weight, and allow air to pass around the body. Workers employed in refrigerated places should wear heavy warm clothing.

### *Care and Maintenance*

24.80. Since material used for protective clothing such as overalls, gloves, aprons and safety belts varies considerably, it is of great importance that the advice of the manufacturers should be sought and their instructions regarding care and cleaning followed. Cotton clothing should be washed in soapy water. Protective clothing which is to be used when handling or applying toxic substances (pesticides, fertilisers, etc.) should be washed according to the manufacturer's instructions immediately after use. Clothing made of impregnated material or coated with plastic or other substances and designated to protect workers against toxic substances or acids, caustics, solvents, etc., should be cleaned and washed according to the manufacturer's instructions.

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## **25. FIRST AID**

25.1. Rendering effective first aid in accidents has prevented many slight injuries from becoming serious, avoided infection and saved lives. It spares the injured person much suffering and expense and it saves the farmer time and money. It does not require any very complicated organisation or involve any very great difficulties; consequently, no farm should be without some means of rendering it.

25.2. Farm workers should be encouraged to become proficient in first aid by taking courses of training. If first aid is to be effective, however, certain precautions must be observed.

25.3. In the first place, except in emergencies, first aid should be rendered only by a doctor, a registered nurse or a properly trained person.

25.4. Treatment of electric shock has been dealt with in Chapter 4 on electricity.

25.5. Severely injured persons should not be moved before the arrival of a doctor or other qualified person, except for the purpose of removing them from dangerous places.

25.6. All injuries, however slight, should be reported as soon as practicable to the nearest first-aid man.

25.7. One or more well-stocked first-aid boxes should be provided at suitable places near workplaces, on motor vehicles and on dangerous field machines such as threshers; they should be protected against contamination from dust, moisture, etc. In some countries the contents of first-aid boxes are prescribed by regulations.

25.8. First-aid boxes should be in charge of a responsible person who is qualified to render first aid, and should contain simple and clear instructions to be followed in emergencies.

25.9. Arrangements should be made to ensure the prompt transport by ambulance of sick or injured workers to a hospital or other equivalent treatment centre, where necessary.

25.10. Notices should be posted at suitable places about the farm to indicate—

- (a) the position of the nearest first-aid box and the place where the person in charge of it can be found;
  - (b) the position of the nearest telephone for calling the ambulance, and the telephone number and name of the person or centre to be called; and
  - (c) the name, address and telephone number of the doctor to be called in an emergency.
-

## 26. FARM SAFETY AND HEALTH ORGANISATION

26.1. Some kind of safety and health organisation is common in factories and mines, but this is rarely the case on farms. Nevertheless these organisations do very good work and certainly more than repay the trouble of setting them up and running them. Some have reduced accidents to a mere fraction of what they used to be. The larger farms, therefore, might well consider making some formal arrangements for promoting the safety and health of their workers and at the same time for preserving their property from damage by fire, explosion, breakage, excessive wear and tear and so on.

26.2. Among the steps that they might take are the appointment of one of the workers as a safety officer or safety steward, or the formation of a joint safety committee.

26.3. Safety officers or safety stewards would have the task of seeing that buildings and equipment are kept in a safe condition and that work is done in a safe manner, reporting any defects discovered to the employer and endeavouring to correct unsafe practices among fellow-workers.

26.4. Joint safety committees, are particularly valuable because they bring management and workers together in a common endeavour and enable workers to participate directly in safety work. They thus serve to arouse the interest and perhaps enthusiasm of the workers for safe and healthy working conditions and—what is also important—to promote good industrial relations.

26.5. The functions of safety committees include—

- (a) drawing up rules for the guidance of workers in performing their jobs in a safe manner;
- (b) considering suggestions for improving methods of work so as to make them safer;

- (c) taking part in the investigation of accidents and discovering the lessons to be learned from them;
- (d) preparing safety leaflets, posters, etc., that draw attention to particular hazards.

26.6. There are many government departments and national safety associations that will help farmers to organise safety on the farm.

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