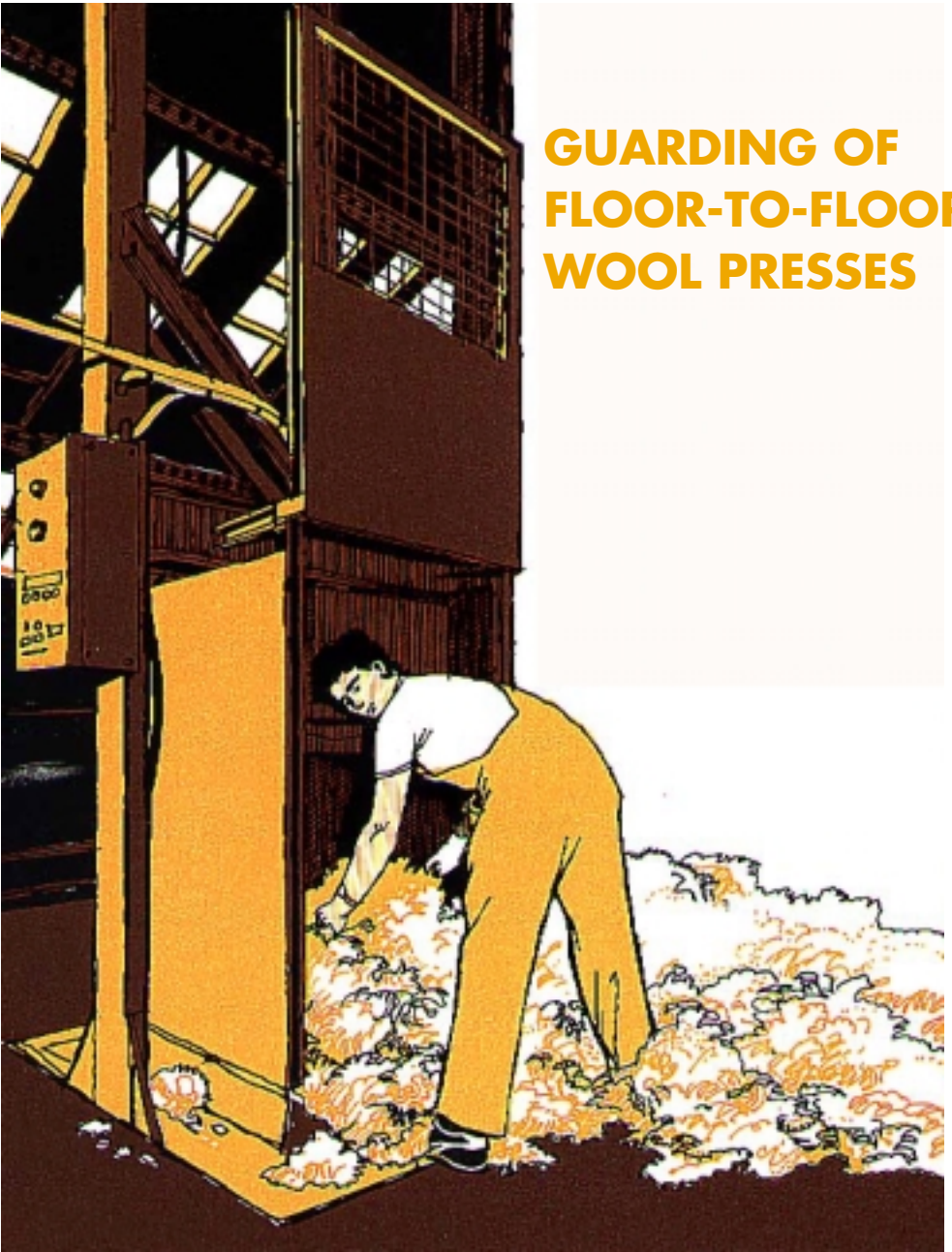


GUARDING OF FLOOR-TO-FLOOR WOOL PRESSES



NOTE

The technical information in this book was current at the time of printing in 1984. While the guarding principles are still valid, the information does not necessarily reflect technological changes since the booklet was first published.

This booklet should be read in conjunction with the *OSH Guidelines for Guarding Principles and General Safety for Machinery*.

First published by the Department of Labour,
Wellington, New Zealand, in 1984

This pdf created December 2001

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INTRODUCTION

Floor-to-floor wool presses compress loose wool for the purpose of baling. The wool, which may be “greasy” or scoured, is loaded into a chute at the upper floor. It is then compressed by the ram to the lower floor, where it is sewn and bound into a fabric casing.

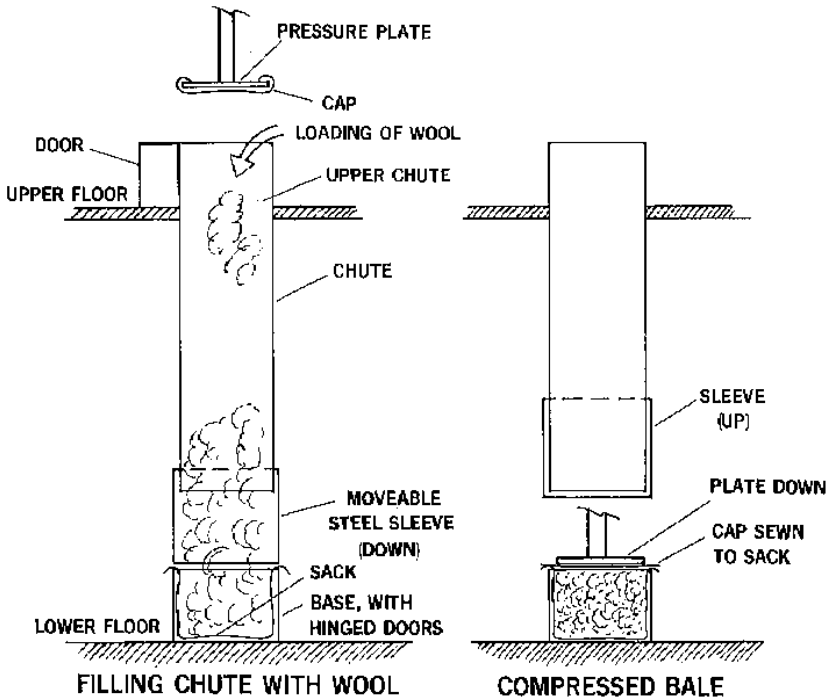


Fig.1: Principle of floor-to-floor press

Fig. 1 illustrates the basic parts of a press. In operation, the bottom box is first lined with a bag of hessian or other material which overlaps the top edge. The moveable sleeve at the bottom of the fixed chute is then lowered to form a continuous chute aligned with the bottom box. A predetermined amount of wool is then fed into the opening at the upper floor.

The operator attaches the bale cap material to the underside of the pressure plate by means of metal spikes located around the plate's edges. The pressure plate is then actuated to descend and compress the wool. Next, the sleeve at the lower floor is raised, allowing the operator to sew the cap to the bag.

The pressure plate is returned to its original position and the completed bale is removed from the bottom box by opening a hinged door.

There are two main types of press, mechanical and hydraulic, the difference being in the method of actuating the pressure plate. Most presses are hydraulically powered, the pressure plate being driven by a ram. Mechanical presses, which are generally of an older design, employ a system of pulleys and wire cables driven by a winch.

HAZARDS

Floor-to-floor presses have been the cause of fatalities and serious injuries. Some possible causes of injury are:

- (a) Trapping between the pressure plate and the edges of the upper chute, or the edges of the bottom box.
- (b) Trapping between the pressure plate and the lower edge of the chute (or sleeve) as the plate rises.
- (c) Trapping between the descending sleeve and the bottom box.
- (d) Falling into the press.
- (e) Hazards in various other areas, depending on the design of press, such as those created by a free-falling pressure plate, nip points, and trapping hazards between moving and stationary parts.

LEGAL REQUIREMENTS

The Machinery Act 1950 requires the moving parts of any prime mover, every part of any transmission machinery, and every dangerous part of any machinery to be securely fenced, unless the parts are in such a position or of such construction as to be as safe to every person employed or working on the premises as they would be if securely fenced.

The guarding requirements for floor-to-floor wool presses can be met by:

- (a) Complete enclosure of the moving parts of the prime mover and transmission.
- (b) The fitting of guards which prevent a person from being trapped by the pressure plate.
- (c) Design features which will prevent trapping by the sleeve or other moveable structures.
- (d) Utilising a fail-safe control system.

Any viable system of guarding which meets the requirements of the Machinery Act 1950 will be acceptable to the Department of Labour, and the examples and guidelines given in this booklet do not exhaust all the possibilities.

UPPER FLOOR GUARDING

At the upper level, wool is loaded into the chute and the bale cap attached to the pressure plate. These operations require close access to the pressure plate while it is exposed and while there is a large, clear opening into the chute.

Because of the high downward force exerted by the pressure plate and the ease of access, a guard must be provided to prohibit entry to the trapping area. This guard should be interlocked in such a way as to prevent descent of the pressure plate when open. The guard must not be able to be opened when the pressure plate is descending, or, alternatively must stop the descent if opened.

If there is any possibility of a trapping hazard during ascent of the pressure plate, then the guard must not be able to be opened when the pressure plate is ascending. or, alternatively, must stop the ascent if opened.

This requirement could be met by employing a rise and fall guard or a hinged guard. The rise and fall guard could be four-sided. Or if two opposite sides of the feed opening have fixed walls, then the guards could consist of single panels. Rise and fall guards may be easier to open than hinged guards if there is a lot of wool in close proximity, but in general will require some form of counterbalancing.

Interlocking can be achieved in the case of the rise and fall guard by the use of a normally closed limit switch and linear cam. The hinged type of guard could employ a normally closed switch and crescent-shaped cam on the hinge centre line.

LOWER FLOOR GUARDING

Pressure Plate Hazard

To provide adequate safety at the lower floor level, it is necessary to prevent a trapping hazard between the descending pressure plate and the bottom box, and between the ascending pressure plate and the lower edge of the chute or sleeve.

By interlocking the sleeve with the means of pressure plate actuation, it is possible to ensure that the plate will not descend until the sleeve is at its lowest position. A normally closed limit switch should be used, together with a suitable means of actuation such as a linear cam.

Trapping between the rising pressure plate and chute or sleeve can be prevented by shaping the plate like a box, i.e., by raising vertical sides from the plate edges in such a way as not to leave a lip (fig. 2). Small holes or recesses in the sides can accommodate cap attachment spikes.

It is possible that this design of pressure plate may slow down bale sewing and hence be unsuitable for high-production rates. An alternative is to ensure that the sleeve is in its lowest position before raising the pressure plate, and this can be done in the way described earlier. A properly designed system of trip bars can also prevent this hazard.

Sleeve Hazard

At the lower floor, the downward travel of the sleeve creates a trapping hazard with the bottom box. During the full downward travel of the sleeve, the closing force between it and the bottom box should not be sufficient to cause injury. This can be achieved by allowing descent under gravity and counterbalancing it by cylinder annulus pressure or weight and pulley systems as appropriate.

If counterbalancing is achieved by hydraulic means, the weight of the sleeve should not be excessive (additional mechanical counterbalancing will probably be necessary). Alternatively, if the sleeve can exert a sufficient force to cause injury to a person caught between it and the bottom box, then provision must be made to immediately stop or reverse the downward motion in the event of trapping occurring. This may be achieved by trip bars and limit switches.

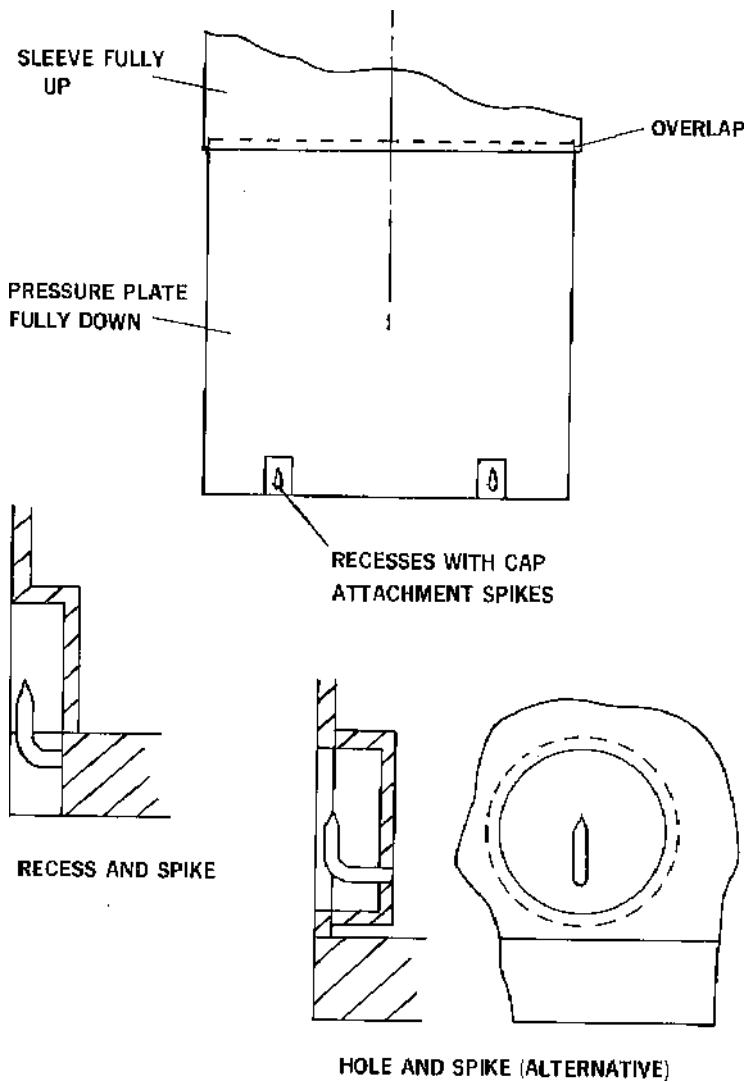


Fig.2: Box-shaped pressure plate

An acceptable trip bar system is shown in fig. 3. The lower edge of the sleeve is surrounded by trip bars which are mounted from it, one on each side (a total of four). Each bar is suspended in such a way that it can move:

- (a) Freely and without sticking;
- (b) Without tilting, i.e. parallel to horizontal;
- (c) Only in the vertical direction;
- (d) Without touching adjacent bars (except in the case of switch failure, which is dealt with below).

Each bar acts on a limit switch and all four limit switches are wired in series. Upward movement of any bar (relative to the sleeve) depresses the limit switch, which causes the sleeve motion to be arrested. (In some cases, dealt with later, it may also arrest pressure plate motion).

The bars are each shaped to have a notch at one end and a protrusion at the other. They are suspended in such a way that adjacent bars loosely dovetail together but do not actually touch.

The normal movement of a bar is sufficient only to activate its respective limit switch. The dimension referred to in fig. 3 as the “take-up gap” must be greater than the movement to activate one limit switch. The minimum vertical movement of which each bar must be capable is equal to the take-up gap plus the movement to activate the limit switches on both adjacent bars.

In this way, if a limit switch fails when its bar is pressed, the bar will push on those adjacent to it and activate their limit switches. Thus each limit switch is backed up by at least two others.

If this trip bar system is used also to protect against the trapping hazard between the raised sleeve and the rising pressure plate, then the trip bars must be sufficiently close to the sleeve so that a hand cannot be caught between the sleeve and pressure plate before activating the limit switch. In this case, activation of a trip bar will also stop the movement of the pressure plate.

Incidental trapping hazards such as between the rising plate and stationary parts such as the end of guide rails must also be avoided.

It is essential when employing such a trip bar system to check each bar for freedom of movement and correct functioning at regular intervals — preferably at least once a week. Care should be taken to

check that the sleeve is actually stopped by the switch under scrutiny and not by an adjacent switch. Any stiffness or failure should immediately be remedied and the press must not be used until this has been done.

Checking of trip bar systems should be done by a competent person, who should not be exposed to danger in the event of a malfunction.

In designing such a system, it is necessary to ensure that the movement of the bars cannot be accidentally or deliberately impeded. Some form of shrouding of the mechanism will be necessary.

A practical example of a trip bar system is shown, with the shrouding removed, in plate 1.

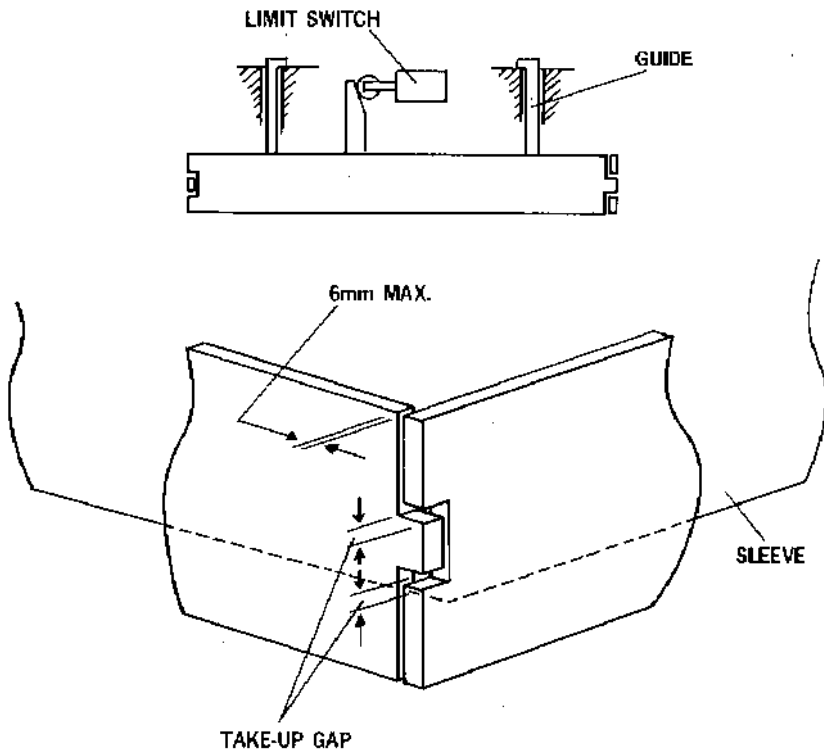


Fig.3: Trip bar system

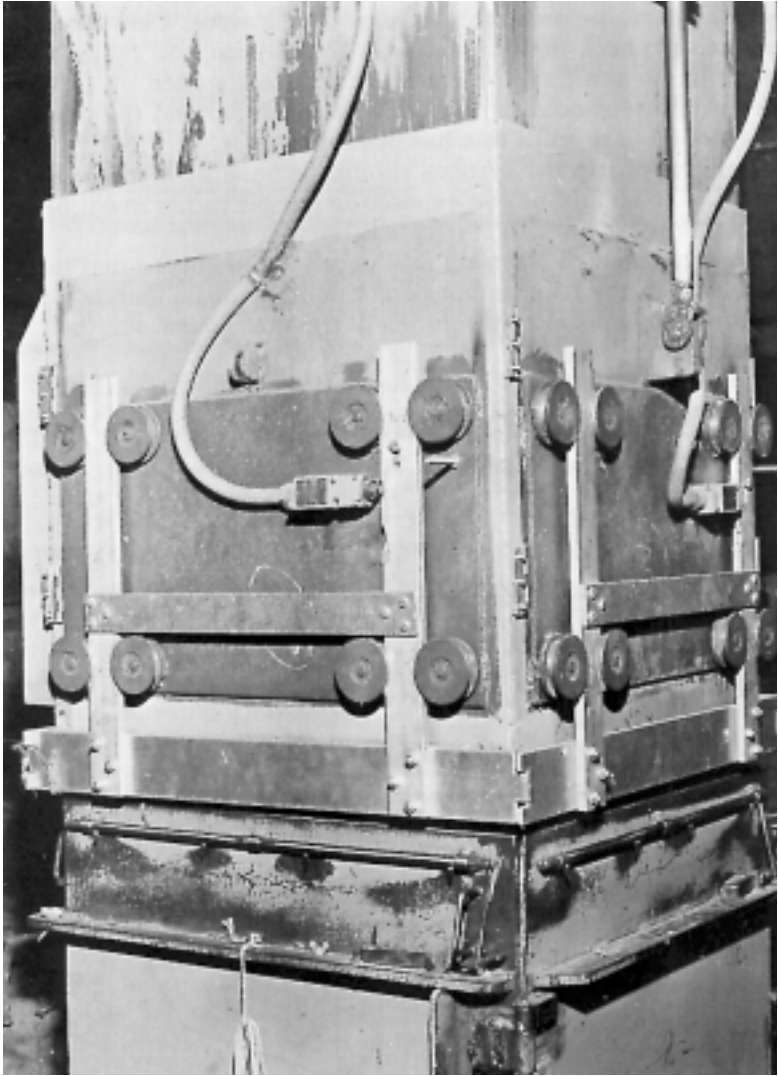


Plate 1: Sleeve-mounted trip bar system (shrouding removed)

Photos courtesy of Wrightson NMA and Millers Mechanical Equipment (NZ) Ltd.

INTERLOCKING AND CONTROLS

The means of control for the moving parts of the press are an important safety consideration. Actuation of the pressure plate must not be possible unless all trapping hazards are guarded at both upper and lower levels. This requires a reliable system of interlocking, usually making use of electrical limit switches.

It is normal practice to arrange the controls so that from the upper floor the pressure plate can be raised and lowered, and from the lower floor the sleeve can be raised and lowered and the pressure plate raised only. It is important that an efficient means of signalling between levels is provided in order to ascertain or indicate the state of readiness at each location. There should be an emergency stop at each level. The entire control circuit should fail to safety.

The control circuit with interlocks must, for downward motion of the pressure plate, satisfy the minimum condition indicated by the flow chart in fig. 4. For upward motion of the pressure plate, the flow chart would be as in fig. 5.

PRESS GUARDING EXAMPLES

Mechanical Type

Refer to figs 6 and 7. In this example, the chute above the floor has two hinged doors for the loading of loose wool. Fig. 7 shows the closed doors overlapped by a rise and fall guard.

The interlocking cage-type rise and fall guard is manually operated and can be constructed on four sides with expanded metal, secured to angle steel framing. It runs on vertical guides consisting of a tube on either side. The guard is counterbalanced by weights enclosed in the tubes.

Fitted to the rise and fall guard is a linear cam which keeps the normally closed limit switch roller depressed in all guard positions except fully closed, when the limit switch roller “drops off” the cam and completes the circuit. Thus the press can only operate when the guard is in the closed position.

In the fully closed position of the cage guard, the bottom edge overlaps the filling doors, thus ensuring that they are closed.

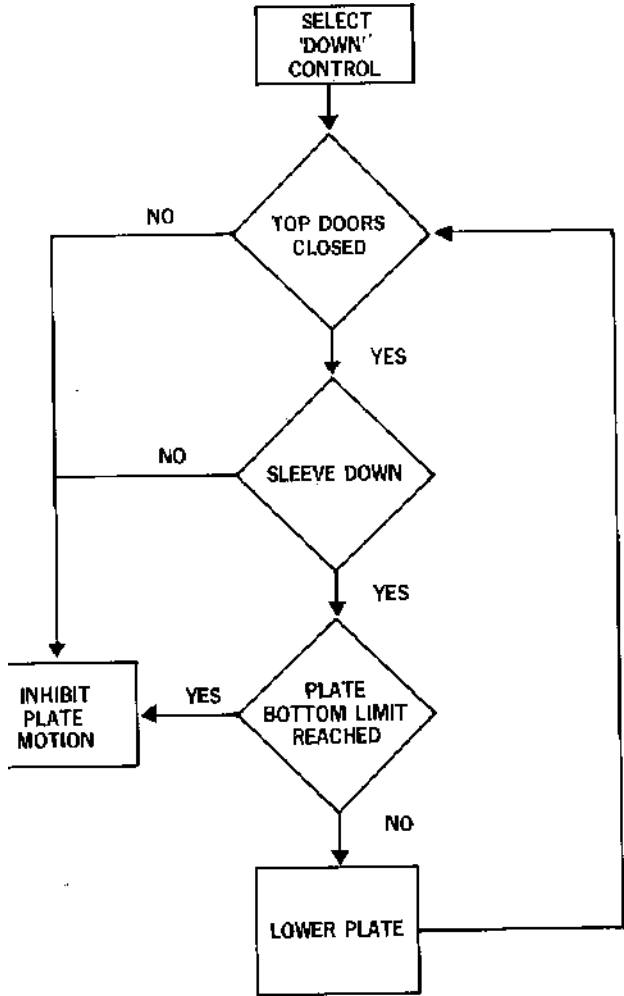


Fig. 4: Pressure plate descent

With such an arrangement, it is not necessary to fit limit switches to the hinged doors.

An emergency stop button is provided at both the upper and lower stations.

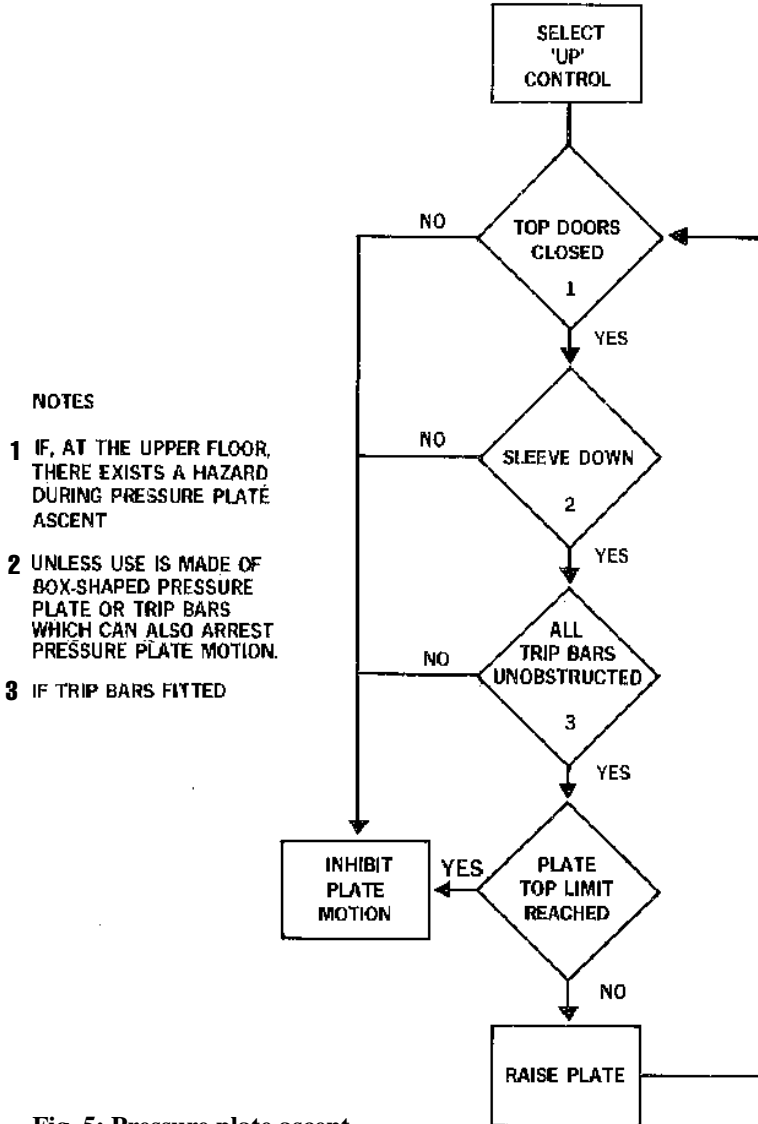


Fig. 5: Pressure plate ascent

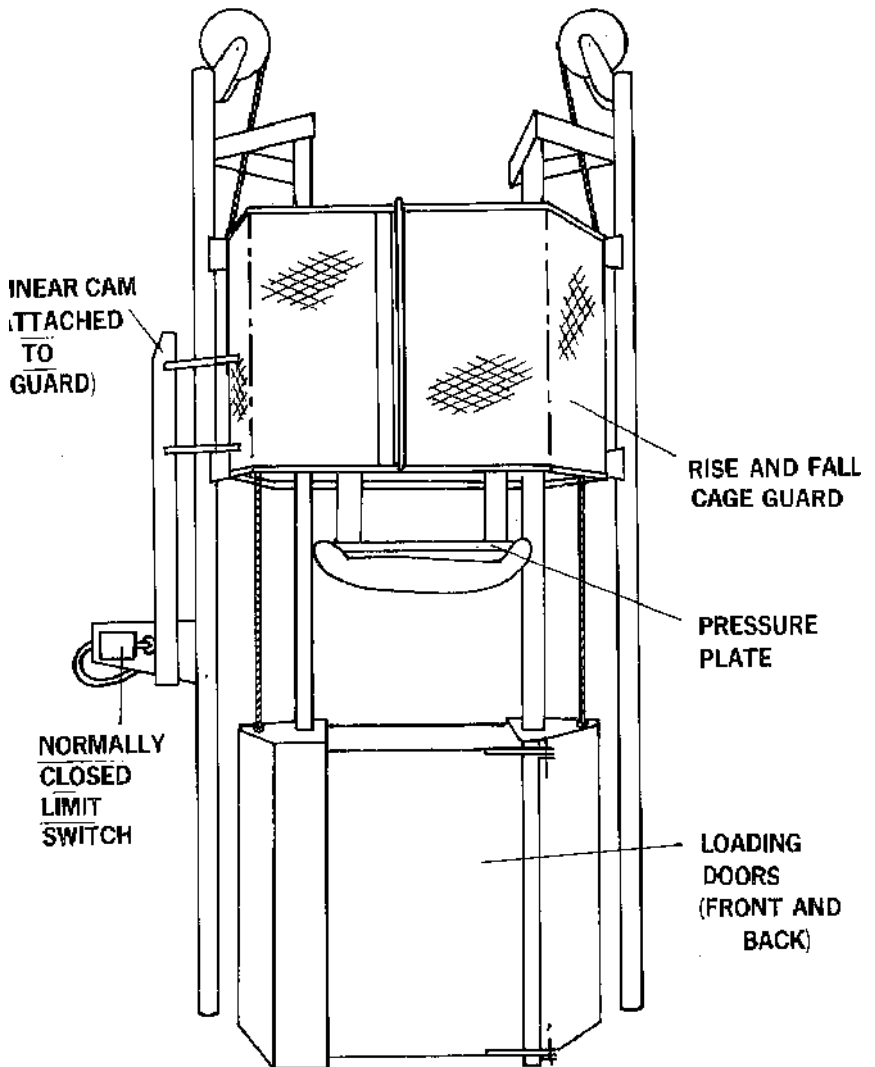


Fig. 6: Mechanical floor-to-floor wool press (upper floor, guard open)

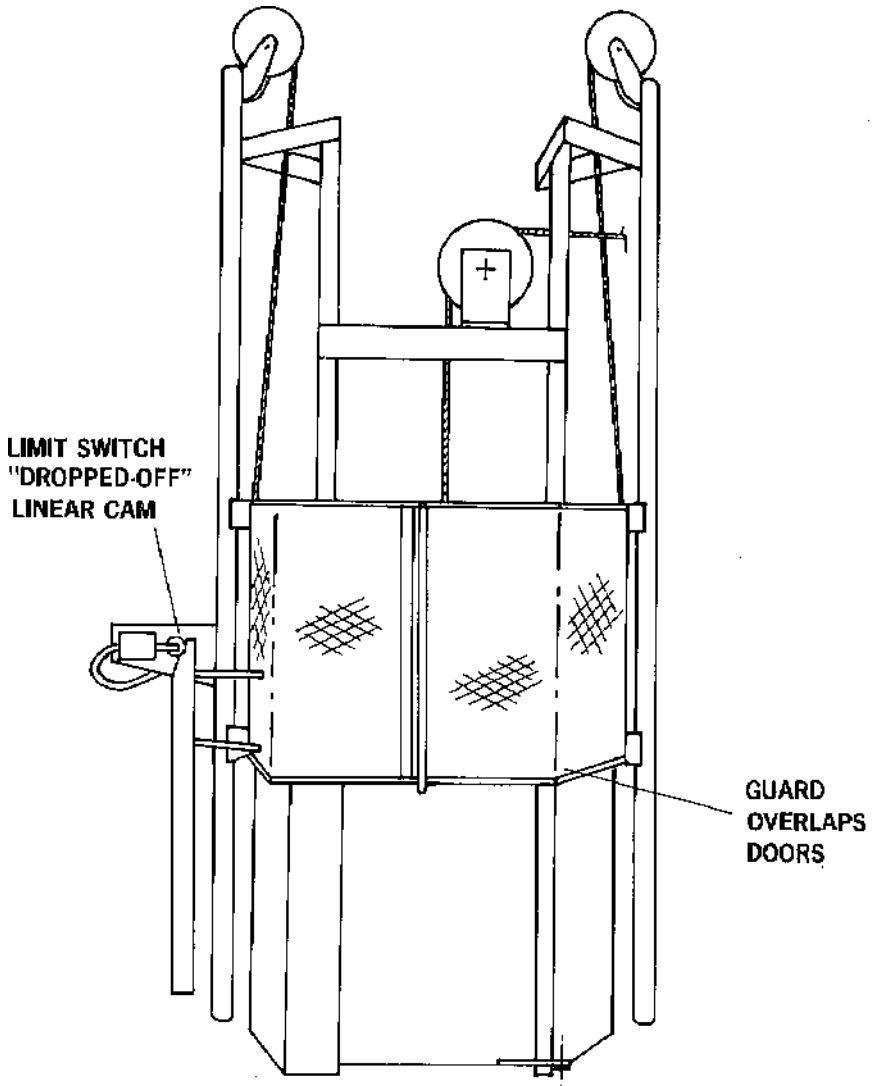


Fig. 7: Mechanical floor-to-floor wool press (upper floor, guard closed)

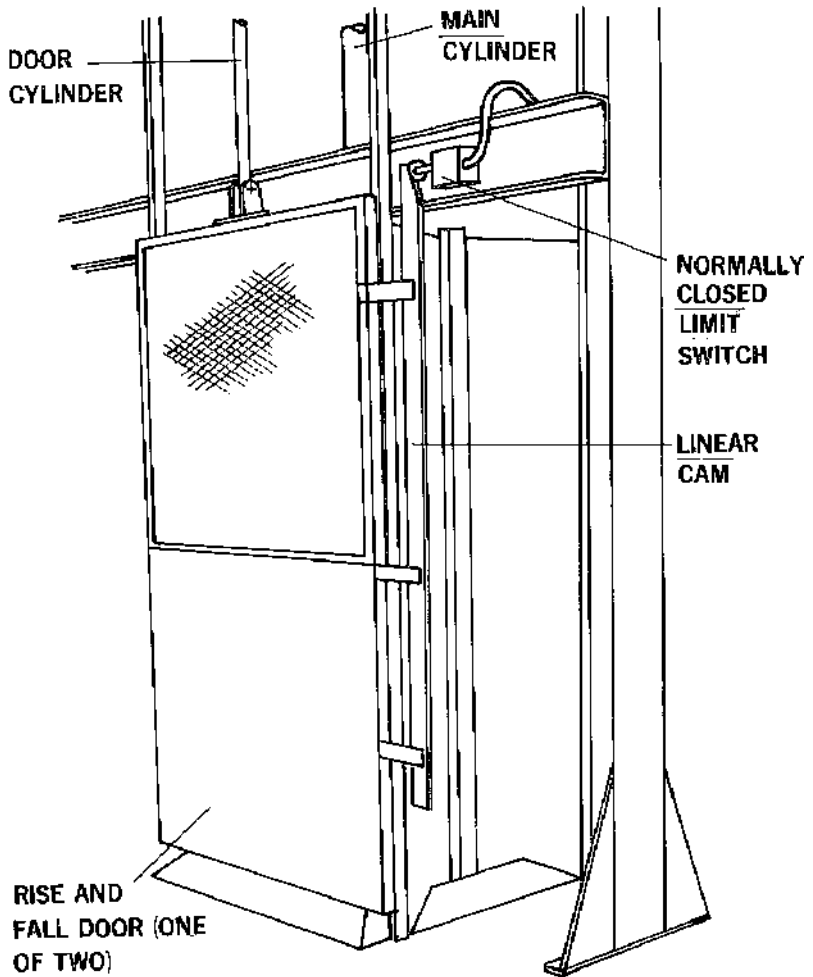


Fig. 8: Hydraulic floor-to-floor wool press (upper floor)

Hydraulic Type

Fig. 8 shows a typical upper floor guarding arrangement. In this example, rise and fall front and rear guards are used. These are hydraulically actuated and the closing force, being limited to the weight of the guard, is insufficient to cause injury.

As with the mechanical type, a linear cam and normally closed type limit switch are used to prevent pressure plate movement when either guard is open. A practical example is shown in plate 2. In this case the guard is manually opened and closed.

Fig. 9 shows how, at the bottom of the sleeve, there is a skirt which surrounds the bottom box, thus ensuring the doors are closed before a stroke. This is only necessary if the pressure plate can come below the bottom edge of the sleeve in its lowest position.

A linear cam and normally closed limit switch ensure that the sleeve is in the down position before a stroke of the pressure plate can be initiated.

An emergency stop button is provided at both the upper and lower stations.

HIGH-DENSITY PRESSES

High-density presses also have to be guarded to meet the requirements of the Machinery Act 1950. Because of the wide diversity of designs, these machines are not covered in this booklet, and advice on guarding should be sought directly from the Department of Labour.

USE OF LIMIT SWITCHES

Limit switches used in safety applications (e.g., trip bars, guard interlocking) should be of a type and be so installed as to meet the requirements of the department in force at the time. In general, limit switches should be wired normally closed (this is implied in the term “normally closed limit switch”). Information and advice on this subject is freely available from the Department of Labour.

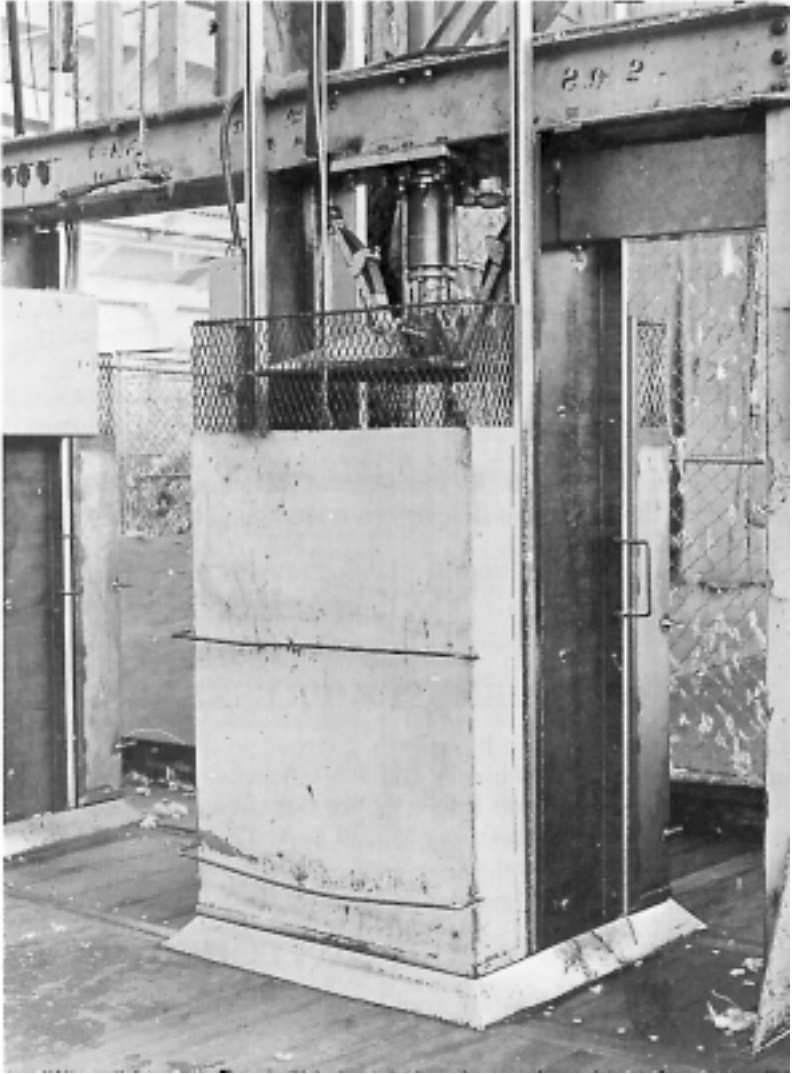


Plate 2: Manually operated rise and fall gate

Photos courtesy of Donald Reid and Co. Ltd and Ronald Smith Engineering Ltd.

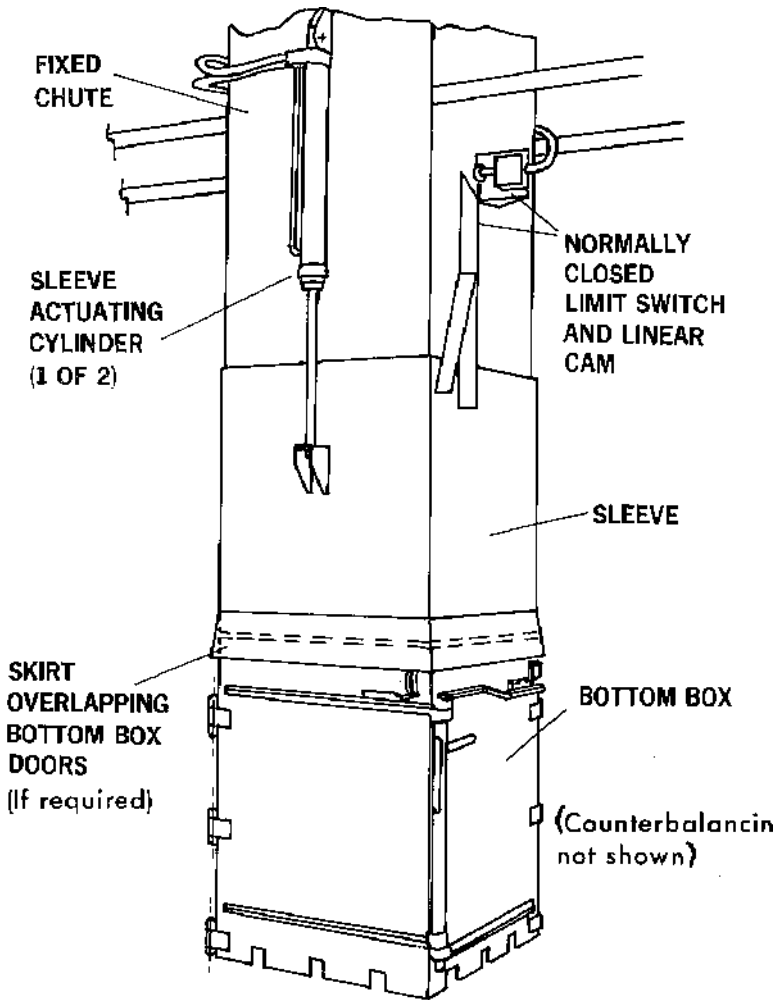


Fig. 9: Hydraulic floor-to-floor wool press (lower floor)

USE OF LIGHT BEAMS

The configuration of the floor-to-floor wool press does not readily lend itself to protection by light beams (photoelectric devices). In addition, when using light beams, considerable efforts need to be made, both mechanical and electronic, to ensure that the system fails to safety. Any person considering the use of such a system is strongly advised to seek the department's advice at an early stage.

CONSTRUCTION OF GUARDS

Guards should be soundly constructed of suitable materials and be incapable of deflection which would allow entry to the danger zone. Where bars are used, or there are holes or slots in a guard, the permissible dimensions of the spaces in relation to distance from dangerous parts can be ascertained by referring to the department's booklet *The Ergonomics of Machine Guarding*.

Care should be taken to ensure that no trapping hazards have been overlooked. It is important to design guards in such a way, especially if they are opened and/or closed under power, that these do not create a new hazard. In the case of vertically opening gates of substantial construction, it is prudent to build in safeguards against cable failure (if appropriate). Such safeguards are easy to devise and examples are shown in BS 5304:1975.

If vertical gates are operated by hydraulic cylinder, for example, they should close under their own weight and the closing force should not be excessive (counterbalancing should be used to keep this force within acceptable limits). The department is able to advise on the suitability of proposed guarding.

MAINTENANCE

All guards should be examined at regular intervals to check the condition and function of interlocks. If a sleeve-mounted tripbar system, as described earlier, has been fitted, the special maintenance checks associated with it must be carried out. It is strongly advised that safety checks, as with maintenance generally, be formalised and strictly adhered to.