Table of Contents

Machine Guarding Basics

Follow-up Activities

- Identified improperly guarded machines in our facility and talked to management about proper guarding requirements.
- Utilized the Machine Guarding Checklist from the manual to evaluate our current machine guarding status.
- Researched our machine related injury and accident statistics (incident rates, OSHA logs, etc.) and identified problem areas.

Activity Plan

	Activity	Other people involved	Target Deadline
❑			
❑			
❑			
❑			
❑			
❑			
❑			
❑			

Resources Available from the Division of Safety & Hygiene (DSH) Libraries

(800) 644-6292 (614) 466-7388

library@bwc.state.oh.us

www.ohiobwc.com

Safety training:

- Safety talks, outlines and scripts - DSH Safety leader's discussion guide, Training Center's One-hour safety presentations, reference books, web resources
- Videos – hundreds of safety and health topics
- Books and articles on training techniques

Machine and equipment safety:

- Safety standards (ANSI, NFPA, CGA)
- Books and articles on power presses, material handling equipment, lockout/tagout, etc.

Sample written programs:

- DSH program profiles and sample written programs
- Reference books
- Internet resources

Illness and injury statistics:

- Statistics from the U.S. Bureau of Labor Statistics
- National Safety Council's *Injury Facts*
- National Institute of Occupational Safety & Health (NIOSH) studies

Hazard communication and chemical safety:

- Chemical safety information
- Material safety data sheets (MSDSs)
- Sample written programs
- Videos
- Internet resources

Safety standards

- American National Standards Institute (ANSI) standards (including standards for construction, machinery and equipment, personal protective equipment)
- National Fire Protection Association (NFPA) fire codes (including the Life Safety Code and the National Electrical Code)
- Compressed Gas Association (CGA) standards

Other topics of interest (books, articles, magazines, videos and standards):

- Confined spaces
- Electrical safety
- Job safety analysis
- New employee orientation
- Powered industrial trucks
- Respiratory protection
- Scaffolds
- Spill response

Directories and lists of vendors of safety equipment

Occupational Safety & Health Administration (OSHA) regulations

Manual of Uniform Traffic Control Devices (MUTCD)

Recommendations of useful Internet sites

BWC publications

Saving You Time and Research

Requests for copies of OSHA standards, information on starting a safety committee, a video on accident investigation techniques -- these are some of the thousands of inquiries BWC's Division of Safety & Hygiene (DSH) libraries receive each year.

DSH has two libraries to serve you:

- The central library in the William Green Building in downtown Columbus;
- The resource center and video library located at the Ohio Center for Occupational Safety and Health (OCOSH) in Pickerington.

Both libraries are open 8 a.m. to 4:45 p.m., Monday through Friday. Your need for information does not require a visit to the library. You can phone, fax, or e-mail your requests and receive a quick response.

The central library provides free information services on the topics of occupational safety and health, workers' compensation and rehabilitation.

The OCOSH resource center provides similar services for those who visit OCOSH for meetings and training center classes.

The video library offers an extensive collection of videotapes to supplement your organization's safety and health training program. It is a convenient and popular source for Ohio employers to borrow quality occupational safety- and health-related training aids.

Visit our Web site at **www.ohiobwc.com.**

Central library
30 W. Spring St., Third Floor
Columbus OH 43215-2256
1-800-OHIOBWC
(614) 466-7388
(614) 644-9634 (fax)
library@bwc.state.oh.us

OCOSH resource center
13430 Yarmouth Drive
Pickerington OH 43147
1-800-OHIOBWC
Resource center (614) 728-6464
Video library (614) 644-0018

INTERNET WEB SITES
FOR
OCCUPATIONAL SAFETY & HEALTH INFORMATION
April 2005

GENERAL

NATIONAL SAFETY COUNCIL (NSC)
http://www.nsc.org/

The NSC has a user friendly web site for innovative and current information on home, farm and community, on the road and workplace safety and as well statistical data and charts.

NORTH DAKOTA WORKFORCE SAFETY & INSURANCE
http://www.workforcesafety.com/

For workplace safety, North Dakota's WSI site puts forth their "safe operating procedures" page where they give information on accident and near miss reports, substance abuse, material handling and storage, walking and working surfaces, and safety program development and orientation.

OCCUPATIONAL & INDUSTRIAL SAFETY RESOURCES
http://www.khake.com/page59.html

Maintained by a Vocational Information Center, this web site provides links to occupational and industrial safety with lists of directories, national centers, hotlines and help lines as well as specific area coverage such as emergency, disaster and natural hazards, and tool, machine and equipment safety options.

OKLAHOMA STATE UNIVERSITY
http://www.pp.okstate.edu/ehs/

The Department of Environmental Health & Safety at OSU offers an online safety resource library that is constantly being updated with topics from A-Z including specific areas of safety such as fire, construction, HAZCOM and training. Go to the "Links Library" option.

SAFETY DIRECTORY
http://www.safetydirectory.com/

Safety Directory.com is an Internet gateway to occupational health & safety sites. This web site is indexed with information on industry specific topics, training, illness and injury, as well as safety publications and resources.

FEDERAL GOVERNMENT

CENTERS FOR DISEASE CONTROL & PREVENTION (CDC)
http://www.cdc.gov/

The CDC is always a good resource for current medical issues throughout the United States. Health topics from A-Z give an in-depth look at most communicable diseases as well as topics such as safe driving, violence, and air pollution, and workplace safety and health topics.

FEDERAL EMERGENCY MANAGEMENT ASSOCIATION (FEMA)
http://www.fema.gov/

For up-to-date information on active disasters and emergencies nationwide access this web site first. Publications include options for emergency preparedness and prevention, response and recovery, disaster fact sheets, and public awareness information.

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY & HEALTH (NIOSH)
http://www.cdc.gov/niosh/homepage.html

NIOSH's web site provides current information on many services as well as safety research, including ergonomics programs, respirators, and mining safety. At the chemical page you will find databases and other helpful resources, information on personal protective equipment, as well as government agency web sites of interest.

OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION (OSHA)
http://www.osha.gov

OSHA'S official web site includes media releases, online publications, statistics, standards & directives, "Technical Links," training center courses, "hot topics," and "what's new" as well a very useful A-Z index page.

INTERNATIONAL RESOURCES

HEALTH & SAFETY EXECUTIVE (HSE)
http://www.hse.gov.uk/

The United Kingdom has an international safety web site with a good deal to offer on occupational safety & health. Drop down boxes offer A-Z industry information, health and safety topics, tools, research, as well as publications and statistics.

ERGNET
http://www.sunderland.ac.uk/~ts0gli/ergnet.htm

The University of Sunderland in the UK is an international web site directory of "places for ergonomics and human factors". Featuring lists of sources such as societies, organizations, government bodies, institutes, centers and laboratories, this site also gives links to journals, a research database and other general ergonomic sites.

OHIO

OHIO EPA (OEPA)

http://www.epa.state.oh.us

At the official web site for Ohio's Environmental Protection Agency; use the "Topic Index" to find regulations and information on permits, hazardous waste, pollution prevention, wastewater, wetlands, and much more.

OHIO STATE LIBRARY/OHIOLINK
http://winslo.state.oh.us

At **OhioLink**, a statewide library and information network, you can search the State Library of Ohio's collection for the BWC's Division of Safety & Hygiene library books as well as other Ohio College and university library collections. Also available at this web site are searchable versions of Ohio Administrative laws and rules, electronic databases, and other Ohio library directories.

SPECIFIC (BY SUBJECT)

CONSTRUCTION
http://www.cdc.gov/elcosh/index.html

CDC's **eLCOSH** is a comprehensive library of construction-related safety information presented in both English and Spanish with items listed under trade, hazard, job site, and others. Also see: The Construction Industry Safety Council, a Center to Protect Workers' Rights resource center at ***http://www.buildsafe.org/RSC.htm*** for OSHA publications in PDF and hazard alerts.

ERGONOMICS
http://www.ergoweb.com

ERGOWEB provides current information on ergonomics and human factor science. Offered are: research, case studies, reference material and a forum for questions, answers and discussion.

LABORATORY SAFETY
http://safety.science.tamu.edu/

Texas A&M University College of Science is an optional choice for safety in the laboratory information. From hazard identification to waste disposal this web site offers thorough coverage of laboratory safe practices.

MATERIAL SAFETY SHEETS
http://www.ilpi.com/msds/index.html

This web site offers many solutions for finding MSDS (100 free sites) as well as chemical manufacturers and suppliers, pesticides including fertilizers, government sites, and other miscellaneous locations for chemical data. Also check any toxicological effects at *http://www.atsdr.cdc.gov/toxprofiles/* and health and safety information on household chemical ingredients at *http://householdproducts.nlm.nih.gov/*.

MOTOR CARRIER SAFETY PROGRAMS

http://www.fmcsa.dot.gov/safetyprogs/saftprogs.htm

The Federal Motor Carrier Safety Administration (FMCSA), an administration within the U.S. Department of Transportation, regulates and supports the Nation's interstate commercial carrier industry. The FMCSA web page offers several safety programs in PDF format such as brake safety, fatigue, HAZMAT safety, speed management, sharing the road safely, and other insurance and licensing information.

RADIATION
http://www.physics.isu.edu/radinf/

The Radiation Information Network offers a web site that is in-depth with information on radiation topics and issues. In addition to what's new in the field and general information there are regulatory, organizational and society links as well as research and educational resources available to access.

SAFETY STATISTICS
http://stats.bls.gov/

Occupational health and safety statistics by industry and occupation can be researched for injuries, illnesses, and fatality data at this web site starting with the "Overview of BLS Statistics on Worker Safety and Health" page.

SAFETY BRIEFINGS, MANUALS, PRODUCTS & PROGRAMS

OSHA POWERPOINT SAFETY PRESENTATIONS
http://esf.uvm.edu/siríppt/powerpt.html

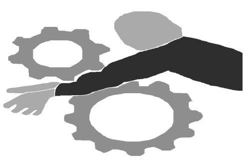
An extensive safety PowerPoint presentation library is available at this web site featuring A-Z topics such as accident investigations, bomb threats, chemical spills, construction, electrical, hand tools, emergency response, fire safety, forklifts, JSA, laser, OSHA compliance, PPE, razor knife safety, safe lifting, and many more.

SAFETY PUBLICATIONS & VIDEO RESOURCES
http://www.cbs.state.or.us/external/osha/standards/pub.htm

A valuable resource for safety resources, the Oregon State's Department of Consumer and Business Publications web site is packed with downloadable information. Areas covered are agriculture, asbestos abatement, occupational exposures, HAZCOM, HAZMAT, HAZWOPER, safety practices, writing manuals and programs, tools of the trade, workers' compensation and ergonomics.

Subpart O — MACHINE GUARDING

- 1910.211 Definitions
- 1910.212 General Requirements for all Machines.
- 1910.213 Woodworking Machinery



Subpart O

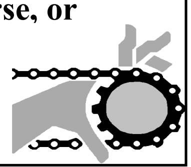
- 1910.215 Abrasive Wheel Machinery
- 1910.216 Mills and Calendars
- 1910.217 Mechanical Power Presses
- 1910.218 Forging Machinery
- 1910.219 Mechanical Power- Transmission

Basics of Machine Safeguarding

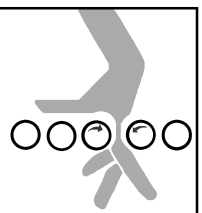
- A good rule to remember is: Any machine part , function, or process which may cause injury must be safeguarded.

Basics Areas of Safeguarding

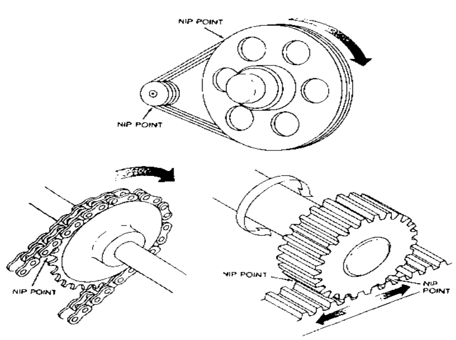
- The point of operation
- Power transmission apparatus
- Other moving parts (reciprocating, transverse, or rotating)



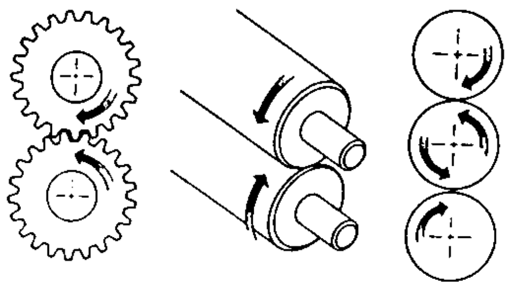
Motions



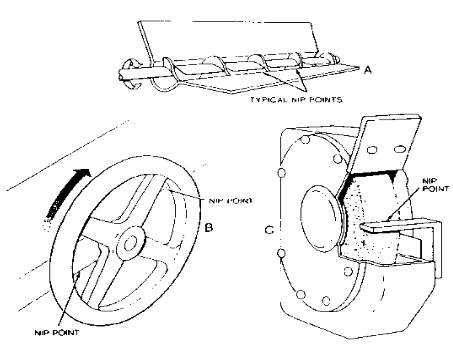
- Motions
  1) Rotating (including in-running nip points.
  2) Reciprocating
  3) Transverse



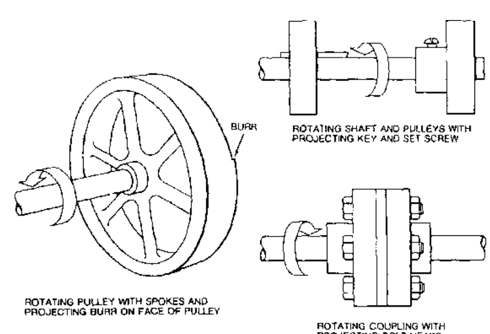
Nip Points



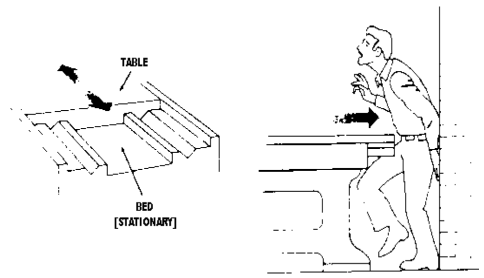
In Running Nip Points On Rolls



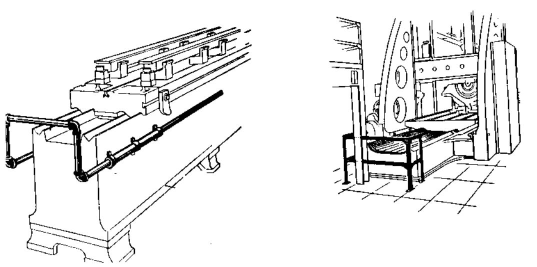
Nip Points



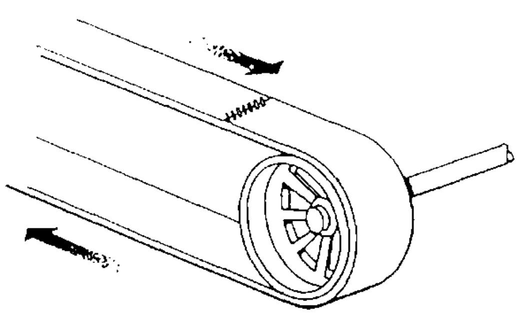
Rotating Hazards



Pinch Points Caused By Tables



Guarding Table Pinch Points



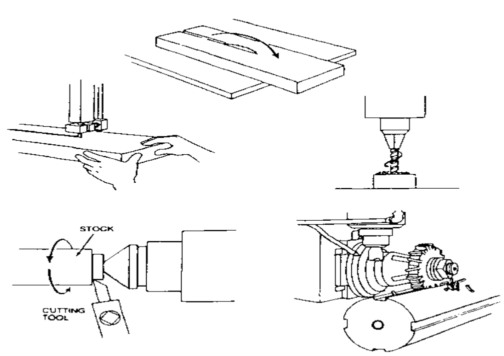
Transverse Motion Of A Belt

Safeguarding

- Guards--- Prevents access to the danger areas.
- Devices---Controls access to the Point of Operation.

Actions

- Cutting
- Punching
- Shearing
- Bending

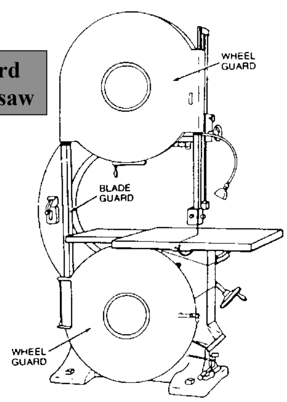


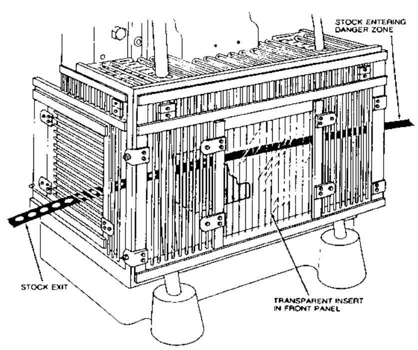
Different Actions

Guards

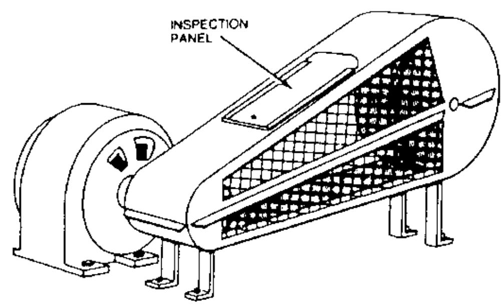
- Fixed
- Interlocked
- Adjustable
- Self-adjusting

Fixed Guard On A Bandsaw

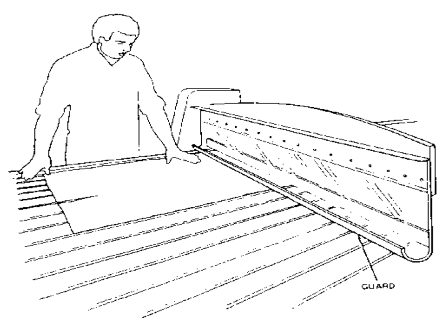




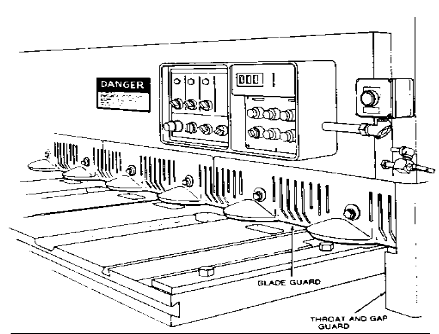
Fixed Guard On A Power Press



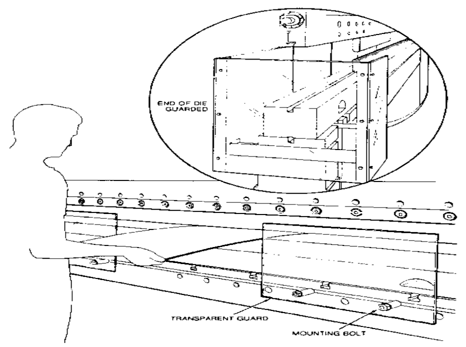
Fixed Guard Enclosing Belt & Pulleys



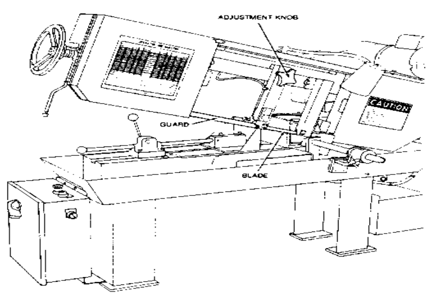
Fixed Guard On Veneer Clipper



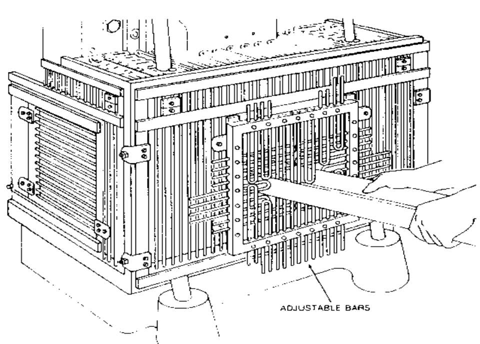
Fixed Guard on a Power Squaring Shear



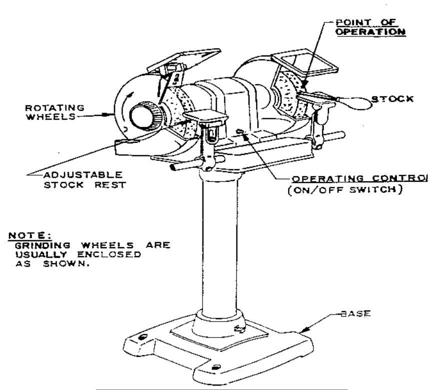
Ends & Unused Portion Of Press Brake Guarded



Adjustable Guard On Horizontal Bandsaw

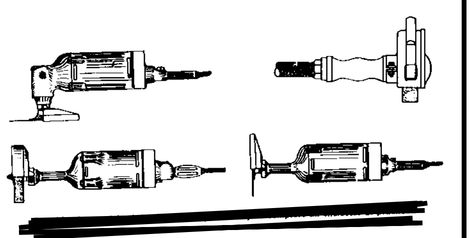


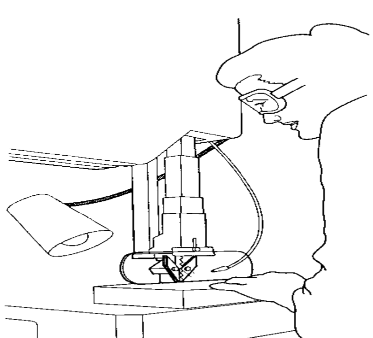
Adjustable Guard On Power Press



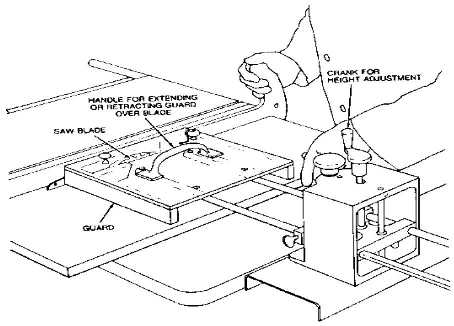
Pedestal Grinder

Portable Grinders

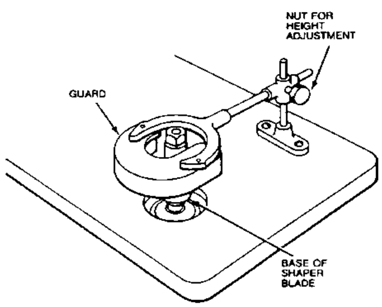




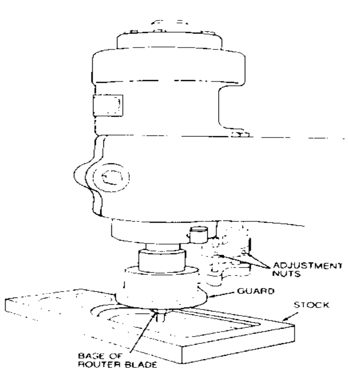
Adjustable Guard On Bandsaw



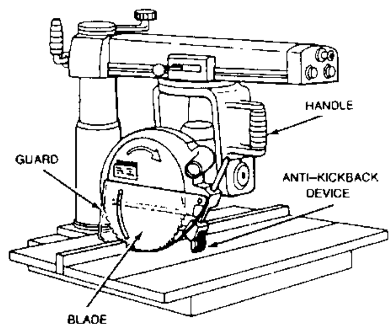
Adjustable Guard on Table Saw



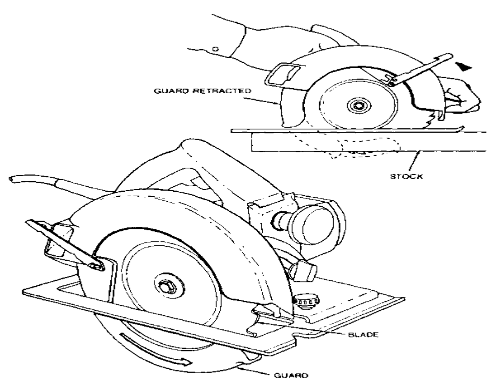
Adjustable Guard On Wood Shaper



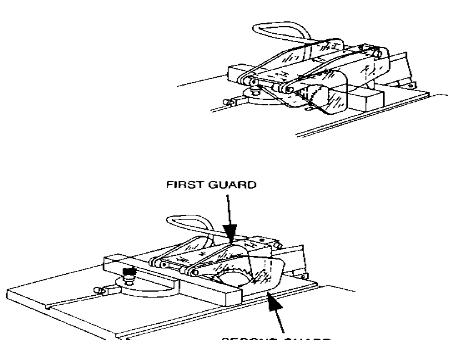
Adjustable Guard On Router



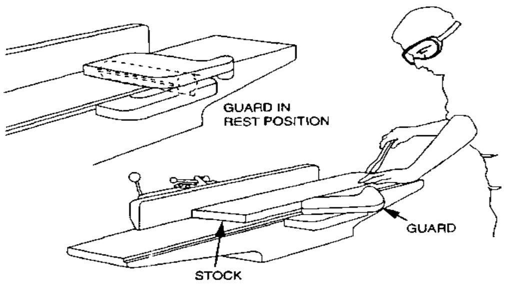
Self-Adjusting Guard On Radial Arm Saw



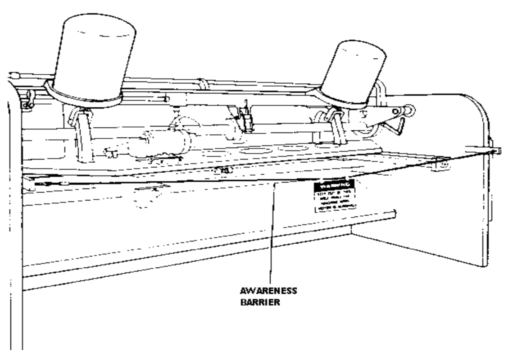
Self -Adjusting Guard On Circular Saw



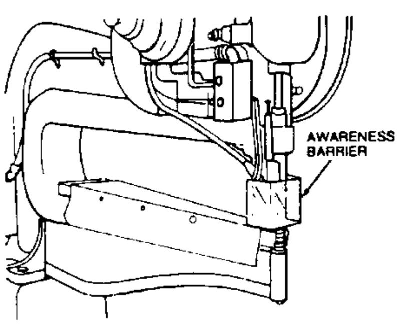
Self-Adjusting Guard Table Saw



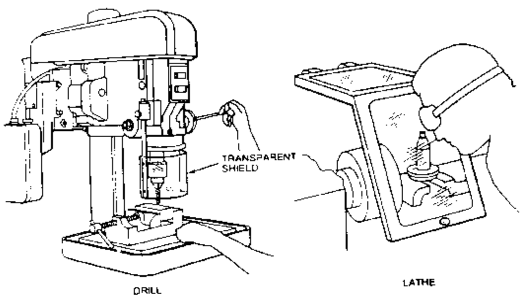
Self-Adjusting Guard On Jointer



Awareness Barrier On Back Side Of Shear



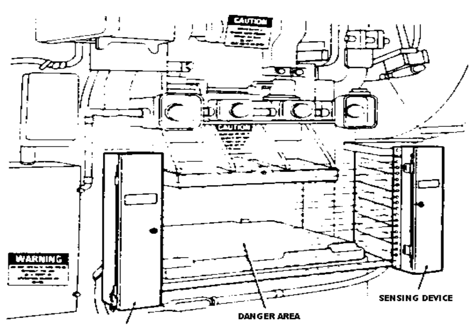
Awareness Barrier On Stitching Machine



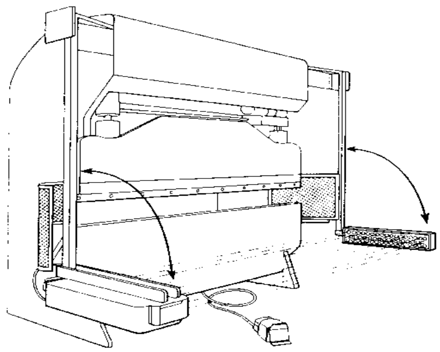
Shields On A Drill Press and Lathe

Devices

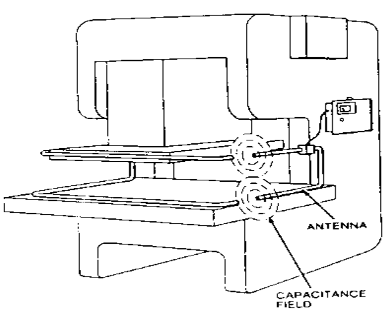
- Presence Sensing
  1) Photo-electrical
  2) Radio-frequency
  3) Electromechanical
- Pullback
- Restraint



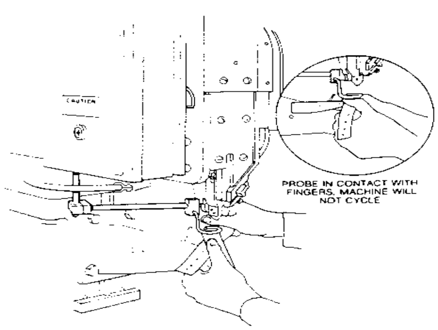
Photoelectric Presence Sensing Device On Power Press



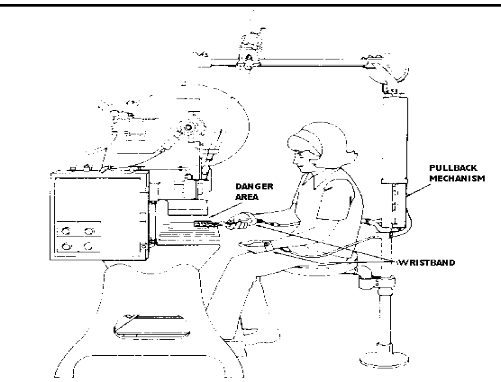
Photoelectric Presence Sensing Device On Press Brake



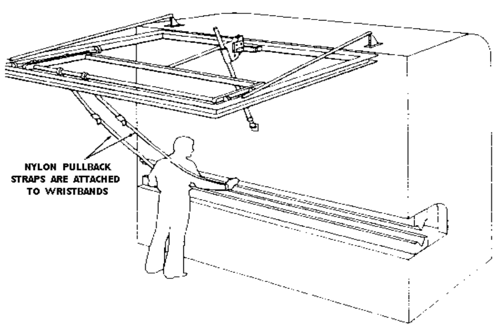
Radio-frequency Presence Sensing Device On Press



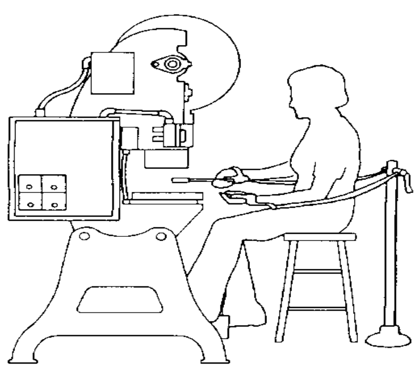
Electromechanical Sensing Device On An Eye-letter



Pullback Device On A Power Press



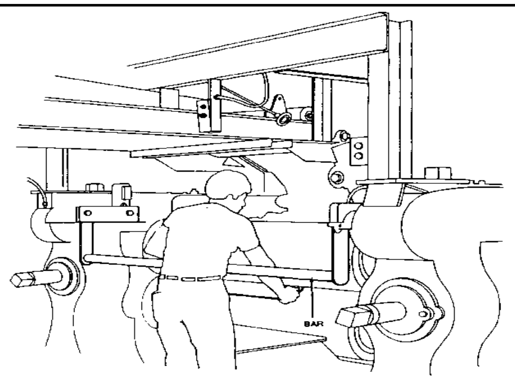
Pullback Device On A Press Brake



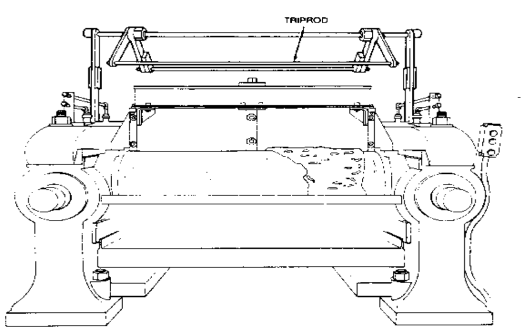
Restraint Device On A Power Press

Devices

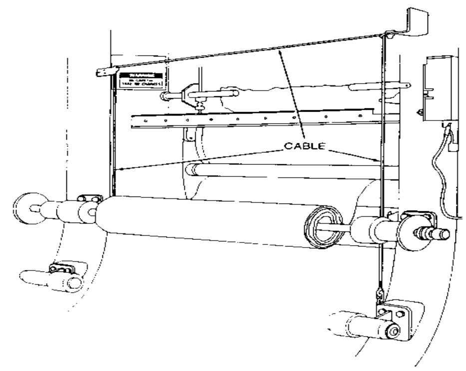
- **Safety Controls**
  1) **Safety trip control**
     (a) **Pressure-sensitive body bar**
     (b) **Safety triprod**
     (c) **Safety tripwire cable**
- **Two-hand control**
- **Two-hand trip**



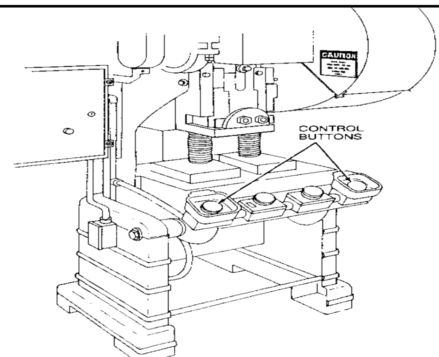
Pressure-Sensitive Body Bar On Rubber Mill



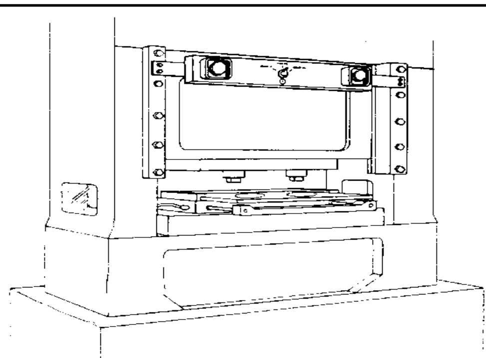
Safety Triprod on a Rubber Mill



Safety Tripwire Cable On A Calender



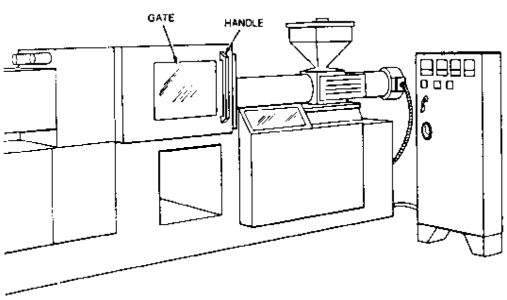
Two-Hand Control Buttons On A Part-Revolution Clutch Power Press



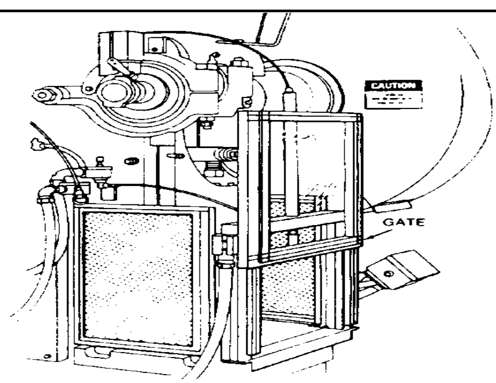
Two-Hand Trip Buttons On A
Full-Revolution Clutch Power Press

Devices

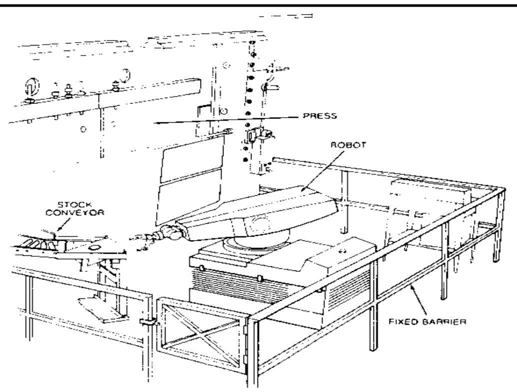
- **Gates**
  1) Interlocked
  2) Other
- **Location/Distance**



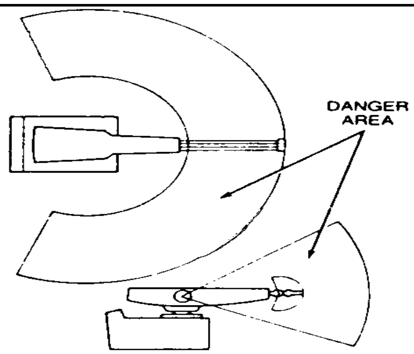
Horizontal Injection Molding Machine With Gate Guards



Power Press With Gate Guards



Robot With Fixed Barrier Guards

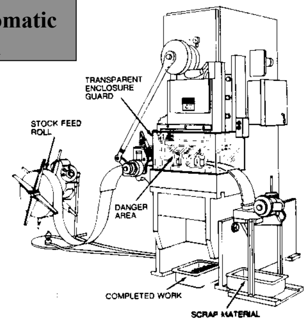


Robot Danger Areas

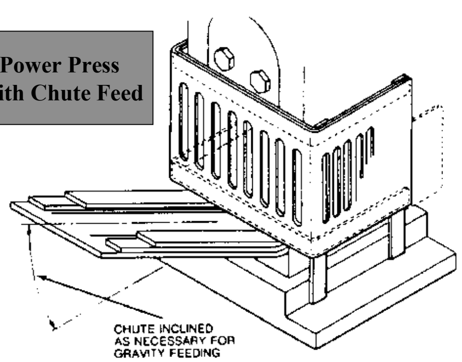
Potential Feeding and Ejection Methods to Improve Safety for the Operator

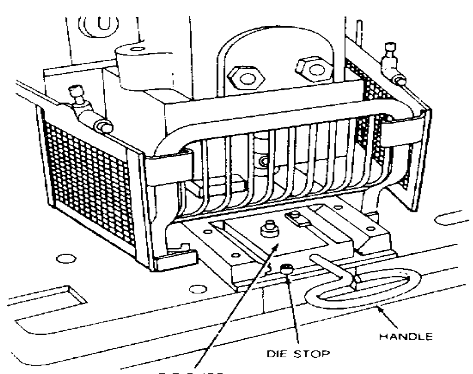
- **Automatic feed**
- **Semi-automatic feed**
- **Automatic ejection**
- **Semi-automatic ejection**

Power Press With Automatic Feed

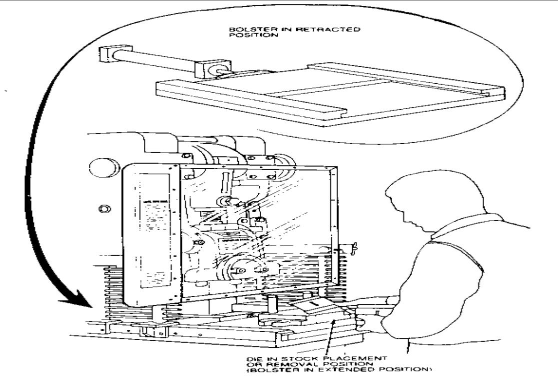


Power Press With Chute Feed

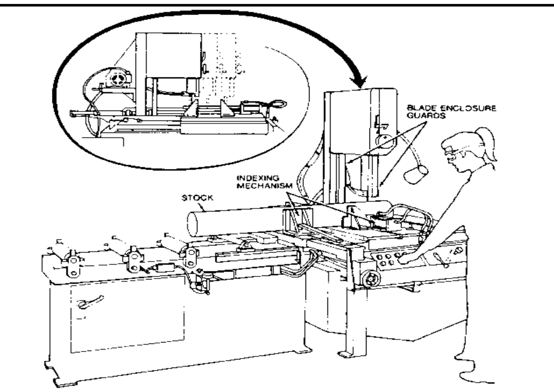




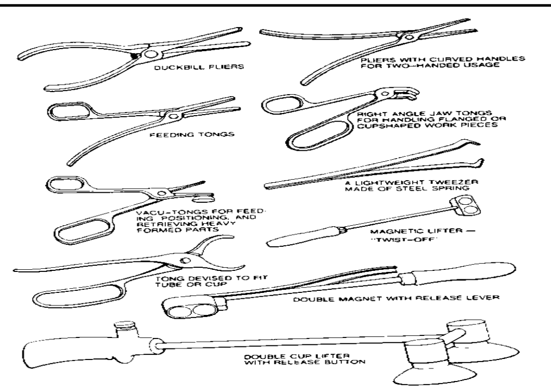
Power Press With Sliding Die



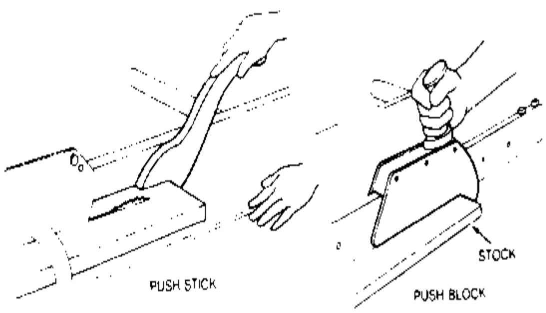
Power Press With Sliding Bolster



Saw With Auto Indexing Mechanism & Traveling Head



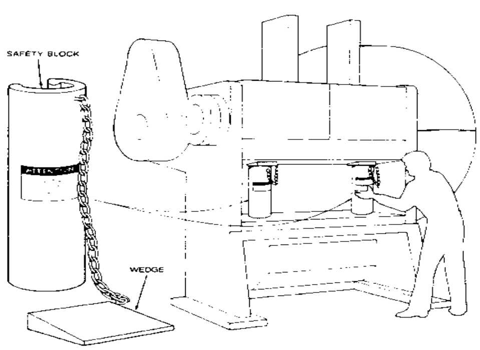
Holding Tools



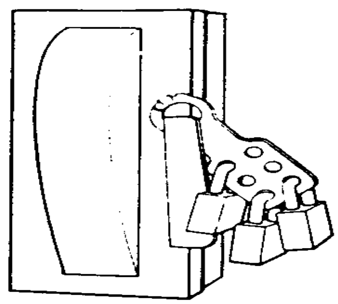
Pushing Devices

5 Concerns on any Machine

- **Safeguarding---guard, device, method**
- **Controls---control reliability**
- **Disconnect---lockable in off position**
- **Starter---magnetic (for drop-out protection)**
- **Covers---rotating components covered to 7ft. from floor or from working platform.**



Safety Blocks Installed On Power Presses



Lockout Devices Required For All Machines

Regulations (Standards - 29 CFR)
Definitions. - 1910.211

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.211
- **Title:** Definitions.

1910.211(a)

As used in 1910.213 and 1910.214 unless the context clearly requires otherwise, the following woodworking machinery terms shall have the meaning prescribed in this paragraph.

1910.211(a)(1)

"Point of operations" means that point at which cutting, shaping, boring, or forming is accomplished upon the stock.

1910.211(a)(2)

"Push stick" means a narrow strip of wood or other soft material with a notch cut into one end and which is used to push short pieces of material through saws.

1910.211(a)(3)

"Block" means a short block of wood, provided with a handle similar to that of a plane and a shoulder at the rear end, which is used for pushing short stock over revolving cutters.

1910.211(b)

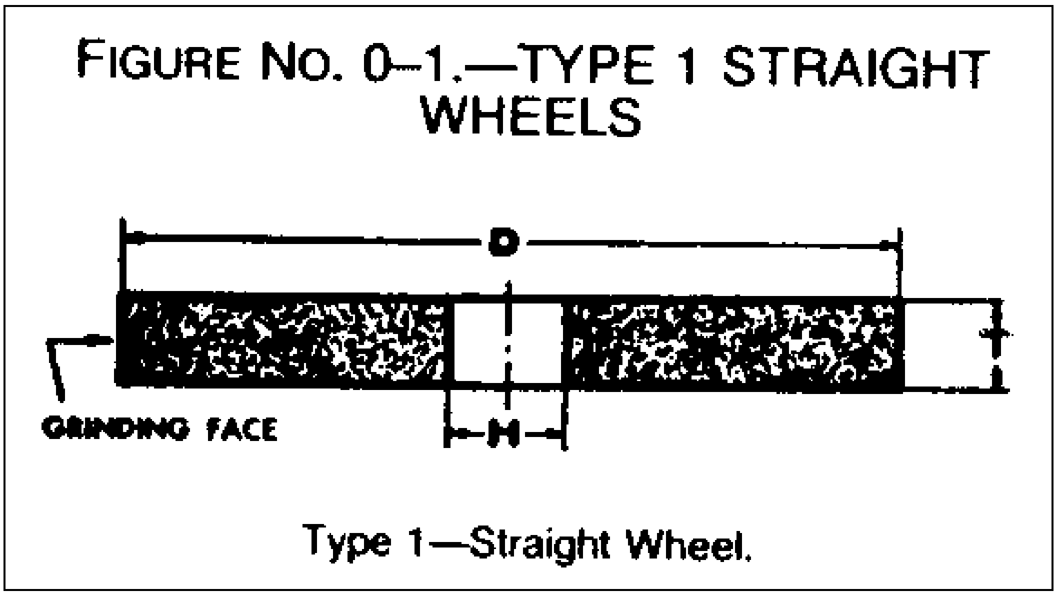
As used in 1910.215 unless the context clearly requires otherwise, the following abrasive wheel machinery terms shall have the meanings prescribed in this paragraph.

1910.211(b)(1)

"Type 1 straight wheels" means wheels having diameter, thickness, and hole size dimensions, and they should be used only on the periphery. Type 1 wheels shall be mounted between flanges.

Limitation: Hole dimension (H) should not be greater than two-thirds of wheel diameter dimension (D) for precision, cylindrical, centerless, or surface grinding applications. Maximum hole size for all other applications should not exceed one-half wheel diameter.

FIGURE NO. O-1. - TYPE 1 STRAIGHT WHEELS



Peripheral grinding wheel having a diameter, thickness and hole.

..1910.211(b)(2)

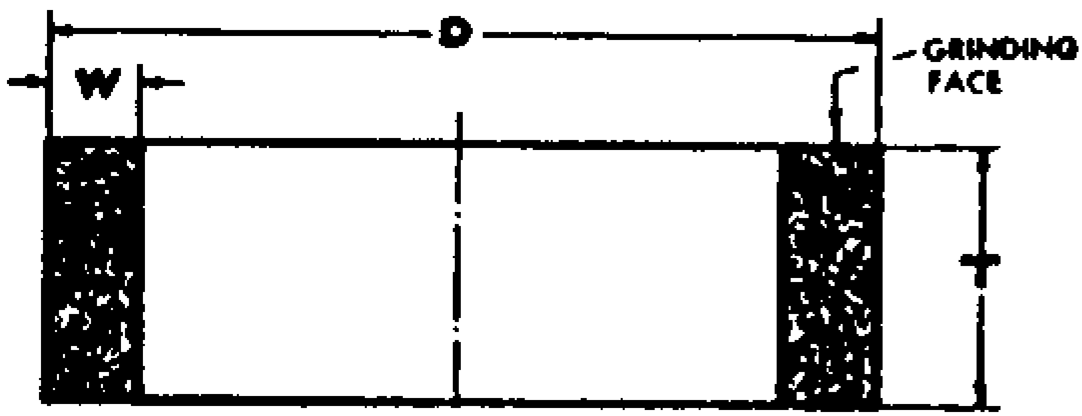
1910.211(b)(2)

"Type 2 cylinder wheels" means wheels having diameter, wheel thickness, and rim thickness dimensions. Grinding is performed on the rim face only, dimension W. Cylinder wheels may be plain, plate mounted, inserted nut, or of the projecting stud type.

Limitation: Rim he ight, T dimension, is generally equal to or greater than rim thickness, W dimension.

FIGURE NO. O-2. - TYPE 2 CYLINDER WHEELS

FIGURE NO. 0-2.—TYPE 2 CYLINDER WHEELS



Type 2—Cylinder Wheel

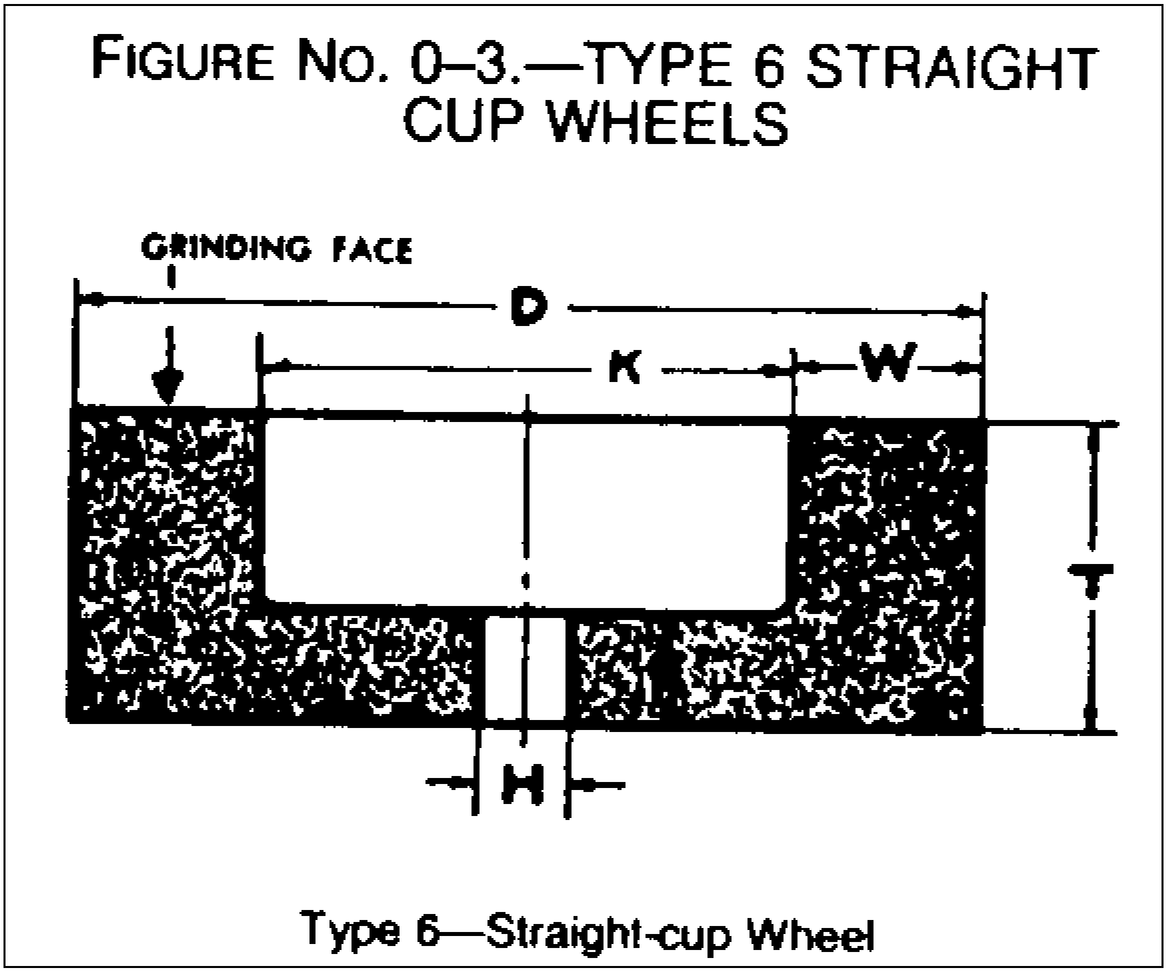
Side grinding wheel having a diameter, thickness and wall - wheel is mounted on the diameter.

1910.211(b)(3)

"Type 6 straight cup wheels" means wheels having diameter, thickness, hole size, rim thickness, and back thickness dimensions. Grinding is always performed on rim face, W dimension.

LIMITATION: Minimum back thickness, E dimension, should not be less than one-fourth T dimension. In addition, when unthreaded hole wheels are specified, the inside flat, K dimension, must be large enough to accommodate a suitable flange.

FIGURE NO. O-3. - TYPE 6 STRAIGHT CUP WHEELS



Side grinding wheel having a diameter, thickness and hole with one side straight or flat and the opposite side recessed. This type, however, differs from Type 5 in that the grinding is performed on the wall of the abrasive created by the difference between the diameter of the recess and the outside diameter of the wheel. Therefore, the wall dimension "W" takes precedence over the diameter of the recess as an essential intermediate dimension to describe this shape type.

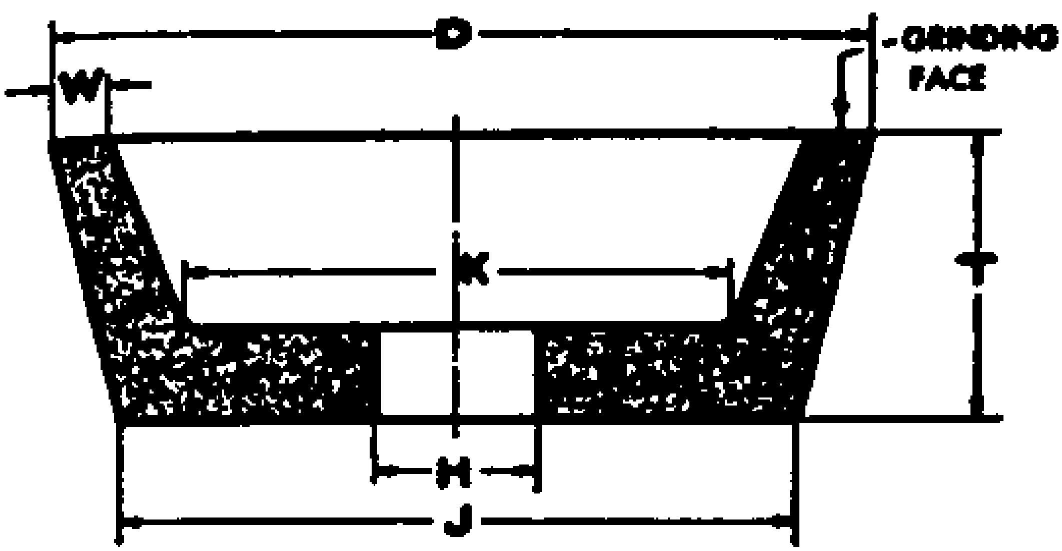
1910.211(b)(4)

"Type 11 flaring cup wheels" mean wheels having double diameter dimensions D and J, and in addition have thickness, hole size, rim and back thickness dimensions. Grinding is always performed on rim face, W dimension. Type 11 wheels are subject to all limitations of use and mounting listed for type 6 straight sided cup wheels definition.

LIMITATION: Minimum back thickness, E dimension, should not be less than one- fourth T dimension. In addition when unthreaded hole wheels are specified the inside flat, K dimension, shall be large enough to accommodate a suitable flange.

FIGURE NO. O-4. - TYPE 11 FLARING CUP WHEELS

FIGURE NO. 0–4.—TYPE 11 FLARING CUP WHEELS



Type 11—Flaring-cup Wheel

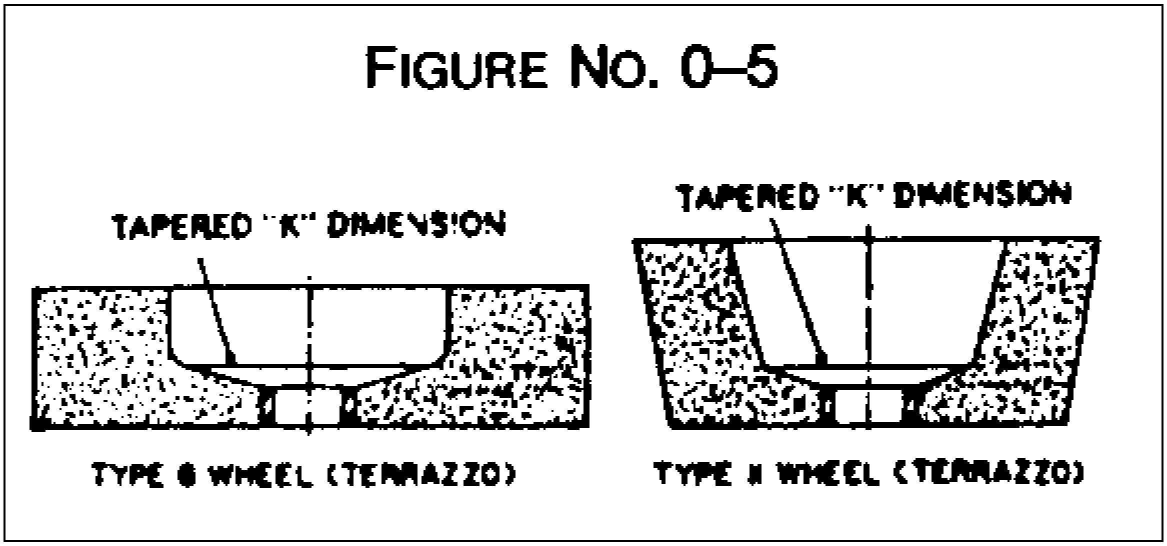
Side grinding wheel having a wall flared or tapered outward from the back. Wall thickness at the back is normally greater than at the grinding face (W).

1910.211(b)(5)

"Modified types 6 and 11 wheels (terrazzo)" mean some type 6 and 11 cup wheels used in the terrazzo trade having tapered K dimensions to match a special tapered flange furnished by the machine builder.

LIMITATION: These wheels shall be mounted only with a special tapered flange.

FIGURE NO. O-5



Typical examples of modified types 6 and 11 wheels (terrazzo) showing tapered K dimensions.

..1910.211(b)(6)

1910.211(b)(6)

"Types 27 and 28 depressed center wheels" mean wheels having diameter, thickness, and hole size dimensions. Both types are reinforced, organic bonded wheels having offset hubs which permit side and peripheral grinding operations without interference with the mounting. Type 27 wheels are manufactured with flat grinding rims permitting notching and cutting operations. Type 28 wheels have saucer shaped grinding rims.

1910.211(b)(6)(i)

Limitations: Special supporting, back adapter and inside flange nuts are required for the proper mounting of these types of wheels subject to limitations of 1910.215(c)(4)(i) and (ii).

1910.211(b)(6)(ii)

Mounts which are affixed to the wheel by the manufacturer may not require an inside nut and shall not be reused.

1910.211(b)(7)

"Type 27A depressed center, cutting-off wheels" mean wheels having diameter, thickness, and hole size dimensions. They are reinforced, organic bonded, offset hub type wheels, usually 16 inches diameter and larger, specially designed for use on cutting-off machines where mounting

nut or outer flange interference cannot be tolerated.
LIMITATIONS: See 1910.215(c)(1).

1910.211(b)(8)

"Surface feet per minute" (s.f.p.m.) means the distance in feet any one abrasive grain on the peripheral surface of a grinding wheel travels in 1 minute.

Surface Feet Per Minute = 3.1416 X diameter in inches X r.p.m. divided by 12 or .262 X diameter in inches X r.p.m.

Examples:
a) 24-inch diameter wheel, 1,000 revolutions per minute. Surface Feet per minute .262 X 24 X 1,000 = 6,288 s.f.p.m.

b) 12-inch diameter wheel, 1,000 revolutions per minute. Surface Feet per minute .262 X 12 X 1,000 = 3,144 s.f.p.m.

1910.211(b)(9)

"Flanges" means collars, discs or plates between which wheels are mounted and are referred to as adaptor, sleeve, or back up type. See paragraph (c) of 1910.215 for full description.

..1910.211(b)(10)

1910.211(b)(10)

"Snagging" means grinding which removes relatively large amounts of material without regard to close tolerances or surface finish requirements.

1910.211(b)(11)

"Off-hand grinding" means the grinding of any material or part which is held in the operator's hand.

1910.211(b)(12)

"Safety guard" means an enclosure designed to restrain the pieces of the grinding wheel and furnish all possible protection in the event that the wheel is broken in operation. See paragraph (b) of 1910.215.

1910.211(b)(13)

"Cutting off wheels" means wheels having diameter thickness and hole size dimensions and are subject to all limitations of mounting and use listed for type 1 wheels, the definition in subparagraph (1) of this paragraph and paragraph (d) of 1910.215. They may be steel centered, diamond abrasive or organic bonded abrasive of the plain or reinforced type.

1910.211(b)(13)(i)

Limitation: Cutting off wheels are recommended only for use on specially designed and fully guarded machines and are subject to the following maximum thickness and hole size limitations.

Wheel diameter	Max. thickness (inch)
6 inch and smaller	3/18
Larger than 6 inches to 12 inches	1/4
Larger than 12 inches to 23 inches	3/8
Larger than 23 inches	1/2

1910.211(b)(13)(ii)

Maximum hole size for cutting-off wheels should not be larger than 1/4-wheel diameter.

..1910.211(b)(14)

1910.211(b)(14)

"Abrasive wheel" means a cutting tool consisting of abrasive grains held together by organic or inorganic bonds. Diamond and reinforced wheels are included.

1910.211(b)(15)

"Organic wheels" means wheels which are bonded by means of an organic material such as resin, rubber, shellac, or other similar bonding agent.

1910.211(b)(16)

"Inorganic wheels" means wheels which are bonded by means of inorganic material such as clay, glass, porcelain, sodium silicate, magnesium oxychloride, or metal. Wheels bonded with clay, glass, porcelain or related ceramic materials are characterized as "vitrified bonded wheels."

1910.211(c)

As used in 1910.216, unless the context clearly requires otherwise, the following mills and calenders in the rubber and plastic industries terms shall have the meanings prescribed in this paragraph.

1910.211(c)(1)

Bite" means the nip point between any two inrunning rolls.

1910.211(c)(2)

"Calender" means a machine equipped with two or more metal rolls revolving in opposite directions and used for continuously sheeting or plying up rubber and plastics compounds and for frictioning or coating materials with rubber and plastics compounds.

..1910.211(c)(3)

1910.211(c)(3)

"Mill" means a machine consisting of two adjacent metal rolls, set horizontally, which revolve in opposite directions (i.e., toward each other as viewed from above) used for the mechanical working of rubber and plastics compounds.

1910.211(d)

As used in 1910.217, unless the context clearly requires otherwise, the following power press terms shall have the meaning prescribed in this paragraph.

1910.211(d)(1)

"Antirepeat" means the part of the clutch/brake control system designed to limit the press to a single stroke if the tripping means is held operated. Antirepeat requires release of all tripping mechanisms before another stroke can be initiated. "Antirepeat" is also called single stroke reset or reset circuit.

1910.211(d)(2)

"Brake" means the mechanism used on a mechanical power press to stop and/or hold the crankshaft, either directly or through a gear train, when the clutch is disengaged.

1910.211(d)(3)

"Bolster plate" means the plate attached to the top of the bed of the press having drilled holes or T-slots for attaching the lower die or die shoe.

1910.211(d)(4)

"Clutch" means the coupling mechanism used on a mechanical power press to couple the flywheel to the crankshaft, either directly or through a gear train.

..1910.211(d)(5)

1910.211(d)(5)

"Full revolution clutch" means a type of clutch that, when tripped, cannot be disengaged until the crankshaft has completed a full revolution and the press slide a full stroke.

1910.211(d)(6)

"Part revolution clutch" means a type of clutch that can be disengaged at any point before the crankshaft has completed a full revolution and the press slide a full stroke.

1910.211(d)(7)

"Direct drive" means the type of driving arrangement wherein no clutch is used; coupling and decoupling of the driving torque is accomplished by energization and deenergization of a motor. Even though not employing a clutch, direct drives match the operational characteristics of "part revolution clutches" because the driving power may be disengaged during the stroke of the press.

1910.211(d)(8)

"Concurrent" means acting in conjunction, and is used to describe a situation wherein two or more controls exist in an operated condition at the same time.

1910.211(d)(9)

"Continuous" means uninterrupted multiple strokes of the slide without intervening stops (or other clutch control action) at the end of individual strokes.

1910.211(d)(10)

"Counterbalance" means the mechanism that is used to balance or support the weight of the connecting rods, slide, and slide attachments.

1910.211(d)(11)

"Device" means a press control or attachment that:

..1910.211(d)(11)(i)

1910.211(d)(11)(i)

Restrains the operator from inadvertently reaching into the point of operation, or

1910.211(d)(11)(ii)

Prevents normal press operation if the operator's hands are inadvertently within the point of operation, or

1910.211(d)(11)(iii)

Automatically withdraws the operator's hands if the operator's hands are inadvertently within the point of operation as the dies close, or

1910.211(d)(11)(iv)

Prevents the initiation of a stroke, or stops of stroke in progress, when there is an intrusion through the sensing field by any part of the operator's body or by any other object.

1910.211(d)(12)

"Presence sensing device" means a device designed, constructed and arranged to create a sensing field or area that signals the clutch/brake control to deactivate the clutch and activate the brake of the press when any part of the operator's body or a hand tool is within such field or area.

1910.211(d)(13)

"Gate or movable barrier device" means a movable barrier arranged to enclose the point of operation before the press stroke can be started.

..1910.211(d)(14)

1910.211(d)(14)

"Holdout or restraint device" means a mechanism, including attachments for operator's hands, that when anchored and adjusted prevent the operator's hands from entering the point of operation.

1910.211(d)(15)

"Pull-out device" means a mechanism attached to the operator's hands and connected to the upper die or slide of the press, that is designed, when properly adjusted, to withdraw the operator's hands as the dies close, if the operator's hands are inadvertently within the point of operation.

1910.211(d)(16)

"Sweep device" means a single or double arm (rod) attached to the upper die or slide of the press and designed to move the operator's hands to a safe position as the dies close, if the operator's hands are inadvertently within the point of operation.

1910.211(d)(17)

"Two hand control device" means a two hand trip that further requires concurrent pressure from both hands of the operator during a substantial part of the die-closing portion of the stroke of the press.

1910.211(d)(18)

"Die" means the tooling used in a press for cutting or forming material. An upper and a lower die make a complete set.

1910.211(d)(19)

"Die builder" means any person who builds dies for power presses.

..1910.211(d)(20)

1910.211(d)(20)

"Die set" means a tool holder held in alignment by guide posts and bushings and consisting of a lower shoe, an upper shoe or punch holder, and guide posts and bushings.

1910.211(d)(21)

"Die setter" means an individual who places or removes dies in or from mechanical power presses, and who, as a part of his duties, makes the necessary adjustments to cause the tooling to function properly and safely.

1910.211(d)(22)

"Die setting" means the process of placing or removing dies in or from a mechanical power press, and the process of adjusting the dies, other tooling and safeguarding means to cause them to function properly and safely.

1910.211(d)(23)

"Die shoe" means a plate or block upon which a die holder is mounted. A die shoe functions primarily as a base for the complete die assembly, and, when used, is bolted or clamped to the bolster plate or the face of slide.

1910.211(d)(24)

"Ejector" means a mechanism for removing work or material from between the dies.

1910.211(d)(25)

"Face of slide" means the bottom surface of the slide to which the punch or upper die is generally attached.

1910.211(d)(26)

"Feeding" means the process of placing or removing material within or from the point of operation.

..1910.211(d)(27)

1910.211(d)(27)

"Automatic feeding" means feeding wherein the material or part being processed is placed within or removed from the point of operation by a method or means not requiring action by an operator on each stroke of the press.

1910.211(d)(28)

"Semiautomatic feeding" means feeding wherein the material or part being processed is placed within or removed from the point of operation by an auxiliary means controlled by operator on each stroke of the press.

1910.211(d)(29)

"Manual feeding" means feeding wherein the material or part being processed is handled by the operator on each stroke of the press.

1910.211(d)(30)

"Foot control" means the foot operated control mechanism designed to be used with a clutch or clutch/brake control system.

1910.211(d)(31)

"Foot pedal" means the foot operated lever designed to operate the mechanical linkage that trips a full revolution clutch.

1910.211(d)(32)

"Guard" means a barrier that prevents entry of the operator's hands or fingers into the point of operation.

1910.211(d)(33)

"Die enclosure guard" means an enclosure attached to the die shoe or stripper, or both, in a fixed position.

1910.211(d)(34)

"Fixed barrier guard" means a die space barrier attached to the press frame.

..1910.211(d)(35)

1910.211(d)(35)

"Interlocked press barrier guard" means a barrier attached to the press frame and interlocked so that the press stroke cannot be started normally unless the guard itself, or its hinged or movable sections, enclose the point of operation.

1910.211(d)(36)

"Adjustable barrier guard" means a barrier requiring adjustment for each job or die setup.

1910.211(d)(37)

"Guide post" means the pin attached to the upper or lower die shoe operating within the bushing on the opposing die shoe, to maintain the alignment of the upper and lower dies.

1910.211(d)(38)

"Hand feeding tool" means any hand held tool designed for placing or removing material or parts to be processed within or from the point of operation.

1910.211(d)(39)

"Inch" means an intermittent motion imparted to the slide (on machines using part revolution clutches) by momentary operation of the "Inch" operating means. Operation of the "Inch" operating means engages the driving clutch so that a small portion of one stroke or indefinite stroking can occur, depending upon the length of time the "Inch" operating means is held operated. "Inch" is a function used by the die setter for setup of dies and tooling, but is not intended for use during production operations by the operator.

1910.211(d)(40)

"Jog" means an intermittent motion imparted to the slide by momentary operation of the drive motor, after the clutch is engaged with the flywheel at rest.

..1910.211(d)(41)

1910.211(d)(41)

"Knockout" means a mechanism for releasing material from either die.

1910.211(d)(42)

"Liftout" means the mechanism also known as knockout.
1910.211(d)(43)

"Operator's station" means the complete complement of controls used by or available to an operator on a given operation for stroking the press.

1910.211(d)(44)

"Pinch point" means any point other than the point of operation at which it is possible for a part of the body to be caught between the moving parts of a press or auxiliary equipment, or between moving and stationary parts of a press or auxiliary equipment or between the material and moving part or parts of the press or auxiliary equipment.

1910.211(d)(45)

"Point of operation" means the area of the press where material is actually positioned and work is being performed during any process such as shearing, punching, forming, or assembling.

..1910.211(d)(46)

1910.211(d)(46)

"Press" means a mechanically powered machine that shears, punches, forms or assembles metal or other material by means of cutting, shaping, or combination dies attached to slides. A press consists of a stationary bed or anvil, and a slide (or slides) having a controlled reciprocating motion toward and away from the bed surface, the slide being guided in a definite path by the frame of the press.

1910.211(d)(47)

"Repeat" means an unintended or unexpected successive stroke of the press resulting from a malfunction.

1910.211(d)(48)

"Safety block" means a prop that, when inserted between the upper and lower dies or between the bolster plate and the face of the slide, prevents the slide from falling of its own deadweight.

1910.211(d)(49)

"Single stroke" means one complete stroke of the slide, usually initiated from a full open (or up) position, followed by closing (or down) ,and then

a return to the full open position.
1910.211(d)(50)

"Single stroke mechanism" means an arrangement used on a full revolution clutch to limit the travel of the slide to one complete stroke at each engagement of the clutch.

1910.211(d)(51)

"Slide" means the main reciprocating press member. A slide is also called a ram, plunger, or platen.

1910.211(d)(52)

"Stop control" means an operator control designed to immediately deactivate the clutch control and activate the brake to stop slide motion.

..1910.211(d)(53)

1910.211(d)(53)

"Stripper" means a mechanism or die part for removing the parts or material from the punch.

1910.211(d)(54)

"Stroking selector" means the part of the clutch/brake control that determines the type of stroking when the operating means is actuated. The stroking selector generally includes positions for "Off" (Clutch Control), "Inch," "Single Stroke," and "Continuous" (when Continuous is furnished).

1910.211(d)(55)

"Trip or (tripping)" means activation of the clutch to "run" the press.

1910.211(d)(56)

"Turnover bar" means a bar used in die setting to manually turn the crankshaft of the press.

1910.211(d)(57)

"Two-hand trip" means a clutch actuating means requiring the concurrent use of both hands of the operator to trip the press.

1910.211(d)(58)

"Unitized tooling" means a type of die in which the upper and lower members are incorporated into a self-contained unit so arranged as to hold the die members in alignment.

1910.211(d)(59)

"Control system" means sensors, manual input and mode selection elements, interlocking and decision-making circuitry, and output elements to the press operating mechanism.

..1910.211(d)(60)

1910.211(d)(60)

"Brake monitor" means a sensor designed, constructed, and arranged to monitor the effectiveness of the press braking system.

1910.211(d)(61)

"Presence sensing device initiation" means an operating mode of indirect manual initiation of a single stroke by a presence sensing device when it senses that work motions of the operator, related to feeding and/or removing parts, are completed and all parts of the operator's body or hand tools are safely clear of the point of operation.

1910.211(d)(62)

"Safety system" means the integrated total system, including the pertinent elements of the press, the controls, the safeguarding and any required supplemental safeguarding, and their interfaces with the operator, and the environment, designed, constructed and arranged to operate together as a unit, such that a single failure or single operating error will not cause injury to personnel due to point of operation hazards.

1910.211(d)(63)

"Authorized person" means one to whom the authority and responsibility to perform a specific assignment has been given by the employer.

..1910.211(d)(64)

1910.211(d)(64)

"Certification" or "certify" means, in the case of design certification/validation, that the manufacturer has reviewed and tested the design and manufacture, and in the case of installation certification/validation and annual recertification/revalidation, that the employer has reviewed and tested the installation, and concludes in both cases that the requirements of 1910.217 (a) through (h) and Appendix A have been met. The certifications are made to the validation organization.

1910.211(d)(65)

"Validation" or "validate" means for PSDI safety systems that an OSHA recognized third-party validation organization:

1910.211(d)(65)(i)

For design certification/validation has reviewed the manufacturer's certification that the PSDI safety system meets the requirements of 1910.217 (a) through (h) and Appendix A and the underlying tests and analyses performed by the manufacturer, has performed additional tests and analyses which may be required by 1910.217 (a) through (h) and Appendix A, and concludes that the requirements of 1910.217 (a) through (h) and Appendix A have been met; and

1910.211(d)(65)(ii)

For installation certification/validation and annual recertification/revalidation has reviewed the employer's certification that the PSDI safety system meets the requirements of 1910.217 (a) through (h) and Appendix A and the underlying tests performed by the employer, has performed additional tests and analyses which may be required by 1910.217 (a) through (h) and Appendix A, and concludes that the requirements of 1910.217 (a) through (h) and Appendix A have been met.

1910.211(d)(66)

"Certification/validation" and "certify/validate" means the combined process of certification and validation.

..1910.211(e)

1910.211(e)

As used in 1910.218, unless the context clearly requires otherwise, the following forging and hot metal terms shall have the meaning prescribed in this paragraph.

1910.211(e)(1)

"Forging" means the product of work on metal formed to a desired shape by impact or pressure in hammers, forging machines (upsetters), presses, rolls, and related forming equipment. Forging hammers, counterblow equipment and high-energy-rate forging machines impart impact to the workpiece, while most other types of forging equipment impart squeeze pressure in shaping the stock. Some metals can be forged at room temperature, but the majority of metals are made more plastic for forging by heating.

1910.211(e)(2)

"Open framehammers (or blacksmith hammers)" mean hammers used primarily for the shaping of forgings by means of impact with flat dies. Open frame hammers generally are so constructed that the anvil assembly is separate from the operating mechanism and machine supports; it rests on its own independent foundation. Certain exceptions are forging hammers made with frame mounted on the anvil; e.g., the smaller, single-frame hammers are usually made with the anvil and frame in one piece.

1910.211(e)(3)

"Steam hammers" mean a type of drop hammer where the ram is raised for each stroke by a double-action steam cylinder and the energy delivered to the workpiece is supplied by the velocity and weight of the ram and attached upper die driven downward by steam pressure. Energy delivered during each stroke may be varied.

..1910.211(e)(4)

1910.211(e)(4)

"Gravity hammers" mean a class of forging hammer wherein energy for forging is obtained by the mass and velocity of a freely falling ram and the attached upper die. Examples: board hammers and air-lift hammers.

1910.211(e)(5)

"Forging presses" mean a class of forging equipment wherein the shaping of metal between dies is performed by mechanical or hydraulic pressure, and usually is accomplished with a single workstroke of the press for each die station.

1910.211(e)(6)

"Trimming presses" mean a class of auxiliary forging equipment which removes flash or excess metal from a forging. This trimming operation can also be done cold, as can coining, a product sizing operation.

1910.211(e)(7)

"High-energy-rate forging machines" mean a class of forging equipment wherein high ram velocities resulting from the sudden release of a compressed gas against a free piston impart impact to the workpiece.

1910.211(e)(8)

"Forging rolls" mean a class of auxiliary forging equipment wherein stock is shaped between power driven rolls bearing contoured dies. Usually used for preforming, roll forging is often employed to reduce thickness and increase length of stock.

..1910.211(e)(9)

1910.211(e)(9)

"Ring rolls" mean a class for forging equipment used for shaping weldless rings from pierced discs or thick-walled, ring-shaped blanks between rolls which control wall thickness, ring diameter, height and contour.

1910.211(e)(10)

"Bolt-headers" mean the same as an upsetter or forging machine except that the diameter of stock fed into the machine is much smaller, i.e., commonly three-fourths inch or less.

1910.211(e)(11)

Rivet making machines mean the same as upsetters and boltheaders when producing rivets with stock diameter of 1-inch or more. Rivet making with less than 1-inch diameter is usually a cold forging operation, and therefore not included in this subpart.

1910.211(e)(12)

Upsetters (or forging machines, or headers) type of forging equipment, related to the mechanical press, in which the main forming energy is applied horizontally to the workpiece which is gripped and held by prior action of the dies.

1910.211(f)

As used in 1910.219, unless the context clearly requires otherwise, the following mechanical power-transmission guarding terms shall have the meaning prescribed in this paragraph.

1910.211(f)(1)

"Belts" include all power transmission belts, such as flat belts, round belts, V-belts, etc., unless otherwise specified.

..1910.211(f)(2)

1910.211(f)(2)

"Belt shifter" means a device for mechanically shifting belts from tight to loose pulleys or vice versa, or for shifting belts on cones of speed pulleys.

1910.211(f)(3)

"Belt pole" (sometimes called a "belt shipper" or "shipper pole,") means a device used in shifting belts on and off fixed pulleys on line or countershaft where there are no loose pulleys.

1910.211(f)(4)

"Exposed to contact" means that the location of an object is such that a person is likely to come into contact with it and be injured.

1910.211(f)(5)

"Flywheels" include flywheels, balance wheels, and flywheel pulleys mounted and revolving on crankshaft of engine or other shafting.

1910.211(f)(6)

"Maintenance runway" means any permanent runway or platform used for oiling, maintenance, running adjustment, or repair work, but not for passageway.

1910.211(f)(7)

"Nip-point belt and pulley guard" means a device which encloses the pulley and is provided with rounded or rolled edge slots through which the belt passes.

..1910.211(f)(8)

1910.211(f)(8)

"Point of operation" means that point at which cutting, shaping, or forming is accomplished upon the stock and shall include such other points as may offer a hazard to the operator in inserting or manipulating the stock in the operation of the machine.

1910.211(f)(9)

"Prime movers" include steam, gas, oil, and air engines, motors, steam and hydraulic turbines, and other equipment used as a source of power.

1910.211(f)(10)

"Sheaves" mean grooved pulleys, and shall be so classified unless used as flywheels.

[39 FR 23502, June 27, 1974, as amended at 39 FR 41846, Dec. 3, 1974; 53 FR 8353, Mar. 14, 1988]

Regulations (Standards - 29 CFR)
General requirements for all machines. - 1910.212

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.212
- **Title:** General requirements for all machines.

1910.212(a)

Machine guarding.

1910.212(a)(1)

Types of guarding. One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks. Examples of guarding methods are-barrier guards, two-hand tripping devices,electronic safety devices, etc.

1910.212(a)(2)

General requirements for machine guards. Guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself.

1910.212(a)(3)

Point of operation guarding.

1910.212(a)(3)(i)

Point of operation is the area on a machine where work is actually performed upon the material being processed.

..**1910.212(a)(3)(ii)**

1910.212(a)(3)(ii)

The point of operation of machines whose operation exposes an employee to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards therefor, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

1910.212(a)(3)(iii)

Special handtools for placing and removing material shall be such as to permit easy handling of material without the operator placing a hand in the danger zone. Such tools shall not be in lieu of other guarding required by this section, but can only be used to supplement protection provided.

1910.212(a)(3)(iv)

The following are some of the machines which usually require point of operation guarding:

1910.212(a)(3)(iv)(a)

Guillotine cutters.

1910.212(a)(3)(iv)(b)

Shears.

1910.212(a)(3)(iv)(c)

Alligator shears.

1910.212(a)(3)(iv)(d)

Power presses.

1910.212(a)(3)(iv)(e)

Milling machines.

1910.212(a)(3)(iv)(f)

Power saws.

1910.212(a)(3)(iv)(g)

Jointers.

..**1910.212(a)(3)(iv)(h)**

1910.212(a)(3)(iv)(h)

Portable power tools.

1910.212(a)(3)(iv)(i)

Forming rolls and calenders.

1910.212(a)(4)

Barrels, containers, and drums. Revolving drums, barrels, and containers shall be guarded by an enclosure which is interlocked with the drive mechanism, so that the barrel, drum, or container cannot revolve unless the guard enclosure is in place.

1910.212(a)(5)

Exposure of blades. When the periphery of the blades of a fan is less than seven (7) feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than one-half (1/2) inch.

1910.212(b)

Anchoring fixed machinery. Machines designed for a fixed location shall be securely anchored to prevent walking or moving.

Regulations (Standards - 29 CFR)
Woodworking machinery requirements. - 1910.213

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.213
- **Title:** Woodworking machinery requirements.

1910.213(a)

Machine construction general.

1910.213(a)(1)

Each machine shall be so constructed as to be free from sensible vibration when the largest size tool is mounted and run idle at full speed.

1910.213(a)(2)

Arbors and mandrels shall be constructed so as to have firm and secure bearing and be free from play.

1910.213(a)(3)

[Reserved]

1910.213(a)(4)

Any automatic cutoff saw that strokes continuously without the operator being able to control each stroke shall not be used.

1910.213(a)(5)

Saw frames or tables shall be constructed with lugs cast on the frame or with an equivalent means to limit the size of the saw blade that can be mounted, so as to avoid overspeed caused by mounting a saw larger than intended.

..1910.213(a)(6)

1910.213(a)(6)

Circular saw fences shall be so constructed that they can be firmly secured to the table or table assembly without changing their alignment with the saw. For saws with tilting tables or tilting arbors the fence shall be so constructed that it will remain in a line parallel with the saw, regardless of the angle of the saw with the table.

1910.213(a)(7)

Circular saw gages shall be so constructed as to slide in grooves or tracks that are accurately machined, to insure exact alignment with the saw for all positions of the guide.

1910.213(a)(8)

Hinged saw tables shall be so constructed that the table can be firmly secured in any position and in true alignment with the saw.

1910.213(a)(9)

All belts, pulleys, gears, shafts, and moving parts shall be guarded in accordance with the specific requirements of 1910.219.

1910.213(a)(10)

It is recommended that each power-driven woodworking machine be provided with a disconnect switch that can be locked in the off position.

1910.213(a)(11)

The frames and all exposed, noncurrent-carrying metal parts of portable electric woodworking machinery operated at more than 90 volts to ground shall be grounded and other portable motors driving electric tools which are held in the hand while being operated shall be grounded if they operate at more than 90 volts to ground. The ground shall be provided through use of a separate ground wire and polarized plug and receptacle.

..1910.213(a)(12)

1910.213(a)(12)

For all circular saws where conditions are such that there is a possibility of contact with the portion of the saw either beneath or behind the table, that portion of the saw shall be covered with an exhaust hood, or, if no exhaust system is required, with a guard that shall be so arranged as to prevent accidental contact with the saw.

1910.213(a)(13)

Revolving double arbor saws shall be fully guarded in accordance with all the requirements for circular crosscut saws or with all the requirements for circular ripsaws, according to the kind of saws mounted on the arbors.

1910.213(a)(14)

No saw, cutter head, or tool collar shall be placed or mounted on a machine arbor unless the tool has been accurately machined to size and shape to fit the arbor.

1910.213(a)(15)

Combs (featherboards) or suitable jigs shall be provided at the workplace for use when a standard guard cannot be used, as in dadoing, grooving, jointing, moulding, and rabbeting.

1910.213(b)

Machine controls and equipment.

1910.213(b)(1)

A mechanical or electrical power control shall be provided on each machine to make it possible for the operator to cut off the power from each machine without leaving his position at the point of operation.

1910.213(b)(2)

On machines driven by belts and shafting, a locking-type belt shifter or an equivalent positive device shall be used.

..1910.213(b)(3)

1910.213(b)(3)

On applications where injury to the operator might result if motors were to restart after power failures, provision shall be made to prevent machines from automatically restarting upon restoration of power.

1910.213(b)(4)

Power controls and operating controls should be located within easy reach of the operator while he is at his regular work location, making it unnecessary for him to reach over the cutter to make adjustments. This does not apply to constant pressure controls used only for setup purposes.

1910.213(b)(5)

On each machine operated by electric motors, positive means shall be provided for rendering such controls or devices inoperative while repairs or adjustments are being made to the machines they control.

1910.213(b)(6)

Each operating treadle shall be protected against unexpected or accidental tripping.

1910.213(b)(7)

Feeder attachments shall have the feed rolls or other moving parts so covered or guarded as to protect the operator from hazardous points.

1910.213(c)

Hand-fed ripsaws.

..1910.213(c)(1)

1910.213(c)(1)

Each circular hand-fed ripsaw shall be guarded by a hood which shall completely enclose that portion of the saw above the table and that portion of the saw above the material being cut. The hood and mounting shall be arranged so that the hood will automatically adjust itself to the thickness of and remain in contact with the material being cut but it shall not offer any considerable resistance to insertion of material to saw or to passage of the material being sawed. The hood shall be made of adequate strength to resist blows and strains incidental to reasonable operation, adjusting, and handling, and shall be so designed as to protect the operator from flying splinters and broken saw teeth. It shall be made of material that is soft enough so that it will be unlikely to cause tooth breakage. The hood shall be so mounted as to insure that its operation will be positive, reliable, and in true alignment with the saw; and the mounting shall be adequate in strength to resist any reasonable side thrust or other force tending to throw it out of line.

1910.213(c)(2)

Each hand-fed circular ripsaw shall be furnished with a spreader to prevent material from squeezing the saw or being thrown back on the operator. The spreader shall be made of hard tempered steel, or its equivalent, and shall be thinner than the saw kerf. It shall be of sufficient width to provide adequate stiffness or rigidity to resist any reasonable side thrust or blow tending to bend or throw it out of position. The spreader shall be attached so that it will remain in true alignment with the saw even when either the saw or table is tilted. The provision of a spreader in connection with grooving, dadoing, or rabbeting is not required. On the completion of such operations, the spreader shall be immediately replaced.

1910.213(c)(3)

Each hand-fed circular ripsaw shall be provided with nonkickback fingers or dogs so located as to oppose the thrust or tendency of the saw to pick up the material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of materials being cut.

1910.213(d)

Hand-fed crosscut table saws.

..1910.213(d)(1)

1910.213(d)(1)

Each circular crosscut table saw shall be guarded by a hood which shall meet all the requirements of paragraph (c)(1) of this section for hoods for circular ripsaws.

1910.213(e)

Circular resaws.

1910.213(e)(1)

Each circular resaw shall be guarded by a hood or shield of metal above the saw. This hood or shield shall be so designed as to guard against danger from flying splinters or broken saw teeth.

1910.213(e)(2)

Each circular resaw (other than self-feed saws with a roller or wheel at back of the saw) shall be provided with a spreader fastened securely behind the saw. The spreader shall be slightly thinner than the saw kerf and slightly thicker than the saw disk.

1910.213(f)

Self-feed circular saws.

1910.213(f)(1)

Feed rolls and saws shall be protected by a hood or guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and the bottom of the guard shall come down to within three-eighths inch of the plane formed by the bottom or working surfaces of the feed rolls. This distance (three-eighths inch) may be increased to three-fourths inch, provided the lead edge of the hood is extended to be not less than 5 1/2 inches in front of the nip point between the front roll and the work.

..1910.213(f)(2)

1910.213(f)(2)

Each self-feed circular ripsaw shall be provided with sectional non-kickback fingers for the full width of the feed rolls. They shall be located in front of the saw and so arranged as to be in continual contact with the wood being fed.

1910.213(g)

Swing cutoff saws. The requirements of this paragraph are also applicable to sliding cutoff saws mounted above the table.

1910.213(g)(1)

Each swing cutoff saw shall be provided with a hood that will completely enclose the upper half of the saw, the arbor end, and the point of operation at all positions of the saw. The hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters and broken saw teeth. Its hood shall be so designed that it will automatically cover the lower portion of the blade, so that when the saw is returned to the back of the table the hood will rise on top of the fence, and when the saw is moved forward the hood will drop on top of and remain in contact with the table or material being cut.

..1910.213(g)(2)

1910.213(g)(2)

Each swing cutoff saw shall be provided with an effective device to return the saw automatically to the back of the table when released at any point of its travel. Such a device shall not depend for its proper functioning upon any rope, cord, or spring. If there is a counterweight, the bolts supporting the bar and counterweight shall be provided with cotter pins; and the counterweight shall be prevented from dropping by either a bolt passing through both the bar and counterweight, or a bolt put through the extreme end of the bar, or, where the counterweight does not encircle the bar, a safety chain attached to it.

1910.213(g)(3)

Limit chains or other equally effective devices shall be provided to prevent the saw from swinging beyond the front or back edges of the table, or beyond a forward position where the gullets of the lowest saw teeth will rise above the table top.

1910.213(g)(4)

Inverted swing cutoff saws shall be provided with a hood that will cover the part of the saw that protrudes above the top of the table or above the material being cut. It shall automatically adjust itself to the thickness of and remain in contact with the material being cut.

1910.213(h)

Radial saws.

1910.213(h)(1)

The upper hood shall completely enclose the upper portion of the blade down to a point that will include the end of the saw arbor. The upper hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters, broken saw teeth, etc., and will deflect sawdust away from the operator. The sides of the lower exposed portion of the blade shall be guarded to the full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with stock being cut to give maximum protection possible for the operation being performed.

..1910.213(h)(2)

1910.213(h)(2)

Each radial saw used for ripping shall be provided with nonkickback fingers or dogs located on both sides of the saw so as to oppose the thrust or tendency of the saw to pick up the material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of material being cut.

1910.213(h)(3)

An adjustable stop shall be provided to prevent the forward travel of the blade beyond the position necessary to complete the cut in repetitive operations.

1910.213(h)(4)

Installation shall be in such a manner that the front end of the unit will be slightly higher than the rear, so as to cause the cutting head to return gently to the starting position when released by the operator.

1910.213(h)(5)

Ripping and ploughing shall be against the direction in which the saw turns. The direction of the saw rotation shall be conspicuously marked on the hood. In addition, a permanent label not less than 1 1/2 inches by 3/4 inch shall be affixed to the rear of the guard at approximately the level of the arbor, reading as follows: "Danger: Do Not Rip or Plough From This End".

1910.213(i)

Bandsaws and band resaws.

..1910.213(i)(1)

1910.213(i)(1)

All portions of the saw blade shall be enclosed or guarded, except for the working portion of the blade between the bottom of the guide rolls and the table. Bandsaw wheels shall be fully encased. The outside periphery of the enclosure shall be solid. The front and back of the band wheels shall be either enclosed by solid material or by wire mesh or perforated metal. Such mesh or perforated metal shall be not less than 0.037 inch (U.S. Gage No. 20), and the openings shall be not greater than three-eighths inch. Solid material used for this purpose shall be of an equivalent strength and firmness. The guard for the portion of the blade between the sliding guide and the upper-saw-wheel guard shall protect the saw blade at the front and outer side. This portion of the guard shall be self-adjusting to raise and lower with the guide. The upper-wheel guard shall be made to conform to the travel of the saw on the wheel.

1910.213(i)(2)

Each bandsaw machine shall be provided with a tension control device to indicate a proper tension for the standard saws used on the machine, in order to assist in the elimination of saw breakage due to improper tension.

1910.213(i)(3)

Feed rolls of band resaws shall be protected with a suitable guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and the edge of the guard shall come to within three-eighths inch of the plane formed by the inside face of the feed roll in contact with the stock being cut.

1910.213(j)

Jointers.

1910.213(j)(1)

Each hand-fed planer and jointer with horizontal head shall be equipped with a cylindrical cutting head, the knife projection of which shall not exceed one-eighth inch beyond the cylindrical body of the head.

..1910.213(j)(2)

1910.213(j)(2)

The opening in the table shall be kept as small as possible. The clearance between the edge of the rear table and the cutter head shall be not more than one-eighth inch. The table throat opening shall be not more than 2 1/2 inches when tables are set or aligned with each other for zero cut.

1910.213(j)(3)

Each hand-fed jointer with a horizontal cutting head shall have an automatic guard which will cover all the section of the head on the working side of the fence or gage. The guard shall effectively keep the operator's hand from coming in contact with the revolving knives. The guard shall automatically adjust itself to cover the unused portion of the head and shall remain in contact with the material at all times.

1910.213(j)(4)

Each hand-fed jointer with horizontal cutting head shall have a guard which will cover the section of the head back of the gage or fence.

1910.213(j)(5)

Each wood jointer with vertical head shall have either an exhaust hood or other guard so arranged as to enclose completely the revolving head, except for a slot of such width as may be necessary and convenient for the application of the material to be jointed.

1910.213(k)

Tenoning machines.

1910.213(k)(1)

Feed chains and sprockets of all double end tenoning machines shall be completely enclosed, except for that portion of chain used for conveying the stock.

..1910.213(k)(2)

1910.213(k)(2)

At the rear ends of frames over which feed conveyors run, sprockets and chains shall be guarded at the sides by plates projecting beyond the periphery of sprockets and the ends of lugs.

1910.213(k)(3)

Each tenoning machine shall have all cutting heads, and saws if used, covered by metal guards. These guards shall cover at least the unused part of the periphery of the cutting head. If such a guard is constructed of sheet metal, the material used shall be not less than one-sixteenth inch in thickness, and if cast iron is used, it shall be not less than three-sixteenths inch in thickness.

1910.213(k)(4)

Where an exhaust system is used, the guard shall form part or all of the exhaust hood and shall be constructed of metal of a thickness not less than that specified in subparagraph (3) of this paragraph.

1910.213(l)

Boring and mortising machines.

1910.213(l)(1)

Safety-bit chucks with no projecting set screws shall be used.

1910.213(l)(2)

Boring bits should be provided with a guard that will enclose all portions of the bit and chuck above the material being worked.

1910.213(l)(3)

The top of the cutting chain and driving mechanism shall be enclosed.

1910.213(l)(4)

If there is a counterweight, one of the following or equivalent means shall be used to prevent its dropping:

..1910.213(l)(4)(i)

1910.213(l)(4)(i)

It shall be bolted to the bar by means of a bolt passing through both bar and counterweight;

1910.213(l)(4)(ii)

A bolt shall be put through the extreme end of the bar;

1910.213(l)(4)(iii)

Where the counterweight does not encircle the bar, a safety chain shall be attached to it;

1910.213(l)(4)(iv)

Other types of counterweights shall be suspended by chain or wire rope and shall travel in a pipe or other suitable enclosure wherever they might fall and cause injury.

1910.213(l)(5)

Universal joints on spindles of boring machines shall be completely enclosed in such a way as to prevent accidental contact by the operator.

1910.213(l)(6)

Each operating treadle shall be covered by an inverted U-shaped metal guard, fastened to the floor, and of adequate size to prevent accidental tripping.

1910.213(m)

Wood shapers and similar equipment.

..1910.213(m)(1)

1910.213(m)(1)

The cutting heads of each wood shaper, hand-fed panel raiser, or other similar machine not automatically fed, shall be enclosed with a cage or adjustable guard so designed as to keep the operator's hand away from the cutting edge. The diameter of circular shaper guards shall be not less than the greatest diameter of the cutter. In no case shall a warning device of leather or other material attached to the spindle be acceptable.

1910.213(m)(2)

[Reserved]

1910.213(m)(3)

All double-spindle shapers shall be provided with a spindle starting and stopping device for each spindle.

1910.213(n)

Planing, molding, sticking, and matching machines.

1910.213(n)(1)

Each planing, molding, sticking, and matching machine shall have all cutting heads, and saws if used, covered by a metal guard. If such guard is constructed of sheet metal, the material used shall be not less than 1/16 inch in thickness, and if cast iron is used, it shall be not less than three-sixteenths inch in thickness.

1910.213(n)(2)

Where an exhaust system is used, the guards shall form part or all of the exhaust hood and shall be constructed of metal of a thickness not less than that specified in paragraph (h)(1) of this section.

1910.213(n)(3)

Feed rolls shall be guarded by a hood or suitable guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be fastened to the frame carrying the rolls so as to remain in adjustment for any thickness of stock.

..1910.213(n)(4)

1910.213(n)(4)

Surfacers or planers used in thicknessing multiple pieces of material simultaneously shall be provided with sectional infeed rolls having sufficient yield in the construction of the sections to provide feeding contact pressure on the stock, over the permissible range of variation in stock thickness specified or for which the machine is designed. In lieu of such yielding sectional rolls, suitable section kickback finger devices shall be provided at the infeed end.

1910.213(o)

Profile and swing-head lathes and wood heel turning machine.

1910.213(o)(1)

Each profile and swing-head lathe shall have all cutting heads covered by a metal guard. If such a guard is constructed of sheet metal, the material used shall be not less than one-sixteenth inch in thickness; and if cast iron is used, it shall not be less than three-sixteenths inch in thickness.

1910.213(o)(2)

Cutting heads on wood-turning lathes, whether rotating or not, shall be covered as completely as possible by hoods or shields.

1910.213(o)(3)

Shoe last and spoke lathes, doweling machines, wood heel turning machines, and other automatic wood-turning lathes of the rotating knife type shall be equipped with hoods enclosing the cutter blades completely except at the contact points while the stock is being cut.

1910.213(o)(4)

Lathes used for turning long pieces of wood stock held only between the two centers shall be equipped with long curved guards extending over the tops of the lathes in order to prevent the work pieces from being thrown out of the machines if they should become loose.

..1910.213(o)(5)

1910.213(o)(5)

Where an exhaust system is used, the guard shall form part or all of the exhaust hood and shall be constructed of metal of a thickness not less than that specified in subparagraph (1) of this paragraph.

1910.213(p)

Sanding machines.

1910.213(p)(1)

Feed rolls of self-feed sanding machines shall be protected with a semicylindrical guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and firmly secured to the frame carrying the rolls so as to remain in adjustment for any thickness of stock. The bottom of the guard should come down to within three-eighths inch of a plane formed by the bottom or contact face of the feed roll where it touches the stock.

1910.213(p)(2)

Each drum sanding machine shall have an exhaust hood, or other guard if no exhaust system is required, so arranged as to enclose the revolving drum, except for that portion of the drum above the table, if a table is used, which may be necessary and convenient for the application of the material to be finished.

1910.213(p)(3)

Each disk sanding machine shall have the exhaust hood, or other guard if no exhaust system is required, so arranged as to enclose the revolving disk, except for that portion of the disk above the table, if a table is used, which may be necessary for the application of the material to be finished.

..1910.213(p)(4)

1910.213(p)(4)

Belt sanding machines shall be provided with guards at each nip point where the sanding belt runs on to a pulley. These guards shall effectively prevent the hands or fingers of the operator from coming in contact with the nip points. The unused run of the sanding belt shall be guarded against accidental contact.

1910.213(q)

Veneer cutters and wringers.

1910.213(q)(1)

Veneer slicer knives shall be guarded to prevent accidental contact with knife edge, at both front and rear.

1910.213(q)(2)

Veneer clippers shall have automatic feed or shall be provided with a guard which will make it impossible to place a finger or fingers under the knife while feeding or removing the stock.

1910.213(q)(3)

Sprockets on chain or slat-belt conveyors shall be enclosed.

1910.213(q)(4)

Where practicable, hand and footpower guillotine veneer cutters shall be provided with rods or plates or other satisfactory means, so arranged on the feeding side that the hands cannot reach the cutting edge of the knife while feeding or holding the stock in place.

1910.213(q)(5)

Power-driven guillotine veneer cutters, except continuous feed trimmers, shall be equipped with:

1910.213(q)(5)(i)

Starting devices which require the simultaneous action of both hands to start the cutting motion and of at least one hand on a control during the complete stroke of the knife; or

..1910.213(q)(5)(ii)

1910.213(q)(5)(ii)

An automatic guard which will remove the hands of the operator from the danger zone at every descent of the blade, used in conjunction with one-hand starting devices which require two distinct movements of the device to start the cutting motion, and so designed as to return positively to the nonstarting position after each complete cycle of the knife.

1910.213(q)(6)

Where two or more workers are employed at the same time on the same power-driven guillotine veneer cutter equipped with two-hand control, the device shall be so arranged that each worker shall be required to use both hands simultaneously on the controls to start the cutting motion, and at least one hand on a control to complete the cut.

1910.213(q)(7)

Power-driven guillotine veneer cutters, other than continuous trimmers, shall be provided, in addition to the brake or other stopping mechanism, with an emergency device which will prevent the machine from operating in the event of failure of the brake when the starting mechanism is in the nonstarting position.

1910.213(r)

Miscellaneous woodworking machines.

1910.213(r)(1)

The feed rolls of roll type glue spreaders shall be guarded by a semicylindrical guard. The bottom of the guard shall come to within three-eighths inch of a plane formed by bottom or contact face of the feed roll where it touches the stock.

..1910.213(r)(2)

1910.213(r)(2)

Drag saws shall be so located as to give at least a 4-foot clearance for passage when the saw is at the extreme end of the stroke; or if such clearance is not obtainable, the saw and its driving mechanism shall be provided with a standard enclosure.

1910.213(r)(3)

For combination or universal woodworking machines each point of operation of any tool shall be guarded as required for such a tool in a separate machine.

1910.213(r)(4)

The mention of specific machines in paragraphs (a) thru (q) and this paragraph (r) of this section, inclusive, is not intended to exclude other woodworking machines from the requirement that suitable guards and exhaust hoods be provided to reduce to a minimum the hazard due to the point of operation of such machines.

1910.213(s)

Inspection and maintenance of woodworking machinery.

1910.213(s)(1)

Dull, badly set, improperly filed, or improperly tensioned saws shall be immediately removed from service, before they begin to cause the material to stick, jam, or kick back when it is fed to the saw at normal speed. Saws to which gum has adhered on the sides shall be immediately cleaned.

1910.213(s)(2)

All knives and cutting heads of woodworking machines shall be kept sharp, properly adjusted, and firmly secured. Where two or more knives are used in one head, they shall be properly balanced.

..1910.213(s)(3)

1910.213(s)(3)

Bearings shall be kept free from lost motion and shall be well lubricated.

1910.213(s)(4)

Arbors of all circular saws shall be free from play.

1910.213(s)(5)

Sharpening or tensioning of saw blades or cutters shall be done only by persons of demonstrated skill in this kind of work.

1910.213(s)(6)

Emphasis is placed upon the importance of maintaining cleanliness around woodworking machinery, particularly as regards the effective functioning of guards and the prevention of fire hazards in switch enclosures, bearings, and motors.

1910.213(s)(7)

All cracked saws shall be removed from service.

1910.213(s)(8)

The practice of inserting wedges between the saw disk and the collar to form what is commonly known as a "wobble saw" shall not be permitted.

1910.213(s)(9)

Push sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done.

1910.213(s)(10)

[Reserved]

1910.213(s)(11)

[Reserved]

..1910.213(s)(12)

1910.213(s)(12)

The knife blade of jointers shall be so installed and adjusted that it does not protrude more than one-eighth inch beyond the cylindrical body of the head. Push sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done.

1910.213(s)(13)

Whenever veneer slicers or rotary veneer-cutting machines have been shutdown for the purpose of inserting logs or to make adjustments, operators shall make sure that machine is clear and other workmen are not in a hazardous position before starting the machine.

1910.213(s)(14)

Operators shall not ride the carriage of a veneer slicer.

[39 FR 23502, June 27, 1974, as amended at 43 FR 49750, Oct. 24, 1978; 49 FR 5323, Feb. 10, 1984]

Regulations (Standards - 29 CFR)
Cooperage machinery. [Reserved] - 1910.214

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.214
- **Title:** Cooperage machinery. [Reserved]

[Reserved]

Regulations (Standards - 29 CFR)
Abrasive wheel machinery. - 1910.215

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.215
- **Title:** Abrasive wheel machinery.

1910.215(a)

General requirements.

1910.215(a)(1)

Machine guarding. Abrasive wheels shall be used only on machines provided with safety guards as defined in the following paragraphs of this section, except:

1910.215(a)(1)(i)

Wheels used for internal work while within the work being ground;

1910.215(a)(1)(ii)

Mounted wheels, used in portable operations, 2 inches and smaller in diameter; and

1910.215(a)(1)(iii)

Types 16, 17, 18, 18R, and 19 cones, plugs, and threaded hole pot balls where the work offers protection.

1910.215(a)(2)

Guard design. The safety guard shall cover the spindle end, nut, and flange projections. The safety guard shall be mounted so as to maintain proper alignment with the wheel, and the strength of the fastenings shall exceed the strength of the guard, except:

..1910.215(a)(2)(i)

1910.215(a)(2)(i)

Safety guards on all operations where the work provides a suitable measure of protection to the operator, may be so constructed that the spindle end, nut, and outer flange are exposed; and where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted; and

1910.215(a)(2)(ii)

The spindle end, nut, and outer flange may be exposed on machines designed as portable saws.

1910.215(a)(3)

Flanges. Grinding machines shall be equipped with flanges in accordance with paragraph (c) of this section.

1910.215(a)(4)

Work rests. On offhand grinding machines, work rests shall be used to support the work. They shall be of rigid construction and designed to be adjustable to compensate for wheel wear. Work rests shall be kept adjusted closely to the wheel with a maximum opening of one-eighth inch to prevent the work from being jammed between the wheel and the rest, which may cause wheel breakage. The work rest shall be securely clamped after each adjustment. The adjustment shall not be made with the wheel in motion.

1910.215(a)(5)

Excluded machinery. Natural sandstone wheels and metal, wooden, cloth, or paper discs, having a layer of abrasive on the surface are not covered by this section.

1910.215(b)

Guarding of abrasive wheel machinery.

1910.215(b)(1)

Cup wheels. Cup wheels (Types 6 and 11) shall be protected by:

..1910.215(b)(1)(i)

1910.215(b)(1)(i)

Safety guards as specified in paragraphs (b) (1) through (10) of this section;

1910.215(b)(1)(ii)

Band type guards as specified in paragraph (b) (11) of this section; and

1910.215(b)(1)(iii)

Special "Revolving Cup Guards" which mount behind the wheel and turn with it. They shall be made of steel or other material with adequate strength and shall enclose the wheel sides upward from the back for one-third of the wheel thickness. The mounting features shall conform with all requirements of this section. It is necessary to maintain clearance between the wheel side and the guard. This clearance shall not exceed one-sixteenth inch.

1910.215(b)(2)

Guard exposure angles. The maximum exposure angles specified in paragraphs (b) (3) through (8) of this section shall not be exceeded. Visors or other accessory equipment shall not be included as a part of the guard when measuring the guard opening, unless such equipment has strength equal to that of the guard.

1910.215(b)(3)

Bench and floor stands. The angular exposure of the grinding wheel periphery and sides for safety guards used on machines known as bench and floor stands should not exceed 90 deg. or one-fourth of the periphery. This exposure shall begin at a point not more than 65 deg. above the horizontal plane of the wheel spindle. (See Figures O-6 and O-7 and paragraph (b)(9) of this section.)

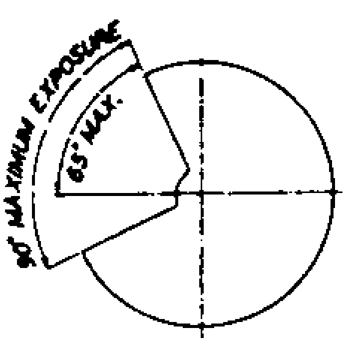


FIGURE NO. O-6

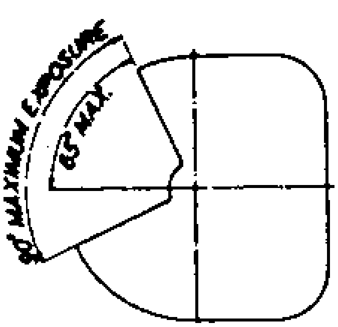


FIGURE NO. O-7

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure shall not exceed 125 deg. (See Figures O-8 and O-9.)

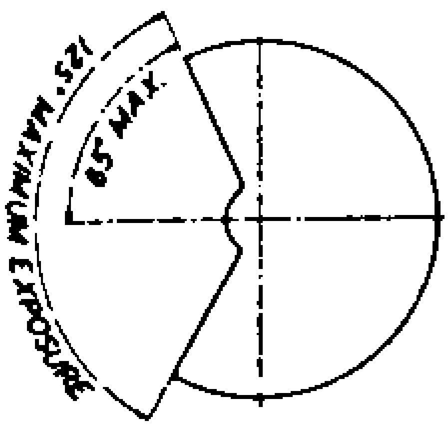


FIGURE NO. O-8

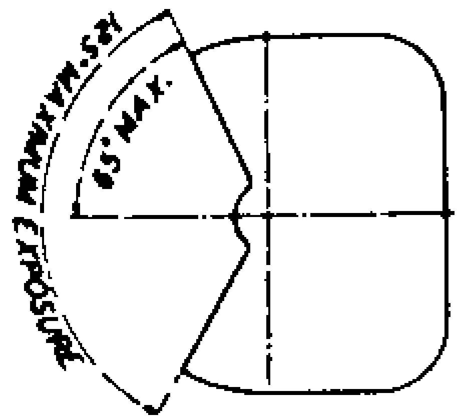


FIGURE NO. O-9

..1910.215(b)(4)

1910.215(b)(4)

Cylindrical grinders. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on cylindrical grinding machines shall not exceed 180 deg. This exposure shall begin at a point not more than 65 deg. above the horizontal plane of the wheel spindle. (See Figures O-10 and O-11 and subparagraph (9) of this paragraph.)

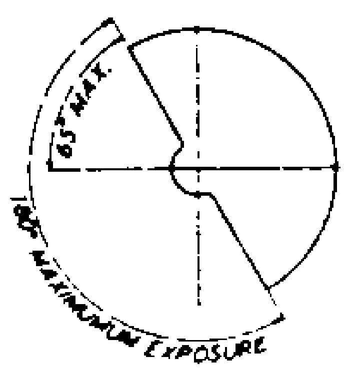


FIGURE NO. O-10

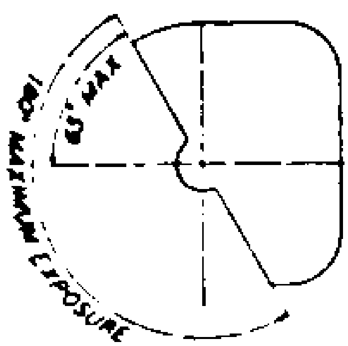


FIGURE NO. O-11

1910.215(b)(5)

Surface grinders and cutting-off machines. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on cutting-off machines and on surface grinding machines which employ the wheel periphery shall not exceed 150 deg. This exposure shall begin at a point not less than 15 deg. below the horizontal plane of the wheel spindle. (See Figures O-12 and O-13)

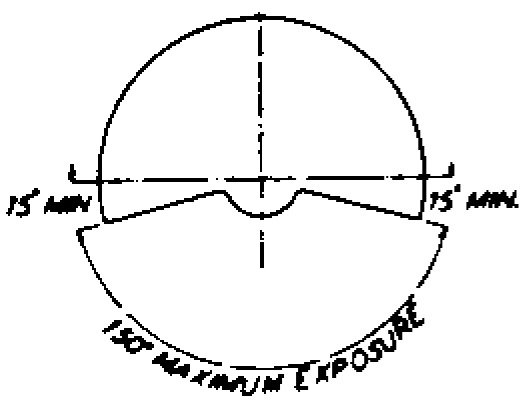


FIGURE NO. O-12

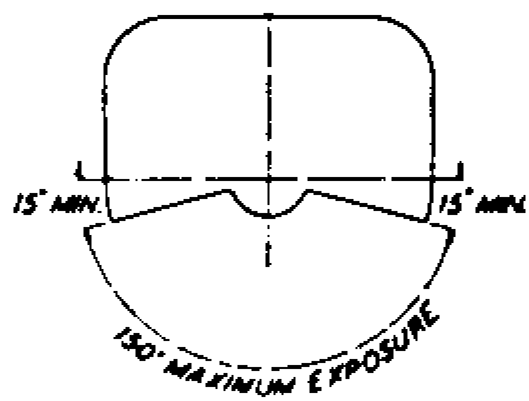


FIGURE NO. O-13

1910.215(b)(6)

Swing frame grinders. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on machines known as swing frame grinding machines shall not exceed 180 deg., and the top half of the wheel shall be enclosed at all times. (See Figures O-14 and O-15.)

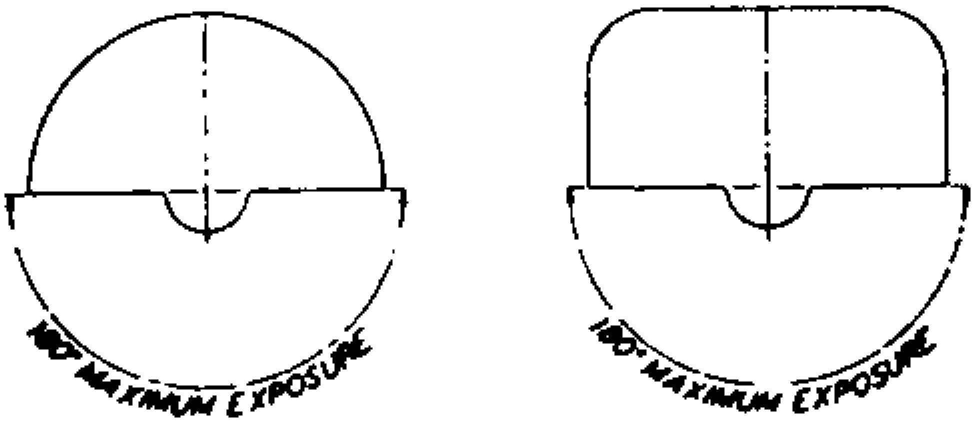


FIGURE NO. O-14 FIGURE NO. O-15

1910.215(b)(7)

Automatic snagging machines. The maximum angular exposure of the grinding wheel periphery and sides for safety guards used on grinders known as automatic snagging machines shall not exceed 180 deg. and the top half of the wheel shall be enclosed at all times. (See Figures O-14 and O-15.)

1910.215(b)(8)

Top grinding. Where the work is applied to the wheel above the horizontal centerline, the exposure of the grinding wheel periphery shall be as small as possible and shall not exceed 60 deg. (See Figures O-16 and O-17.)

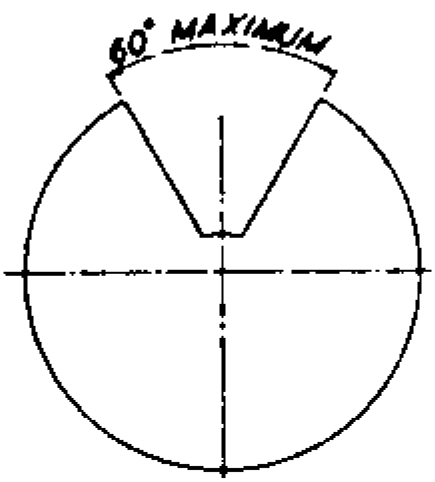


FIGURE NO. O-16

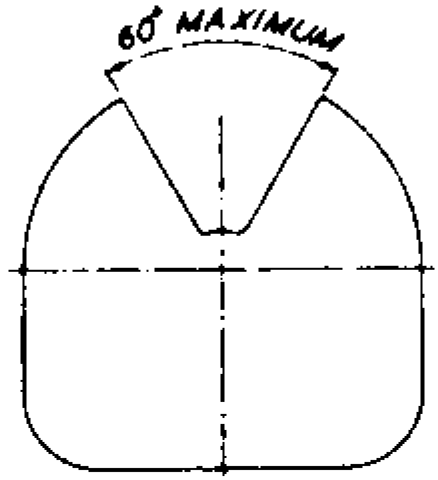


FIGURE NO. O-17

..1910.215(b)(9)

1910.215(b)(9)

Exposure adjustment. Safety guards of the types described in Subparagraphs (3) and (4) of this paragraph, where the operator stands in front of the opening, shall be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in paragraphs (b)(3) and (4) of this section shall never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top shall never exceed one-fourth inch. (See Figures O-18, O-19, O-20, O-21, O-22, and O-23.)

1910.215(b)(10)

Material requirements and minimum dimensions.

1910.215(b)(10)(i)

See Figures O-36 and O-37 and Table O-9 for minimum basic thickness of peripheral and side members for various types of safety guards and classes of service.

1910.215(b)(10)(ii)

If operating speed does not exceed 8,000 surface feet per minute cast iron safety guards, malleable iron guards or other guards as described in paragraph (b)(10)(iii) of this section shall be used.

1910.215(b)(10)(iii)

Cast steel, or structural steel, safety guards as specified in Figures O-36 and O-37 and Table O-9 shall be used where operating speeds of wheels are faster than 8,000 surface feet per minute up to a maximum of 16,000 surface feet per minute.

1910.215(b)(10)(iv)

For cutting-off wheels 16 inches diameter and smaller and where speed does not exceed 16,000 surface feet per minute, cast iron or malleable iron safety guards as specified in Figures O-36 and O-37, and in Table O-9 shall be used.

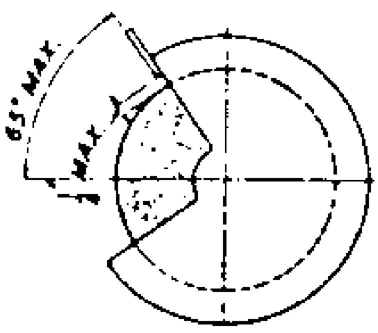


FIGURE NO. O-18

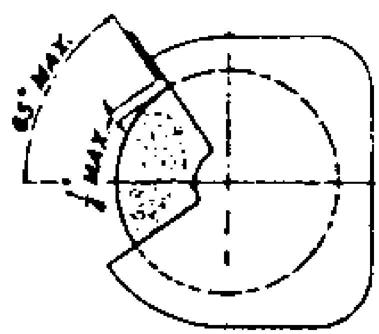


FIGURE NO. O-19

CORRECT

Showing adjustable tongue giving required angular protection for all sizes of wheel used.

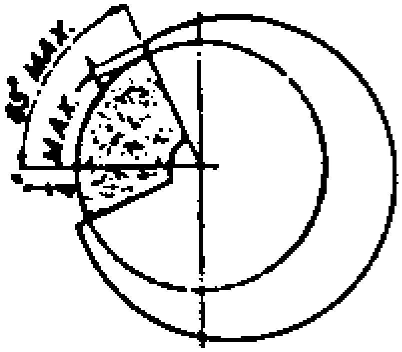


FIGURE NO. O-20

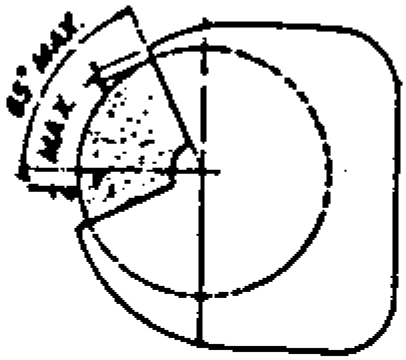


FIGURE NO. O-21

CORRECT

Showing movable guard with opening small enough to give required protection for smallest size wheel used.

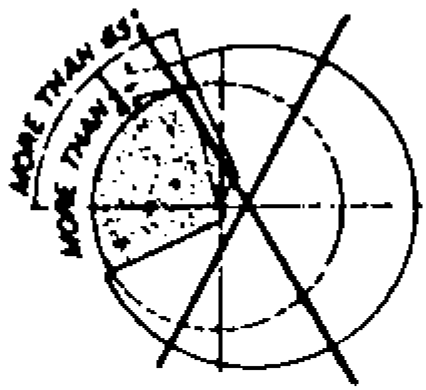


FIGURE NO. O-22

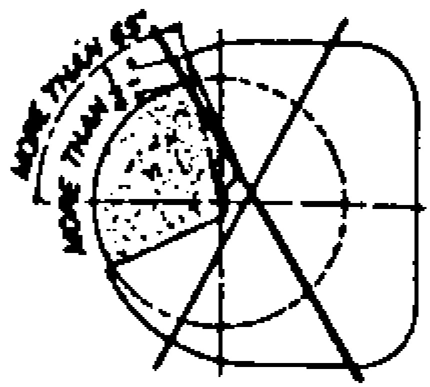


FIGURE NO. O-23

INCORRECT

Showing movable guard with size of opening correct for full size wheel but too large for smaller wheels.

1910.215(b)(10)(v)

For cutting-off wheels larger than 16 inches diameter and where speed does not exceed 14,200 surface feet per minute, safety guards as specified in Figures O-27 and O-28, and in Table O-1 shall be used.

..1910.215(b)(10)(vi)

1910.215(b)(10)(vi)

For thread grinding wheels not exceeding 1 inch in thickness cast iron or malleable iron safety guards as specified in Figures O-36 and O-37,and in Table O-9 shall be used.

1910.215(b)(11)

Band type guards-general specifications. Band type guards shall conform to the following general specifications:

1910.215(b)(11)(i)

The bands shall be of steel plate or other material of equal or greater strength. They shall be continuous, the ends being either riveted, bolted, or welded together in such a manner as to leave the inside free from projections.

1910.215(b)(11)(ii)

The inside diameter of the band shall not be more than 1 inch larger than the outside diameter of the wheel, and shall be mounted as nearly concentric with the wheel as practicable.

1910.215(b)(11)(iii)

The band shall be of sufficient width and its position kept so adjusted that at no time will the wheel protrude beyond the edge of the band a distance greater than that indicated in Figure O-29 and in Table O-2 or the wall thickness (W), whichever is smaller.

..1910.215(b)(12)

1910.215(b)(12)

Guard design specifications. Abrasive wheel machinery guards shall meet the design specifications of the American National Standard Safety Code for the Use, Care, and Protection of Abrasive Wheels, ANSI B7.1-1970, which is incorporated by reference as specified in Sec. 1910.6. This requirement shall not apply to natural sandstone wheels or metal, wooden, cloth, or paper discs, having a layer of abrasive on the surface.

1910.215(c)

Flanges –

1910.215(c)(1)

General requirements. All abrasive wheels shall be mounted between flanges which shall not be less than one-third the diameter of the wheel.

1910.215(c)(1)(i)

Exceptions:

1910.215(c)(1)(i)(a)

Mounted wheels.

1910.215(c)(1)(i)(b)

Portable wheels with threaded inserts or projecting studs.

1910.215(c)(1)(i)(c)

Abrasive discs (inserted nut, inserted washer and projecting stud type).

1910.215(c)(1)(i)(d)

Plate mounted wheels.

1910.215(c)(1)(i)(e)

Cylinders, cup, or segmental wheels that are mounted in chucks.

1910.215(c)(1)(i)(f)

Types 27 and 28 wheels.

1910.215(c)(1)(i)(g)

Certain internal wheels.

1910.215(c)(1)(i)(h)

Modified types 6 and 11 wheels (terrazzo).

..1910.215(c)(1)(i)(i)

1910.215(c)(1)(i)(i)

Cutting-off wheels, Types 1 and 27A (see paragraphs (c)(1) (ii) and (iii) of this section).

1910.215(c)(1)(ii)

Type 1 cutting-off wheels are to be mounted between properly relieved flanges which have matching bearing surfaces. Such flanges shall be at least one-fourth the wheel diameter.

1910.215(c)(1)(iii)

Type 27A cutting-off wheels are designed to be mounted by means of flat, not relieved, flanges having matching bearing surfaces and which may be less than one-third but shall not be less than one-fourth the wheel diameter. (See Figure O-24 for one such type of mounting.)

1910.215(c)(1)(iv)

There are three general types of flanges:

1910.215(c)(1)(iv)(a)

Straight relieved flanges (see Figure O-32);

1910.215(c)(1)(iv)(b)

Straight unrelieved flanges (see Figure O-30);

1910.215(c)(1)(iv)(c)

Adaptor flanges (see Figures O-33 and O-34);

1910.215(c)(1)(v)

Regardless of flange type used, the wheel shall always be guarded. Blotters shall be used in accordance with paragraph (c)(6) of this section.

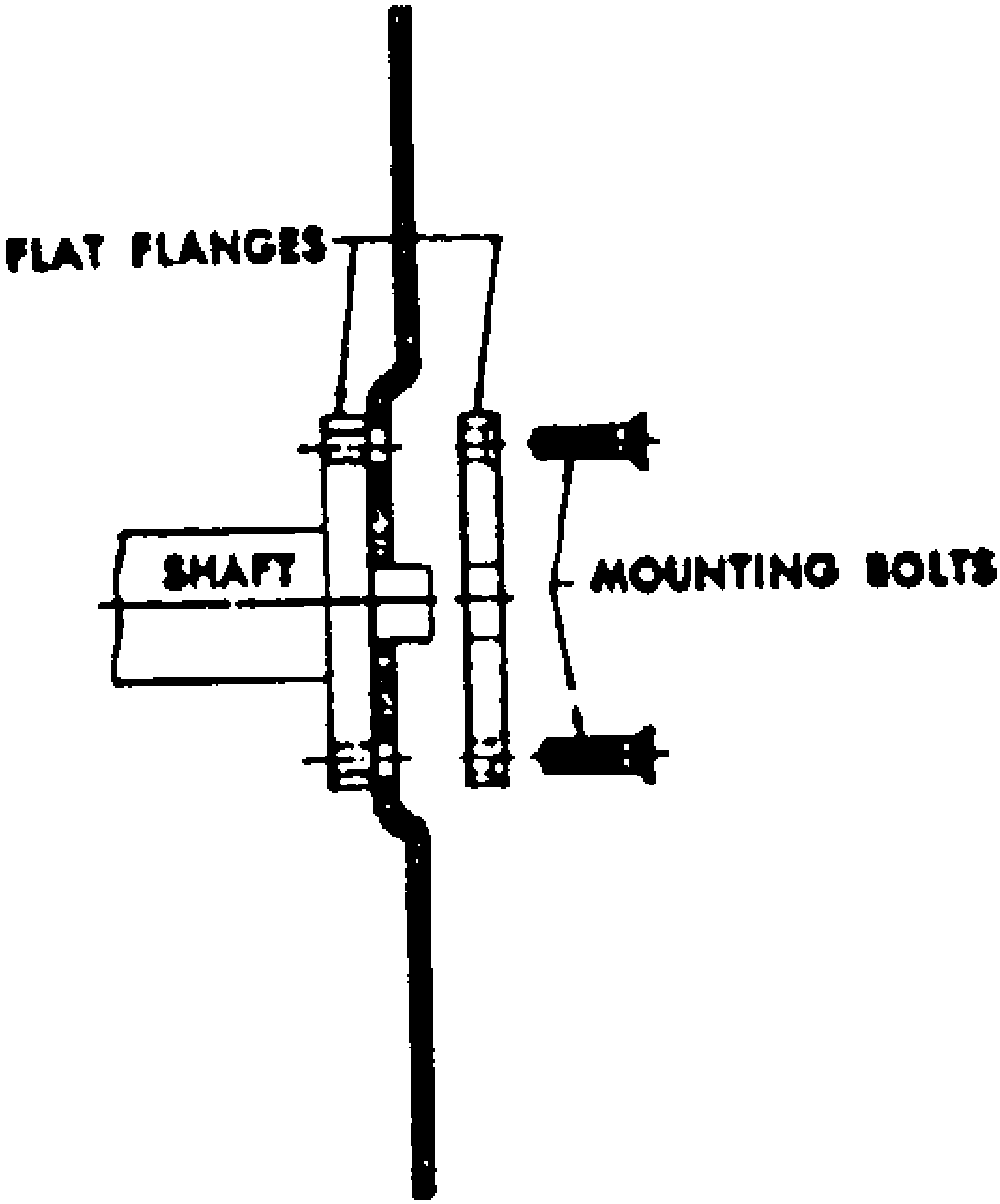


FIGURE NO. O-24

The Type 27 A Wheel is mounted between flat non-relieved flanges of equal bearing surfaces.

..1910.215(c)(2)

1910.215(c)(2)

[Reserved]

1910.215(c)(3)

Finish and balance. Flanges shall be dimensionally accurate and in good balance. There shall be no rough surfaces or sharp edges.

1910.215(c)(4)

Uniformity of diameter.

1910.215(c)(4)(i)

Both flanges, of any type, between which a wheel is mounted, shall be of the same diameter and have equal bearing surface. Exceptions are set forth in the remaining subdivisions of this subparagraph.

1910.215(c)(4)(ii)

Type 27 and Type 28 wheels, because of their shape and usage, require specially designed adaptors. The back flange shall extend beyond the central hub or raised portion and contact the wheel to counteract the side pressure on the wheel in use. The adaptor nut which is less than the minimum one-third diameter of wheel fits in the depressed side of wheel to prevent interference in side grinding and serves to drive the wheel by its clamping force against the depressed portion of the back flange. The variance in flange diameters, the adaptor nut being less than one-third wheel diameter, and the use of side pressure in wheel operation limits the use to reinforced organic bonded wheels. Mounts which are affixed to the wheel by the manufacturer shall not be reused. Type 27 and Type 28 wheels shall be used only with a safety guard located between wheel and operator during use. (See Figure O-24-A.)

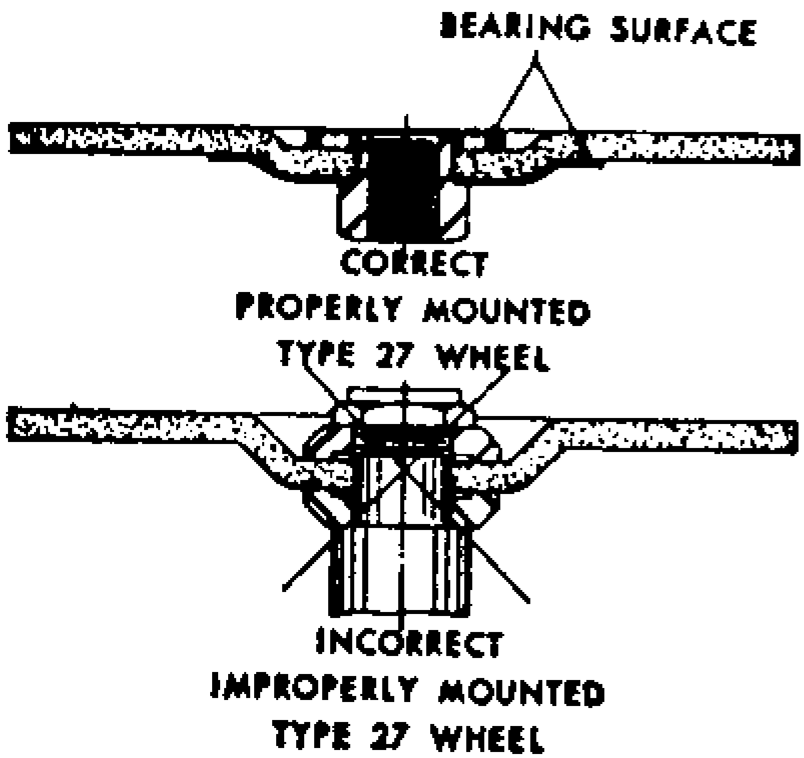


FIGURE NO. O-24-A

Types 27 and 28 wheels, because of their shape, require specially designed adaptors.

..1910.215(c)(4)(iii)

1910.215(c)(4)(iii)

Modified Types 6 and 11 wheels (terrazzo) with tapered K dimension.

1910.215(c)(5)

Recess and undercut.

1910.215(c)(5)(i)

Straight relieved flanges made according to Table O-6 and Figure O-32 shall be recessed at least one-sixteenth inch on the side next to the wheel for a distance as specified in Table O-6.

1910.215(c)(5)(ii)

Straight flanges of the adaptor or sleeve type (Table O-7 and Figures O-33 and O-34) shall be undercut so that there will be no bearing on the sides of the wheel within one-eighth inch of the arbor hole.

1910.215(c)(6)

Blotters.

1910.215(c)(6)(i)

Blotters (compressible washers) shall always be used between flanges and abrasive wheel surfaces to insure uniform distribution of flange pressure. (See paragraph (d)(5) of this section.)

1910.215(c)(6)(ii)

Exception:

1910.215(c)(6)(ii)(a)

Mounted wheels.

1910.215(c)(6)(ii)(b)

Abrasive discs (inserted nut, inserted washer, and projecting stud type).

..1910.215(c)(6)(ii)(c)

1910.215(c)(6)(ii)(c)

Plate mounted wheels.

1910.215(c)(6)(ii)(d)

Cylinders, cups, or segmental wheels that are mounted in chucks.

1910.215(c)(6)(ii)(e)

Types 27 and 28 wheels.

1910.215(c)(6)(ii)(f)

Certain Type 1 and Type 27A cutting-off wheels.

1910.215(c)(6)(ii)(g)

Certain internal wheels.

1910.215(c)(6)(ii)(h)

Type 4 tapered wheels.

1910.215(c)(6)(ii)(i)

Diamond wheels, except certain vitrified diamond wheels.

1910.215(c)(6)(ii)(j)

Modified Types 6 and 11 wheel (terrazzo)-blotters applied flat side of wheel only.

1910.215(c)(7)

Driving flange. The driving flange shall be securely fastened to the spindle and the bearing surface shall run true. When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. (See paragraph (d)(6) of this section.)

..1910.215(c)(8)

1910.215(c)(8)

Dimensions.

1910.215(c)(8)(i)

Tables O-4 and O-6 and Figures O-30 and O-32 show minimum dimensions for straight relieved and unrelieved flanges for use with wheels with small holes that fit directly on the machine spindle. Dimensions of such flanges shall never be less than indicated.

1910.215(c)(8)(ii)

Table O-5, and Table O-7 and Figures O-31, O-33, O-34 show minimum dimensions for straight adaptor flanges for use with wheels having holes larger than the spindle. Dimensions of such adaptor flanges shall never be less than indicated.

1910.215(c)(8)(iii)

Table O-8 and Figure O-35 show minimum dimensions for straight flanges that are an integral part of wheel sleeves which are frequently used on precision grinding machines. Dimensions of such flanges shall never be less than indicated.

1910.215(c)(9)

Repairs and maintenance. All flanges shall be maintained in good condition. When the bearing surfaces become worn, warped, sprung, or damaged they should be trued or refaced. When refacing or truing, care shall be exercised to make sure that proper relief and rigidity is maintained as specified in paragraphs (c) (2) and (5) of this section and they shall be replaced when they do not conform to these subparagraphs and Table O-4, Figure O-30, Table O-5, Figure O-31, Table O-6, Figure O-32, and Table O-8, Figure O-35. Failure to observe these rules might cause excessive flange pressure around the hole of the wheel. This is especially true of wheel-sleeve or adaptor flanges.

..1910.215(d)

1910.215(d)

Mounting –

1910.215(d)(1)

Inspection. Immediately before mounting, all wheels shall be closely inspected and sounded by the user (ring test) to make sure they have not been damaged in transit, storage, or otherwise. The spindle speed of the machine shall be checked before mounting of the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel. Wheels should be tapped gently with a light nonmetallic implement, such as the handle of a screwdriver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked (dead), they shall not be used. This is known as the "Ring Test".

1910.215(d)(1)(i)

Wheels must be dry and free from sawdust when applying the ring test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

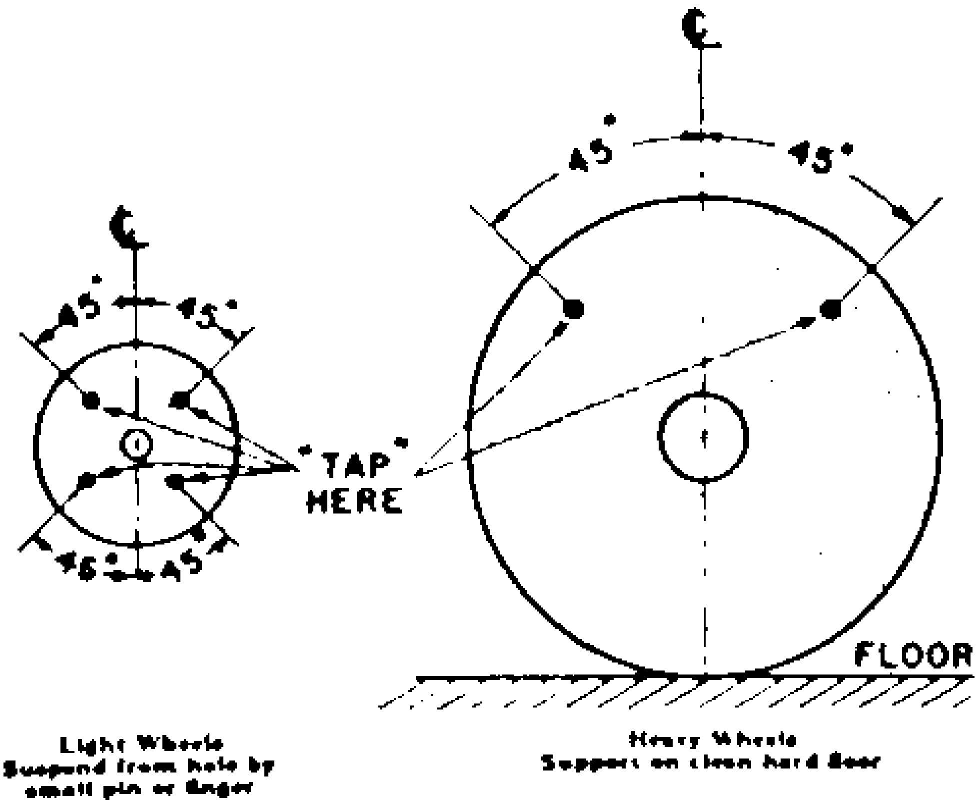


FIGURE NO. O-25 FIGURE NO. O-26

1910.215(d)(1)(ii)

"Tap" wheels about 45 deg. each side of the vertical centerline and about 1 or 2 inches from the periphery as indicated by the spots in Figure O-25 and Figure O-26. Then rotate the wheel 45 deg. and repeat the test. A sound and undamaged wheel will give a clear metallic tone. If cracked, there will be a dead sound and not a clear "ring."

1910.215(d)(2)

Arbor size. Grinding wheels shall fit freely on the spindle and remain free under all grinding conditions. A controlled clearance between the wheel hole and the machine spindle (or wheel sleeves or adaptors) is essential to avoid excessive pressure from mounting and spindle expansion. To accomplish this, the machine spindle shall be made to nominal (standard) size plus zero minus .002 inch, and the wheel hole shall be made suitably oversize to assure safety clearance under the conditions of operating heat and pressure.

1910.215(d)(3)

Surface condition. All contact surfaces of wheels, blotters and flanges shall be flat and free of foreign matter.

..1910.215(d)(4)

1910.215(d)(4)

Bushing. When a bushing is used in the wheel hole it shall not exceed the width of the wheel and shall not contact the flanges.

1910.215(d)(5)

Blotters. When blotters or flange facings of compressible material are required, they shall cover entire contact area of wheel flanges. Blotters need not be used with the following types of wheels:

1910.215(d)(5)(i)

Mounted wheels.

1910.215(d)(5)(ii)

Abrasive discs (inserted nut, inserted washer, and projecting-stud type).

1910.215(d)(5)(iii)

Plate mounted wheels.

1910.215(d)(5)(iv)

Cylinders, cups, or segmental wheels that are mounted in chucks.

1910.215(d)(5)(v)

Types 27 and 28 wheels.

1910.215(d)(5)(vi)

Certain Type 1 and Type 27A cutting-off wheels.

1910.215(d)(5)(vii)

Certain internal wheels.

1910.215(d)(5)(viii)

Type 4 tapered wheels.

1910.215(d)(5)(ix)

Diamond wheels, except certain vitrified diamond wheels.

..1910.215(d)(6)

1910.215(d)(6)

Multiple wheel mounting. When more than one wheel is mounted between a single set of flanges, wheels may be cemented together or separated by specially designed spacers. Spacers shall be equal in diameter to the mounting flanges and have equal bearing surfaces. When mounting wheels which have not been cemented together, or ones which do not utilize separating spacers, care must be exercised to use wheels specially manufactured for that purpose.

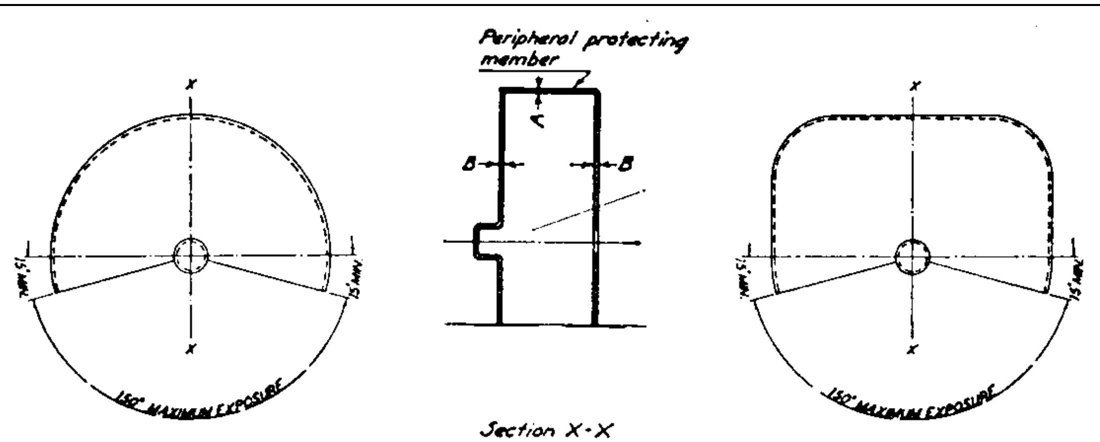


FIGURE NO. 0-27

FIGURE NO. 0-28

TABLE O-1 - MINIMUM BASIC THICKNESS FOR PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS USED WITH CUTTING-OFF WHEELS

Material used in construction of guard	Maximum thickness of cutting wheel	Speed not to exceed	Cutting off wheel diameters					
			6 to 11 inches		Over 11 to 20 inches		Over 20 to 30 inches	
			A	B	A	B	A	B
Structural steel (min. tensile strength 60,000 p.s.i.).	½ inch or less…	14,200 SFPM…	1/16	1/16	3/32	3/32	1/8	1/8
	½ inch or less…	16,000 SFPM…	3/32	1/8	1/8	1/8	3/16	1/8

TABLE O-1 - MINIMUM BASIC THICKNESS FOR PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS USED WITH CUTTING-OFF WHEELS

(Continued)

Material used in construction of guard	Maximum thickness of cutting wheel	Speed not to exceed	Cutting off wheel diameters			
			Over 30 to 48 inches		Over 48 to 72 inches	
			A	B	A	B
Structural steel (min. tensile strength 60,000 p.s.i.).	½ inch or less…	14,200 SFPM…	3/16	3/16	1/4	1/4
	½ inch or less…	16,000 SFPM…	1/4	3/16	5/16	1/4

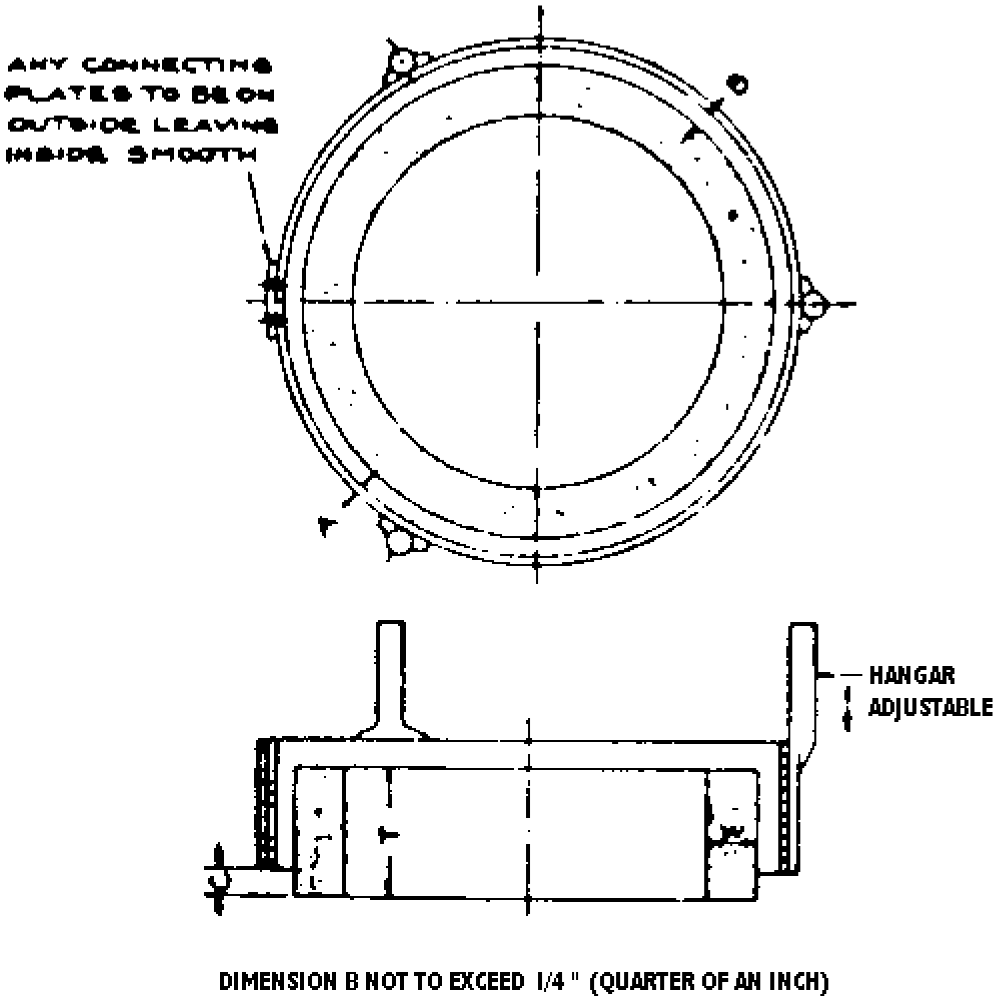


FIGURE NO. O-29

TABLE O-3 - GUIDE FOR CONSTRUCTION OF BAND TYPE GUARDS
[Maximum Wheel Speed 7,000 SFPM]

Minimum material specifications	Diameter of wheel	Minimum thickness of band A	Minimum diameter of rivets	Maximum distance between centers of rivets
	Inches			
Hot rolled Steel SAE 1008……………	Under 8……..	1/16	3/16	3/4
	8 to 24……	1/8	1/4	1
	Over 24 to 30	1/4	3/8	1 1/4

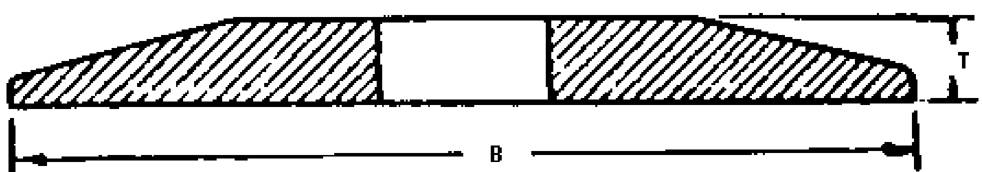


FIGURE NO. O-30

Driving flange secured to spindle for use only on portable wheels with threaded inserts or projecting studs.

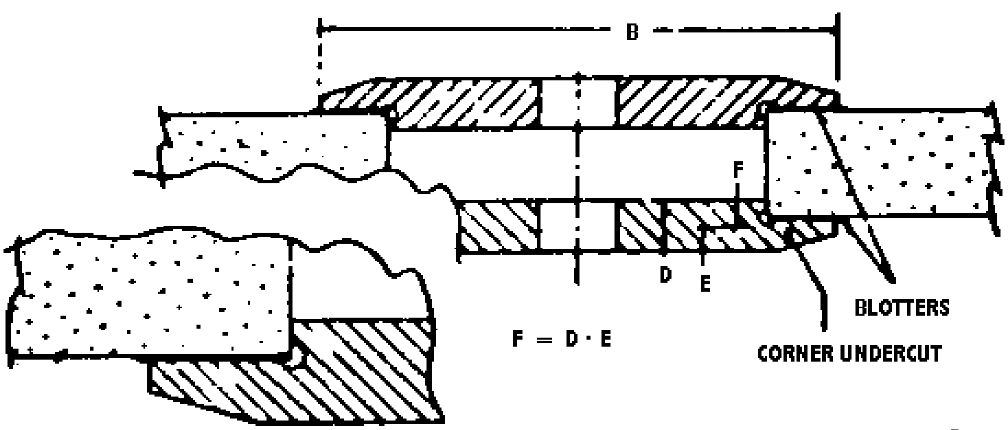


FIGURE NO. O-31

TABLE O-5 - MINIMUM DIMENSIONS FOR STRAIGHT ADAPTOR FLANGE -- FOR ORGANIC BONDED WHEELS OVER 1 1/2 INCHES THICK(1)

(In inches)

wheel diameter	Wheel Hole Diameter	B – Minimum Flange Diameter	D – Minimum Thickness Of flange At bore	E – Minimum Thickness Of flange At edge of Undercut	F(1) – (D-E) minimum thickness
12 to 14………..	4	6	7/8	3/8	1/2
	5	7	7/8	3/8	1/2
	6	8	7/8	3/8	1/2
Larger Than 14 To 18………….	4	6	7/8	3/8	1/2
	5	7	7/8	3/8	1/2
	6	8	7/8	3/8	1/2
	7	9	7/8	3/8	1/2
	8	10	7/8	3/8	1/2
Larger Than 18 To 24………….	6	8	1	1/2	1/2
	7	9	1	1/2	1/2
	8	10	1	1/2	1/2
	10	12	1	1/2	1/2
	12	14	1	1/2	1/2
Larger Than 24 To 30………….	12	15	1	1/2	1/2
Larger Than 30 To 36………….	12	15	1 3/8	7/8	1/2

Footnote(1) For wheels under 1 1/4 inches thick F dimension shall not exceed 40 percent of wheel thickness.

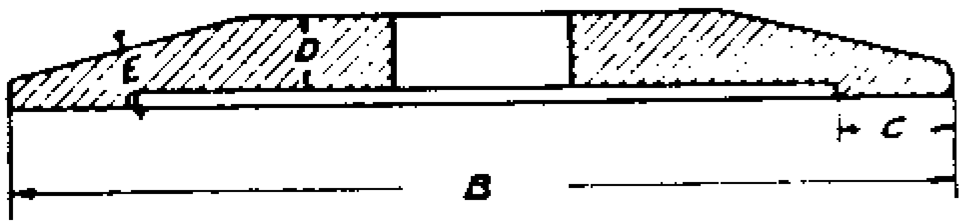


FIGURE NO. 0-32

Driving flange secured to spindle.

TABLE O-6 - MINIMUM DIMENSIONS FOR STRAIGHT RELIEVED FLANGES(1)
(In inches)

A -- Diameter Of wheel	B -- Minimum Outside Diameter Of flanges	C -- Radial width of bearing surface		D – Minimum Thickness Of Flange At bore	E – Minimum Thickness Of flange At edge Or recess
		Minimum	Maximum		
1………...	3/8	1/16	1/8	1/16	1/16
2………...	3/4	1/8	3/16	1/8	3/32
3………...	1	1/8	3/16	3/16	3/32
4………...	1 3/8	1/8	3/16	3/16	1/8
5………...	1 3/4	3/16	1/4	1/4	1/8
6………...	2	1/4	1/2	3/8	3/16
7………...	2 1/2	1/4	1/2	3/8	3/16
8………...	3	1/4	1/2	3/8	3/16
10……….	3 1/2	5/16	5/8	3/8	1/4
12……….	4	5/16	5/8	1/2	5/16
14……….	4 1/2	3/8	3/4	1/2	5/16
16……….	5 1/2	1/2	1	1/2	5/16
18……….	6	1/2	1	5/8	3/8
20……….	7	5/8	1 1/4	5/8	3/8
22……….	7 1/2	5/8	1 1/4	5/8	7/16
24……….	8	3/4	1 1/4	5/8	7/16
26……….	8 1/2	3/4	1 1/4	5/8	1/2
28……….	10	7/8	1 1/2	3/4	1/2
30……….	10	7/8	1 1/2	3/4	5/8
36……….	12	1	2	7/8	3/4
42……….	14	1	2	7/8	3/4
48……….	16	1 1/4	2	1 1/8	1
60……….	20	1 1/4	2	1 1/4	1 1/8
72……….	24	1 1/2	2 1/2	1 3/8	1 1/4

Footnote(1) Flanges for wheels under 2 inches diameter may be unrelieved and shall be maintained flat and true.

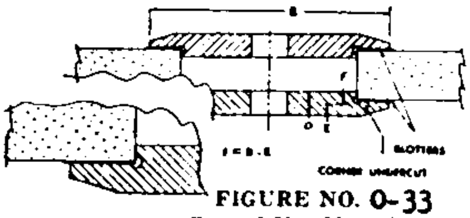


FIGURE NO. O-33
Central Nut Mounting
Driving flange secured to spindle.

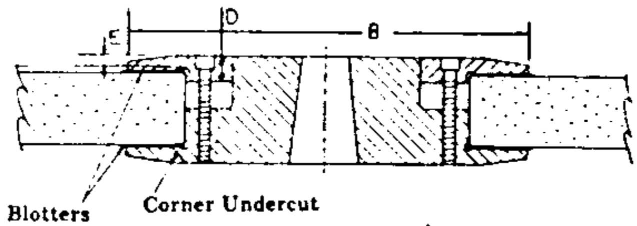


FIGURE NO. O-34
Multiple Screw Mounting
Driving flange secured to spindle.

TABLE O-7 - MINIMUM DIMENSIONS FOR STRAIGHT FLANGES
- FOR MECHANICAL GRINDERS 12,500 S.F.P.M.
TO 16,5 S.F.P.M.(1)

Wheel Diameter	Wheel Hole Diameter	B – Minimum Flange Diameter	D – Minimum Thickness Of Flange At bore	E – Minimum Thickness Of flange At edge of undercut	F(2)— (D-E) minimum thickness
20	6	8	1	½	½
20	8	10	1 ½	34	¾
24	12	15	2	1	1
30	12	15	2	1	1
36	12	15	2	1	

Footnote(1) Flanges shall be of steel, quality SAE 1040 or equivalent, annealed plate, heat treated to R.25-30.
Footnote(2) For wheels under 1 1/4 inch thick F dimension shall not exceed 40 percent of wheel thickness.

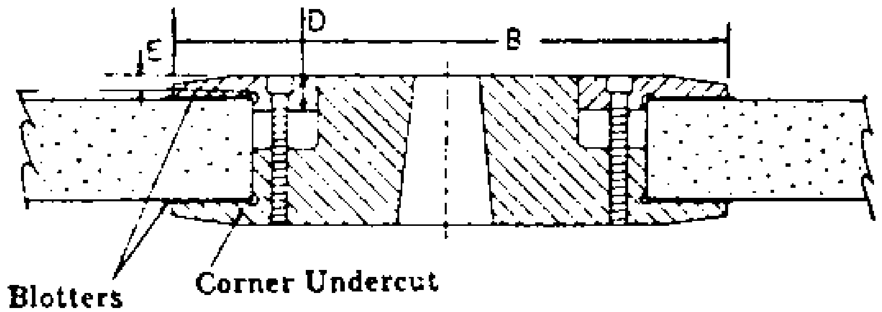


FIGURE NO. O-35

Driving flange secured to spindle.

TABLE O-8 - MINIMUM DIMENSIONS FOR STRAIGHT FLANGES USED AS WHEEL SLEEVES FOR PRECISION GRINDING ONLY

(In inches)

wheel diameter	Wheel Hole Diameter	B – Minimum Outside Diameter Of flange	D – Minimum Thickness Of flange At bore	E – Minimum Thickness Of flange At edge of Undercut
12 to 14………..	5	7	1/2	7/16
Larger than 14 to 20………..	5	7	5/8	7/16
	6	8	5/8	7/16
	8	10	5/8	7/16
	10	11 1/2	5/8	7/16
	12	13 1/2	5/8	7/16
Larger than 20 to 30………..	8	10	3/4	1/2
	10	11 1/2	3/4	1/2
	12	13 1/2	3/4	1/2
	16	17 1/2	3/4	1/2
Larger than 30 to 42………..	12	13 1/2	3/4	1/2
	16	17 1/2	3/4	1/2
	18	19 1/2	3/4	1/2
	20	21 1/2	3/4	1/2
Larger than 42 to 60……….	16	20	1	3/4

	20	24	1	3/4
	24	29	1 1/8	7/8

NOTE: These flanges may be clamped together by means of a central nut, or by a series of bolts or some other equivalent means of fastening. For hole sizes smaller than shown in this table, use table 12.

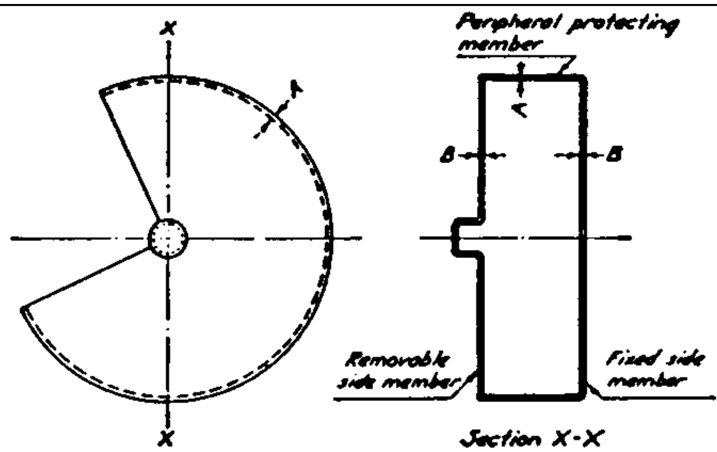


FIGURE NO. O-36

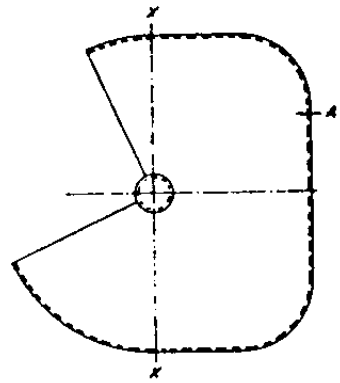


FIGURE NO. O-37

TABLE O-9 - MINIMUM BASIC THICKNESS OF PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS

(In inches)

Material used In construction Of guard	Maximum Thickness Of grinding Wheel	Grinding wheel diameters					
		3 to 6 inches		Over 6 to 12 inches		Over 12 to 16 inches	
		A	B	A	B	A	B
Material Satisfactory(1) For speeds up To 8,000 SFPM	2	1/4	1/4	3/8	5/16	1/2	3/8
	4	5/16	5/16	3/8	5/16	1/2	3/8
	6	3/8	5/16	1/2	7/16	5/8	1/2
	8			5/8	9/16	7/8	3/4
	10			3/4	11/16	7/8	3/4
	16					1 1/8	1
	20						
Cast iron (min. tensile strength 20,000 p.s.i.) class 20.							

Material	2	¼	¼	3/8	5/16	½	3/8
Satisfactory(1)	4	5/16	5/16	3/8	5/16	½	3/8
For speeds up	6	3/8	5/16	½	7/16	5/8	½
To 9,000 SFPM.	8			½	7/16	5/8	½
	10			½	7/16	5/8	½
	16					13/16	11/16
	20						
Malleable iron							
(min. tensile strength							
50,000 p.s.i.)Grade 32510							
Materials	2	1/4	1/4	5/16	5/16	3/8	3/8
Satisfactory(1)	4	1/4	1/4	1/2	1/2	1/2	1/2
For speeds up	6	3/8	1/4	3/4	5/8	3/4	5/8
To 16,000 SFPM.	8			7/8	3/4	7/8	3/4
	10			1	7/8	1	7/8
	16					1 1/4	1 1/8
	20						
Steel castings							
(min. tensile strength							
60,000 p.s.i.)							
Grade V60-30							
Structural steel	2	1/8	1/16	5/16	1/4	5/16	1/4
(min. tensile strength	4	1/8	1/16	3/8	5/16	3/8	5/16
60,000 p.s.i.)	6	3/16	1/16	1/2	3/8	7/16	3/8
	8			1/2	3/8	9/16	7/16
	10	9/16	7/16	5/8	1/2	5/8	1/2
	16					5/8	9/16
	20						

TABLE O-9 - MINIMUM BASIC THICKNESS OF PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS
(In inches)

[Continued]

Material used In construction Of guard	Maximum Thickness of Grinding wheel	Grinding wheel diameters			
		Over 16 to 20 inches		Over 20 to 24 inches	
		A	B	A	B
Material	2	5/8	1/2	7/8	5/8
Satisfactory(1)	4	3/4	5/8	1	5/8
For speeds up	6	1	5/8	1 1/8	3/4
To 8,000 SFPM.	8	1	3/4	1 1/8	3/4
	10	1	3/4	1 1/8	3/4

	16	1 1/4	1	1 5/16	1
	20	1 3/8	1 1/8	1 3/8	1 1/8
Cast iron (min.tensile strength 20,000 p.s.i.) Class 20.					
Material Satisfactory(1)	2	5/8	1/2	3/4	5/8
	4	5/8	1/2	3/4	5/8
For speeds up	6	3/4	5/8	7/8	5/8
To 9,000 SFPM.	8	3/4	5/8	7/8	5/8
	10	3/4	5/8	7/8	5/8
	16	13/16	11/16	1	3/4
	20	7/8	3/4	1	¾
Malleable iron (min. tensile strength 50,000 p.s.i.) Grade 32510					
Materials Satisfactory(1)	2	1/2	7/16	5/8	1/2
	4	9/16	1/2	5/8	1/2
For speeds up	6	3/4	5/8	13/16	11/16
To 16,000 SFPM.	8	7/8	3/4	7/8	3/4
	10	1	7/8	1 1/8	15/16
	16	1 1/4	1 1/8	1 1/4	1 1/8
	20	1 3/8	1 1/4	1 3/8	1 1/4
Steel castings (min. tensile strength 60,000 p.s.i.) Grade V60-30					
Structural steel	2	5/16	1/4	5/16	1/4
(min. tensile strength	4	3/8	5/16	3/8	5/16
60,000 p.s.i.)	6	7/16	3/8	7/16	3/8
	8	9/16	7/16	9	
	10	5/8	1/2	5/8	1/2
	16	3/4	5/8	3/4	5/8
	20	13/16	11/16	13/16	11/16

TABLE O-9 - MINIMUM BASIC THICKNESS OF PERIPHERAL AND SIDE MEMBERS FOR SAFETY GUARDS

(In inches)

[Continued]

Material used In construction Of guard	Maximum Thickness of Grinding wheel	Grinding wheel diameters			
		Over 24 to 30 inches		Over 30 to 48 inches	
		A	B	A	B
Material Satisfactory(1) For speeds up To 8,000 SFPM.	2	1	3/4	1 1/4	1
	4	1 1/8	3/4	1 3/8	1
	6	1 1/4	7/8	1 1/2	1 1/8
	8	1 1/4	7/8	1 1/2	1 1/8
	10	1 1/4	7/8	1 1/2	1 1/8
	16	1 7/16	1 1/16	1 3/4	1 3/8
	20	1 1/2	1 3/8	2	1 5/8
Cast iron (min.tensile strength 20,000 p.s.i.) Class 20.					
Material Satisfactory(1) For speeds up To 9,000 SFPM.	2	7/8	3/4	1	7/8
	4	7/8	3/4	1 1/8	7/8
	6	1	3/4	1 1/4	7/8
	8	1	3/4	1 1/4	7/8
	10	1	3/4	1 1/4	7/8
	16	1 1/8	7/8	1 3/8	1
	20	1 1/8	7/8	1 1/2	1 1/8
Malleable iron (min. tensile strength 50,000 p.s.i.) Grade 32510					
Materials Satisfactory(1) For speeds up To 16,000 SFPM.	2	¾	5/8	7/8	3/4
	4	¾	5/8	1	3/4
	6	13/16	11/16	1 1/8	3/4
	8	15/16	13/16	1 3/8	1
	10	1 1/8	1	1 7/16	1 1/16
	16	1 ¼	1 1/8	1 13/16	1 7/16
	20	1 7/16	1 5/16	2 1/16	1 11/16
Steel castings (min. tensile strength 60,000 p.s.i.) Grade V60-30					

Structural steel (min. tensile strength 60,000 p.s.i.)	2	3/8	5/16	1/2	3/8
	4	3/8	5/16	1/2	3/8
	6	7/16	3/8	3/4	1/2
	8				
	10	7/8	5/8		
	16	13/16	11/16	1 1/16	13/16
	20	7/8	3/4	1 3/16	15/16

Footnote(1) The recommendations listed in the above table are guides for the conditions stated. Other material, designs or dimensions affording equal or superior protection are also acceptable.

TABLE O-2 - EXPOSURE VERSUS WHEEL THICKNESS
[in inches]

Overall thickness of wheel (T)	Maximum Exposure Of wheel (C)
1/2………………………………	1/4
1………………………………..	1/2
2………………………………..	3/4
3………………………………..	1
4………………………………..	1 1/2
5 and over ……………………..	2

TABLE O-4 - MINIMUM DIMENSIONS FOR STRAIGHT UNRELIEVED FLANGES FOR WHEELS WITH THREADED INSERTS OR PROJECTING STUDS.

A – Diameter of Wheel	B(1) – Minimum Outside diameter Of flange	T – Minimum Thickness of flange
1………………………………	5/8	1/8
2………………………………	1	1/8
3………………………………	1	3/16
4………………………………	1 3/8	3/16
5………………………………	1 3/4	1/4
6………………………………	2	3/8

NOTE(1): Must be large enough to extend beyond the bushing. Where prong anchor or cupback bushing are used, this footnote does not apply.

[39 FR 23502, June 27, 1974, as amended at 43 FR 49750, Oct. 24, 1978; 49 FR 5323, Feb. 10, 1984; 61 FR 9227, March 7, 1996]

Regulations (Standards - 29 CFR)
Mills and calenders in the rubber and plastics industries. - 1910.216

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.216
- **Title:** Mills and calenders in the rubber and plastics industries.

1910.216(a)

General requirements –

1910.216(a)(1)

[Reserved]

1910.216(a)(2)

[Reserved]

1910.216(a)(3)

Auxiliary equipment. Mechanical and electrical equipment and auxiliaries shall be installed in accordance with this section and Subpart S of this part.

1910.216(a)(4)

Mill roll heights. All new mill installations shall be installed so that the top of the operating rolls is not less than 50 inches above the level on which the operator stands, irrespective of the size of the mill. This distance shall apply to the actual working level, whether it be at the general floor level, in a pit, or on a platform.

1910.216(b)

Mill safety controls –

1910.216(b)(1)

Safety trip control. A safety trip control shall be provided in front and in back of each mill. It shall be accessible and shall operate readily on contact. The safety trip control shall be one of the following types or a combination thereof:

..1910.216(b)(1)(i)

1910.216(b)(1)(i)

Pressure-sensitive body bars. Installed at front and back of each mill having a 46-inch roll height or over. These bars shall operate readily by pressure of the mill operator's body.

1910.216(b)(1)(ii)

Safety triprod. Installed in the front and in the back of each mill and located within 2 inches of a vertical plane tangent to the front and rear rolls. The top rods shall be not more than 72 inches above the level on which the operator stands. The triprods shall be accessible and shall operate readily whether the rods are pushed or pulled.

1910.216(b)(1)(iii)

Safety tripwire cable or wire center cord. Installed in the front and in the back of each mill and located within 2 inches of a vertical plane tangent to the front and rear rolls. The cables shall not be more than 72 inches above the level on which the operator stands. The tripwire cable or wire center cord shall operate readily whether cable or cord is pushed or pulled.

1910.216(b)(2)

[Reserved]

1910.216(b)(3)

Auxiliary equipment. All auxiliary equipment such as mill divider, support bars, spray pipes, feed conveyors, strip knives, etc., shall be located in such a manner as to avoid interference with access to and operation of safety devices.

..1910.216(c)

1910.216(c)

Calender safety controls –

1910.216(c)(1)

Safety trip, face. A safety triprod, cable, or wire center cord shall be provided across each pair of in-running rolls extending the length of the face of the rolls. It shall be readily accessible and operate whether pushed or pulled. The safety tripping devices shall be located within reach of the operator and the bite.

1910.216(c)(2)

Safety trip, side. On both sides of the calender and near each end of the face of the roll, there shall be a cable or wire center cord connected to the safety trip. They shall operate readily when pushed or pulled.

1910.216(d)

Protection by location –

1910.216(d)(1)

Mills. Where a mill is so installed that persons cannot normally reach through, over, under, or around to come in contact with the roll bite or be caught between a roll and an adjacent object, then, provided such elements are made a fixed part of a mill, safety control devices listed in paragraph (b) of this section shall not apply.

1910.216(d)(2)

Calenders. Where a calender is so installed that persons cannot normally reach through, over, under, or around to come in contact with the roll bite or be caught between a roll and an adjacent object, then, provided such elements are made a fixed part of a calender, safety control devices listed in paragraph (c) of this section shall not apply.

..1910.216(e)

1910.216(e)

Trip and emergency switches. All trip and emergency switches shall not be of the automatically resetting type, but shall require manual resetting.

1910.216(f)

Stopping limits –

1910.216(f)(1)

Determination of distance of travel. All measurements on mills and calenders shall be taken with the rolls running empty at maximum operating speed. Stopping distances shall be expressed in inches of surface travel of the roll from the instant the emergency stopping device is actuated.

1910.216(f)(2)

Stopping limits for mills. All mills irrespective of the size of the rolls or their arrangement (individually or group-driven) shall be stopped within a distance, as measured in inches of surface travel, not greater than 1 1/2 percent of the peripheral no-load surface speeds of the respective rolls as determined in feet per minute.

1910.216(f)(3)

Stopping limits for calenders.

1910.216(f)(3)(i)

All calenders, irrespective of size of the rolls or their configuration, shall be stopped within a distance, as measured in inches of surface travel, not greater than 1 3/4 percent of the peripheral no-load surface speeds of the respective calender rolls as determined in feet per minute.

1910.216(f)(3)(ii)

Where speeds above 250 feet per minute as measured on the surface of the drive roll are used, stopping distances of more than 1 3/4 percent are permissible. Such stopping distances shall be subject to engineering determination.

[39 FR 23502, June 27, 1974, as amended at 49 FR 5323, Feb. 10, 1984; 61 FR 9227, March 7, 1996]

Regulations (Standards - 29 CFR)
Mechanical power presses. - 1910.217

- **Part Number**: 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.217
- **Title:** Mechanical power presses.

- **Appendix:A , B , C , D**

1910.217(a)

General requirements.

1910.217(a)(1)

[Reserved]

1910.217(a)(2)

[Reserved]

1910.217(a)(3)

[Reserved]

1910.217(a)(4)

Reconstruction and modification. It shall be the responsibility of any person reconstructing, or modifying a mechanical power press to do so in accordance with paragraph (b) of this section.

1910.217(a)(5)

Excluded machines. Press brakes, hydraulic and pneumatic power presses, bulldozers, hot bending and hot metal presses, forging presses and hammers, riveting machines and similar types of fastener applicators are excluded from the requirements of this section.

..1910.217(b)

1910.217(b)

Mechanical power press guarding and construction, general –

1910.217(b)(1)

Hazards to personnel associated with broken or falling machine components. Machine components shall be designed, secured, or covered to minimize hazards caused by breakage, or loosening and falling or release of mechanical energy (i.e. broken springs).

1910.217(b)(2)

Brakes. Friction brakes provided for stopping or holding a slide movement shall be inherently self-engaging by requiring power or force from an external source to cause disengagement. Brake capacity shall be sufficient to stop the motion of the slide quickly and capable of holding the slide and its attachments at any point in its travel.

1910.217(b)(3)

Machines using full revolution positive clutches.

1910.217(b)(3)(i)

Machines using full revolution clutches shall incorporate a single-stroke mechanism.

1910.217(b)(3)(ii)

If the single-stroke mechanism is dependent upon spring action, the spring(s) shall be of the compression type, operating on a rod or guided within a hole or tube, and designed to prevent interleaving of the spring coils in event of breakage.

1910.217(b)(4)

Foot pedals (treadle).

1910.217(b)(4)(i)

The pedal mechanism shall be protected to prevent unintended operation from falling or moving objects or by accidental stepping onto the pedal.

..1910.217(b)(4)(ii)

1910.217(b)(4)(ii)

A pad with a nonslip contact area shall be firmly attached to the pedal.

1910.217(b)(4)(iii)

The pedal return spring(s) shall be of the compression type, operating on a rod or guided within a hole or tube, or designed to prevent interleaving of spring coils in event of breakage.

1910.217(b)(4)(iv)

If pedal counterweights are provided, the path of the travel of the weight shall be enclosed.

1910.217(b)(5)

Hand operated levers.

1910.217(b)(5)(i)

Hand-lever-operated power presses shall be equipped with a spring latch on the operating lever to prevent premature or accidental tripping.

1910.217(b)(5)(ii)

The operating levers on hand-tripped presses having more than one operating station shall be interlocked to prevent the tripping of the press except by the "concurrent" use of all levers.

1910.217(b)(6)

Two-hand trip

1910.217(b)(6)(i)

A two-hand trip shall have the individual operator's hand controls protected against unintentional operation and have the individual operator's hand controls arranged by design and construction and/or separation to require the use of both hands to trip the press and use a control arrangement requiring concurrent operation of the individual operator's hand controls.

..1910.217(b)(6)(ii)

1910.217(b)(6)(ii)

Two-hand trip systems on full revolution clutch machines shall incorporate an antirepeat feature.

1910.217(b)(6)(iii)

If two-hand trip systems are used on multiple operator presses, each operator shall have a separate set of controls.

1910.217(b)(7)

Machines using part revolution clutches.

1910.217(b)(7)(i)

The clutch shall release and the brake shall be applied when the external clutch engaging means is removed, deactivated, or deenergized.

1910.217(b)(7)(ii)

A red color stop control shall be provided with the clutch/brake control system. Momentary operation of the stop control shall immediately deactivate the clutch and apply the brake. The stop control shall override any other control, and reactuation of the clutch shall require use of the operating (tripping) means which has been selected.

1910.217(b)(7)(iii)

A means of selecting Off, "Inch," Single Stroke, and Continuous (when the continuous function is furnished) shall be supplied with the clutch/brake control to select type of operation of the press. Fixing of selection shall be by means capable of supervision by the employer.

1910.217(b)(7)(iv)

The "Inch" operating means shall be designed to prevent exposure of the workers hands within the point of operation by:

..1910.217(b)(7)(iv)(a)

1910.217(b)(7)(iv)(a)

Requiring the concurrent use of both hands to actuate the clutch, or

1910.217(b)(7)(iv)(b)

Being a single control protected against accidental actuation and so located that the worker cannot reach into the point of operation while operating the single control.

1910.217(b)(7)(v)

Two-hand controls for single stroke shall conform to the following requirements:

1910.217(b)(7)(v)(a)

Each hand control shall be protected against unintended operation and arranged by design, construction, and/or separation so that the concurrent use of both hands is required to trip the press.

1910.217(b)(7)(v)(b)

The control system shall be designed to permit an adjustment which will require concurrent pressure from both hands during the die closing portion of the stroke.

1910.217(b)(7)(v)(c)

The control system shall incorporate an antirepeat feature.

1910.217(b)(7)(v)(d)

The control systems shall be designed to require release of all operators' hand controls before an interrupted stroke can be resumed. This requirement pertains only to those single-stroke, two-hand controls manufactured and installed on or after August 31, 1971.

1910.217(b)(7)(vi)

[Reserved]

..1910.217(b)(7)(vii)

1910.217(b)(7)(vii)

Controls for more than one operating station shall be designed to be activated and deactivated in complete sets of two operator's hand controls per operating station by means capable of being supervised by the employer. The clutch/brake control system shall be designed and constructed to prevent actuation of the clutch if all operating stations are bypassed.

1910.217(b)(7)(viii)

Those clutch/brake control systems which contain both single and continuous functions shall be designed so that completion of continuous circuits may be supervised by the employer. The initiation of continuous run shall require a prior action or decision by the operator in addition to the selection of Continuous on the stroking selector, before actuation of the operating means will result in continuous stroking.

1910.217(b)(7)(ix)

If foot control is provided, the selection method between hand and foot control shall be separate from the stroking selector and shall be designed so that the selection may be supervised by the employer.

1910.217(b)(7)(x)

Foot operated tripping controls, if used, shall be protected so as to prevent operation from falling or moving objects, or from unintended operation by accdental stepping onto the foot control.

..1910.217(b)(7)(xi)

1910.217(b)(7)(xi)

The control of air-clutch machines shall be designed to prevent a significant increase in the normal stopping time due to a failure within the operating value mechanism, and to inhibit further operation if such failure does occur. This requirement shall apply only to those clutch/brake air-valve controls manufactured and installed on or after August 31, 1971, but shall not apply to machines intended only for continuous, automatic feeding applications.

1910.217(b)(7)(xii)

The clutch/brake control shall incorporate an automatic means to prevent initiation or continued activation of the Single Stroke or Continuous functions unless the press drive motor is energized and in the forward direction.

1910.217(b)(7)(xiii)

The clutch/brake control shall automatically deactivate in event of failure of the power or pressure supply for the clutch engaging means. Reactivation of the clutch shall require restoration of normal supply and the use of the tripping mechanism(s).

1910.217(b)(7)(xiv)

The clutch/brake control shall automatically deactivate in event of failure of the counterbalance(s) air supply. Reactivation of the clutch shall require restoration of normal air supply and use of the tripping mechanism(s).

1910.217(b)(7)(xv)

Selection of bar operation shall be by means capable of being supervised by the employer. A separate pushbutton shall be employed to activate the clutch, and the clutch shall be activated only if the driver motor is deenergized.

..1910.217(b)(8)

1910.217(b)(8)

Electrical.

1910.217(b)(8)(i)

A main power disconnect switch capable of being locked only in the Off position shall be provided with every power press control system.

1910.217(b)(8)(ii)

The motor start button shall be protected against accidental operation.

1910.217(b)(8)(iii)

All mechanical power press controls shall incorporate a type of drive motor starter that will disconnect the drive motor from the power source in event of control voltage or power source failure, and require operation of the motor start button to restart the motor when voltage conditions are restored to normal.

1910.217(b)(8)(iv)

All a.c. control circuits and solenoid value coils shall be powered by not more than a nominal 120-volt a.c. supply obtained from a transformer with an isolated secondary. Higher voltages that may be necessary for operation of machine or control mechanisms shall be isolated from any control mechanism handled by the operator, but motor starters with integral Start-Stop buttons may utilize line voltage control. All d.c. control circuits shall be powered by not more than a nominal 240-volt d.c. supply isolated from any higher voltages.

1910.217(b)(8)(v)

All clutch/brake control electrical circuits shall be protected against the possibility of an accidental ground in the control circuit causing false operation of the press.

..1910.217(b)(8)(vi)

1910.217(b)(8)(vi)

Electrical clutch/brake control circuits shall incorporate features to minimize the possibility of an unintended stroke in the event of the failure of a control component to function properly, including relays, limit switches, and static output circuits.

1910.217(b)(9)

Slide counterbalance systems.

1910.217(b)(9)(i)

Spring counterbalance systems when used shall incorporate means to retain system parts in event of breakage.

1910.217(b)(9)(ii)

Spring counterbalances when used shall have the capability to hold the slide and its attachments at midstroke, without brake applied.

1910.217(b)(9)(iii)

Air counterbalance cylinders shall incorporate means to retain the piston and rod in case of breakage or loosening.

1910.217(b)(9)(iv)

Air counterbalance cylinders shall have adequate capability to hold the slide and its attachments at any point in stroke, without brake applied.

1910.217(b)(9)(v)

Air counterbalance cylinders shall incorporate means to prevent failure of capability (sudden loss of pressure) in event of air supply failure.

1910.217(b)(10)

Air controlling equipment. Air controlling equipment shall be protected against foreign material and water entering the pneumatic system of the press. A means of air lubrication shall be provided when needed.

..1910.217(b)(11)

1910.217(b)(11)

Hydraulic equipment. The maximum anticipated working pressures in any hydraulic system on a mechanical power press shall not exceed the safe working pressure rating of any component used in that system.

1910.217(b)(12)

Pressure vessels. All pressure vessels used in conjunction with power presses shall conform to the American Society of Mechanical Engineers Code for Pressure Vessels, 1968 Edition, which is incorporated by reference as specified in Sec. 1910.6.

1910.217(b)(13)

Control reliability. When required by paragraph (c)(5) of this section, the control system shall be constructed so that a failure within the system does not prevent the normal stopping action from being applied to the press when required, but does prevent initiation of a successive stroke until the failure is corrected. The failure shall be detectable by a simple test, or indicated by the control system. This requirement does not apply to those elements of the control system which have no effect on the protection against point of operation injuries.

1910.217(b)(14)

Brake system monitoring. When required by paragraph (c)(5) of this section, the brake monitor shall meet the following requirements:

..1910.217(b)(14)(i)

1910.217(b)(14)(i)

Be so constructed as to automatically prevent the activation of a successive stroke if the stopping time or braking distance deteriorates to a point where the safety distance being utilized does not meet the requirements set forth in paragraph (c)(3)(iii)(e) or (c)(3)(vii)(c) of this section. The brake monitor used with the Type B gate or movable barrier device shall be installed in a manner to detect slide top-stop overrun beyond the normal limit reasonably established by the employer.

1910.217(b)(14)(ii)

Be installed on a press such that it indicates when the performance of the braking system has deteriorated to the extent described in paragraph (b)(14)(i) of this section; and

1910.217(b)(14)(iii)

Be constructed and installed in a manner to monitor brake system performance on each stroke.

1910.217(c)

Safeguarding the point of operation –

1910.217(c)(1)

General requirements.

1910.217(c)(1)(i)

It shall be the responsibility of the employer to provide and insure the usage of "point of operation guards" or properly applied and adjusted point of operation devices on every operation performed on a mechanical power press. See Table O-10.

1910.217(c)(1)(ii)

The requirement of paragraph (c)(1)(i) of this section shall not apply when the point of operation opening is one-fourth inch or less. See Table O-10.

1910.217(c)(2)

Point of operation guards.

1910.217(c)(2)(i)

Every point of operation guard shall meet the following design, construction, application, and adjustment requirements:

..1910.217(c)(2)(i)(a)

1910.217(c)(2)(i)(a)

It shall prevent entry of hands or fingers into the point of operation by reaching through, over, under or around the guard;

1910.217(c)(2)(i)(b)

It shall conform to the maximum permissible openings of Table O-10;

1910.217(c)(2)(i)(c)

It shall, in itself, create no pinch point between the guard and moving machine parts;

1910.217(c)(2)(i)(d)

It shall utilize fasteners not readily removable by operator, so as to minimize the possibility of misuse or removal of essential parts;

1910.217(c)(2)(i)(e)

It shall facilitate its inspection, and

1910.217(c)(2)(i)(f)

It shall offer maximum visibility of the point of operation consistent with the other requirements.

1910.217(c)(2)(ii)

A die enclosure guard shall be attached to the die shoe or stripper in a fixed position.

1910.217(c)(2)(iii)

A fixed barrier guard shall be attached securely to the frame of the press or to the bolster plate.

..1910.217(c)(2)(iv)

1910.217(c)(2)(iv)

An interlocked press barrier guard shall be attached to the press frame or bolster and shall be interlocked with the press clutch control so that the clutch cannot be activated unless the guard itself, or the hinged or movable sections of the guard are in position to conform to the requirements of Table O-10.

1910.217(c)(2)(v)

The hinged or movable sections of an interlocked press barrier guard shall not be used for manual feeding. The guard shall prevent opening of the interlocked section and reaching into the point of operation prior to die closure or prior to the cessation of slide motion. See paragraph (c)(3)(ii) of this section regarding manual feeding through interlocked press barrier devices.

1910.217(c)(2)(vi)

The adjustable barrier guard shall be securely attached to the press bed, bolster plate, or die shoe, and shall be adjusted and operated in conformity with Table O-10 and the requirements of this subparagraph. Adjustments shall be made only by authorized personnel whose qualifications include a knowledge of the provisions of Table O-10 and this subparagraph.

1910.217(c)(2)(vii)

A point of operation enclosure which does not meet the requirements of this subparagraph and Table O-10 shall be used only in conjunction with point of operation devices.

1910.217(c)(3)

Point of operation devices.

1910.217(c)(3)(i)

Point of operation devices shall protect the operator by:

..1910.217(c)(3)(i)(a)

1910.217(c)(3)(i)(a)

Preventing and/or stopping normal stroking of the press if the operator's hands are inadvertently placed in the point of operation; or

1910.217(c)(3)(i)(b)

Preventing the operator from inadvertently reaching into the point of operation, or withdrawing his hands if they are inadvertently located in the point of operation, as the dies close; or

1910.217(c)(3)(i)(c)

Preventing the operator from inadvertently reaching into the point of operation at all times; or

1910.217(c)(3)(i)(d)

[Reserved]

1910.217(c)(3)(i)(e)

Requiring application of both of the operator's hands to machine operating controls and locating such controls at such a safety distance from the point of operation that the slide completes the downward travel or stops before the operator can reach into the point of operation with his hands; or

1910.217(c)(3)(i)(f)

Enclosing the point of operation before a press stroke can be initiated, and maintaining this closed condition until the motion of the slide had ceased; or

1910.217(c)(3)(i)(g)

Enclosing the point of operation before a press stroke can be initiated, so as to prevent an operator from reaching into the point of operation prior to die closure or prior to cessation of slide motion during the downward stroke.

..1910.217(c)(3)(ii)

1910.217(c)(3)(ii)

A gate or movable barrier device shall protect the operator as follows:

1910.217(c)(3)(ii)(a)

A Type A gate or movable barrier device shall protect the operator in the manner specified in paragraph (c)(3)(i)(f) of this section, and

1910.217(c)(3)(ii)(b)

A Type B gate or movable barrier device shall protect the operator in the manner specified in paragraph (c)(3)(i)(g) of this section.

1910.217(c)(3)(iii)

A presence sensing point of operation device shall protect the operator as provided in paragraph (c)(3)(i)(a) of this section, and shall be interlocked into the control circuit to prevent or stop slide motion if the operator's hand or other part of his body is within the sensing field of the device during the downstroke of the press slide.

1910.217(c)(3)(iii)(a)

The device may not be used on machines using full revolution clutches.

1910.217(c)(3)(iii)(b)

The device may not be used as a tripping means to initiate slide motion.

..1910.217(c)(3)(iii)(c)

1910.217(c)(3)(iii)(c)

The device shall be constructed so that a failure within the system does not prevent the normal stopping action from being applied to the press when required, but does prevent the initiation of a successive stroke until the failure is corrected. The failure shall be indicated by the system.

1910.217(c)(3)(iii)(d)

Muting (bypassing of the protective function) of such device, during the upstroke of the press slide, is permitted for the purpose of parts ejection, circuit checking, and feeding.

1910.217(c)(3)(iii)(e)

The safety distance (D(s)) from the sensing field to the point of operation shall be greater than the distance determined by the following formula:

$$D(s) = 63 \text{ inches/second } X \; T(s)$$

where:

D(s) = minimum safety distance (inches); 63 inches/second = hand speed constant;
and

T(s) = stopping time of the press measured at approximately 90 deg. position of crankshaft rotation (seconds).

1910.217(c)(3)(iii)(f)

Guards shall be used to protect all areas of entry to the point of operation not protected by the presence sensing device.

1910.217(c)(3)(iv)

The pull-out device shall protect the operator as specified in paragraph (c)(3)(i)(b) of this section, and shall include attachments for each of the operator's hands.

1910.217(c)(3)(iv)(a)

Attachments shall be connected to and operated only by the press slide or upper die.

1910.217(c)(3)(iv)(b)

Attachments shall be adjusted to prevent the operator from reaching into the point of operation or to withdraw the operator's hands from the point of operation before the dies close.

..1910.217(c)(3)(iv)(c)

1910.217(c)(3)(iv)(c)

A separate pull-out device shall be provided for each operator if more than one operator is used on a press.

1910.217(c)(3)(iv)(d)

Each pull-out device in use shall be visually inspected and checked for proper adjustment at the start of each operator shift, following a new die set-up, and when operators are changed. Necessary maintenance or repair or both shall be performed and completed before the press is operated. Records of inspections and maintenance shall be kept in accordance with paragraph (e) of this section.

1910.217(c)(3)(v)

The sweep device may not be used for point of operation safeguarding.

1910.217(c)(3)(vi)

A holdout or a restraint device shall protect the operator as specified in paragraph (c)(3)(i)(c) of this section and shall include attachments for each of the operator's hands. Such attachments shall be securely anchored and adjusted in such a way that the operator is restrained from reaching into the point of operation. A separate set of restraints shall be provided for each operator if more than one operator is required on a press.

1910.217(c)(3)(vii)

The two hand control device shall protect the operator as specified in paragraph (c)(3)(i)(e) of this section.

..1910.217(c)(3)(vii)(a)

1910.217(c)(3)(vii)(a)

When used in press operations requiring more than one operator, separate two hand controls shall be provided for each operator, and shall be designed to require concurrent application of all operators' controls to activate the slide. The removal of a hand from any control button shall cause the slide to stop.

1910.217(c)(3)(vii)(b)

Each two hand control shall meet the construction requirements of paragraph (b)(7)(v) of this section.

1910.217(c)(3)(vii)(c)

The safety distance (D(s)) between each two hand control device and the point of operation shall be greater than the distance determined by the following formula:

D(s) = 63 inches/second X T(s);

where:

D(s) = minimum safety distance (inches); 63 inches/second=hand speed constant;
and

T(s) = stopping time of the press measured at approximately 90 deg. position of crankshaft rotation (seconds).

1910.217(c)(3)(vii)(d)

Two hand controls shall be fixed in position so that only a supervisor or safety engineer is capable of relocating the controls.

1910.217(c)(3)(viii)

The two hand trip device shall protect the operator as specified in paragraph (c)(3)(i)(e) of this section.

1910.217(c)(3)(viii)(a)

When used in press operations requiring more than one operator, separate two hand trips shall be provided for each operator, and shall be designed to require concurrent application of all operators' to activate the slide.

1910.217(c)(3)(viii)(b)

Each two hand trip shall meet the construction requirements of paragraph (b)(6) of this section.

1910.217(c)(3)(viii)(c)

The safety distance (D(m)) between the two hand trip and the point of operation shall be greater than the distance determined by the following formula:

D(m) = 63 inches/second X T(m);

where:

D(m) = minimum safety distance (inches); 63 inches/second=hand speed constant;
and

T(m) = the maximum time the press takes for the die closure after it has been tripped (seconds). For full revolution clutch presses with only one engaging point T(m) is equal to the time necessary for one and one-half revolutions of the crankshaft. For full revolution clutch presses with more than one engaging point, T(m) shall be calculated as follows:

T(m) = [1/2 + (1 divided by Number of engaging points per revolution)] X time necessary to complete one revolution of the crankshaft (seconds).

..1910.217(c)(3)(viii)(d)

1910.217(c)(3)(viii)(d)

Two hand trips shall be fixed in position so that only a supervisor or safety engineer is capable of relocating the controls.

1910.217(c)(4)

Hand feeding tools. Hand feeding tools are intended for placing and removing materials in and from the press. Hand feeding tools are not a point of operation guard or protection device and shall not be used in lieu of the "guards" or devices required in this section.

1910.217(c)(5)

Additional requirements for safe-guarding. Where the operator feeds or removes parts by placing one or both hands in the point of operation, and a two hand control, presence sensing device of Type B gate or movable barrier (on a part revolution clutch) is used for safeguarding:

1910.217(c)(5)(i)

The employer shall use a control system and a brake monitor which comply with paragraphs (b)(13) and (14) of this section;

1910.217(c)(5)(ii)

The exception in paragraph (b) (7)(v)(d) of this section for two hand controls manufactured and installed before August 31, 1971 is not applicable under this paragraph (c)(5);

..1910.217(c)(5)(iii)

1910.217(c)(5)(iii)

The control of air clutch machines shall be designed to prevent a significant increase in the normal stopping time due to a failure within the operating valve mechanism, and to inhibit further operation if such failure does occur, where a part revolution clutch is employed. The exception in paragraph (b)(7)(xi) of this section for controls manufactured and installed before August 31, 1971, is not applicable under this paragraph (c)(5).

1910.217(d)

Design, construction, setting and feeding of dies –

1910.217(d)(1)

General requirements. The employer shall:

1910.217(d)(1)(i)

Use dies and operating methods designed to control or eliminate hazards to operating personnel; and

1910.217(d)(1)(ii)

furnish and enforce the use of hand tools for freeing and removing stuck work or scrap pieces from the die, so that no employee need reach into the point of operation for such purposes.

1910.217(d)(2)

[Reserved]

1910.217(d)(3)

Scrap handling. The employer shall provide means for handling scrap from roll feed or random length stock operations. Scrap cutters used in conjunction with scrap handling systems shall be safeguarded in accordance with paragraph (c) of this section and with 1910.219.

1910.217(d)(4)

Guide post hazard. The hazard created by a guide post (when it is located in the immediate vicinity of the operator) when separated from its bushing by more than one-fourth inch shall be considered as a point of operation hazard and be protected in accordance with paragraph (c) of this section.

..1910.217(d)(5)

1910.217(d)(5)

Unitized tooling. If unitized tooling is used, the opening between the top of the punch holder and the face of the slide, or striking pad, shall be safeguarded in accordance with the requirements of paragraph (c) of this section.

1910.217(d)(6)

Tonnage, stroke, and weight designation. All dies shall be:

1910.217(d)(6)(i)

Stamped with the tonnage and stroke requirements, or have these characteristics recorded if these records are readily available to the die setter;

1910.217(d)(6)(ii)

Stamped to indicate upper die weight when necessary for air counterbalance pressure adjustment; and

1910.217(d)(6)(iii)

Stamped to indicate complete die weight when handling equipment may become overloaded.

1910.217(d)(7)

Die fastening. Provision shall be made in both the upper and lower shoes for securely mounting the die to the bolster and slide. Where clamp caps or setscrews are used in conjunction with punch stems, additional means of securing the upper shoe to the slide shall be used.

1910.217(d)(8)

Die handling. Handling equipment attach points shall be provided on all dies requiring mechanical handling.

..1910.217(d)(9)

1910.217(d)(9)

Diesetting.

1910.217(d)(9)(i)

The employer shall establish a diesetting procedure that will insure compliance with paragraph (c) of this section.

1910.217(d)(9)(ii)

The employer shall provide spring loaded turnover bars, for presses designed to accept such turnover bars.

1910.217(d)(9)(iii)

The employer shall provide die stops or other means to prevent losing control of the die while setting or removing dies in presses which are inclined.

1910.217(d)(9)(iv)

The employer shall provide and enforce the use of safety blocks for use whenever dies are being adjusted or repaired in the press.

1910.217(d)(9)(v)

The employer shall provide brushes, swabs, lubricating rolls, and automatic or manual pressure guns so that operators and diesetters shall not be required to reach into the point of operation or other hazard areas to lubricate material, punches or dies.

..1910.217(e)

1910.217(e)

Inspection, maintenance, and modification of presses –

1910.217(e)(1)

Inspection and maintenance records.

1910.217(e)(1)(i)

It shall be the responsibility of the employer to establish and follow a program of periodic and regular inspections of his power presses to ensure that all their parts, auxiliary equipment, and safeguards are in a safe operating condition and adjustment. The employer shall maintain a certification record of inspections which includes the date of inspection, the signature of the person who performed the inspection and the serial number, or other identifier, of the power press that was inspected.

1910.217(e)(1)(ii)

Each press shall be inspected and tested no less than weekly to determine the condition of the clutch/brake mechanism, antirepeat feature and single stroke mechanism. Necessary maintenance or repair or both shall be performed and completed before the press is operated. These requirements do not apply to those presses which comply with paragraphs (b) (13) and (14) of this section. The employer shall maintain a certification record of inspections, tests and maintenance work which includes the date of the inspection, test or maintenance; the signature of the person who performed the inspection, test, or maintenance; and the serial number or other identifier of the press that was inspected, tested or maintained.

1910.217(e)(2)

Modification. It shall be the responsibility of any person modifying a power press to furnish instructions with the modification to establish new or changed guidelines for use and care of the power press so modified.

1910.217(e)(3)

Training of maintenance personnel. It shall be the responsibility of the employer to insure the original and continuing competence of personnel caring for, inspecting, and maintaining power presses.

..1910.217(f)

1910.217(f)

Operation of power presses –

1910.217(f)(1)

[Reserved]

1910.217(f)(2)

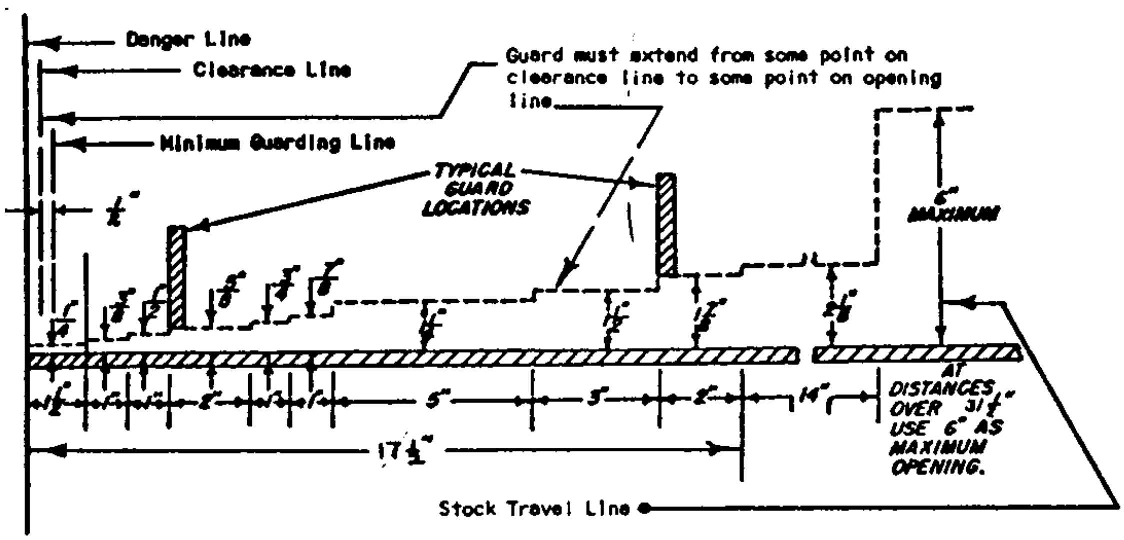
Instruction to operators. The employer shall train and instruct the operator in the safe method of work before starting work on any operation covered by this section. The employer shall insure by adequate supervision that correct operating procedures are being followed.

1910.217(f)(3)

Work area. The employer shall provide clearance between machines so that movement of one operator will not interfere with the work of another. Ample room for cleaning machines, handling material, work pieces, and scrap shall also be provided. All surrounding floors shall be kept in good condition and free from obstructions, grease, oil, and water.

1910.217(f)(4)

Overloading. The employer shall operate his presses within the tonnage and attachment weight ratings specified by the manufacturer.



Explanation of above diagram:

Tve diagram:

This diagram shows the accepted safe openings between the bottom edge of a guard and feed table at various distances from the danger line (point of operation).

The clearance line marks the distance required to prevent contact between guard and moving parts.

The minimum guarding line is the distance between the infeed side of the guard and the danger line which is one-half inch from the danger line.

The various openings are such that for average size hands an operator's fingers won't reach the point of operation.

After installation of point of operation guards and before a job is released for operation a check should be made to verify that the guard will prevent the operator's hands from reaching the point of operation.

Table O-10
[In inches]

Distance of opening from point Of operation hazard	Maximum width of opening
1/2 to 1 1/2	1/4
1 1/2 to 2 1/2	3/8
2 1/2 to 3 1/2..................................	1/2
3 1/2 to 5 1/2..................................	5/8
5 1/2 to 6 1/2..................................	3/4
6 1/2 to 7 1/2..................................	7/8
7 1/2 to 12 1/2................................	1 1/4
12 1/2 to 15 1/2..............................	1 1/2
15 1/2 to 17 1/2..............................	1 7/8
17 1/2 to 31 1/2..............................	2 1/8

This table shows the distances that guards shall be positioned from the danger line in accordance with the required openings.

1910.217(g)

Reports of injuries to employees operating mechanical power presses.

..1910.217(g)(1)

1910.217(g)(1)

The employer shall, within 30 days of the occurrence, report to either the Director of the Directorate of Safety Standards Programs, OSHA, U.S. Department of Labor, Washington, D.C. 20210, or the State agency administering a plan approved by the Assistant Secretary of Labor for Occupational Safety and Health, all point of operation injuries to operators or other employees. The following information shall be included in the report:

1910.217(g)(1)(i)

Employer's name, address and location of the workplace (establishment).

1910.217(g)(1)(ii)

Employee's name, injury sustained, and the task being performed (operation, set-up, maintenance, or other).

1910.217(g)(1)(iii)

Type of clutch used on the press (full revolution, part revolution, or direct drive).

1910.217(g)(1)(iv)

Type of safeguard(s) being used (two hand control, two hand trip, pull-outs, sweeps, or other). If the safeguard is not described in this section, give a complete description.

1910.217(g)(1)(v)

Cause of the accident (repeat of press, safeguard failure, removing stuck part or scrap, no safeguard provided, no safeguard in use, or other).

1910.217(g)(1)(vi)

Type of feeding (manual with hands in dies or with hands out of dies, semiautomatic, automatic, or other).

1910.217(g)(1)(vii)

Means used to actuate press stroke (foot trip, foot control, hand trip, hand control, or other).

..1910.217(g)(1)(viii)

1910.217(g)(1)(viii)

Number of operators required for the operation and the number of operators provided with controls and safeguards.

1910.217(h)

Presence sensing device initiation (PSDI).

1910.217(h)(1)

General

1910.217(h)(1)(i)

The requirements of paragraph (h) shall apply to all part revolution mechanical power presses used in the PSDI mode of operation.

1910.217(h)(1)(ii)

The relevant requirements of paragraphs (a) through (g) of this section also shall apply to all presses used in the PSDI mode of operation whether or not cross referenced in this paragraph (h). Such cross-referencing of specific requirements from paragraphs (a) through (g) of this section is intended only to enhance convenience and understanding in relating to the new provisions to the existing standard, and is not to be construed as limiting the applicability of other provisions in paragraphs (a) through (g) of this section.

1910.217(h)(1)(iii)

Full revolution mechanical power presses shall not be used in the PSDI mode of operation.

..1910.217(h)(1)(iv)

1910.217(h)(1)(iv)

Mechanical power presses with a configuration which would allow a person to enter, pass through, and become clear of the sensing field into the hazardous portion of the press shall not be used in the PSDI mode of operation.

1910.217(h)(1)(v)

The PSDI mode of operation shall be used only for normal production operations. Die-setting and maintenance procedures shall comply with paragraphs (a) through (g) of this section, and shall not be done in the PSDI mode.

1910.217(h)(2)

Brake and clutch requirements.

1910.217(h)(2)(i)

Presses with flexible steel band brakes or with mechanical linkage actuated brakes or clutches shall not be used in the PSDI mode.

1910.217(h)(2)(ii)

Brake systems on presses used in the PSDI mode shall have sufficient torque so that each average value of stopping times (Ts) for stops initiated at approximately 45 degrees, 60 degrees, and 90 degrees, respectively, of crankshaft angular position, shall not be more than 125 percent of the average value of the stopping time at the top crankshaft position. Compliance with this requirement shall be determined by using the heaviest upper die to be used on the press, and operating at the fastest press speed if there is speed selection.

..1910.217(h)(2)(iii)

1910.217(h)(2)(iii)

Where brake engagement and clutch release is effected by spring action, such springs(s) shall operate in compression on a rod or within a hole or tube, and shall be of non-interleaving design.

1910.217(h)(3)

Pneumatic systems.

1910.217(h)(3)(i)

Air valve and air pressure supply/control.

1910.217(h)(3)(i)(A)

The requirements of paragraphs (b)(7)(xiii), (b)(7)(xiv), (b)(10), (b)(12) and (c)(5)(iii) of this section apply to the pneumatic systems of machines used in the PSDI mode.

1910.217(h)(3)(i)(B)

The air supply for pneumatic clutch/brake control valves shall incorporate a filter, an air regulator, and, when necessary for proper operation, a lubricator.

1910.217(h)(3)(i)(C)

The air pressure supply for clutch/brake valves on machines used in the PSDI mode shall be regulated to pressures less than or equal to the air pressure used when making the stop time measurements required by paragraph (h)(2)(ii) of this section.

1910.217(h)(3)(ii)

Air counterbalance systems.

1910.217(h)(3)(ii)(A)

Where presses that have slide counterbalance systems are used in the PSDI mode, the counterbalance system shall also meet the requirements of paragraph (b)(9) of this section.

..1910.217(h)(3)(ii)(B)

1910.217(h)(3)(ii)(B)

Counterbalances shall be adjusted in accordance with the press manufacturer's recommendations to assure correct counterbalancing of the slide attachment (upper die) weight for all operations performed on presses used in the PSDI mode. The adjustments shall be made before performing the stopping time measurements required by paragraphs (h)(2)(ii), (h)(5)(iii), and (h)(9)(v) of this section.

1910.217(h)(4)

Flywheels and bearings. Presses whose designs incorporate flywheels running on journals on the crankshaft or back shaft, or bull gears running on journals mounted on the crankshaft, shall be inspected, lubricated, and maintained as provided in paragraph (h)(10) of this section to reduce the possibility of unintended and uncontrolled press strokes caused by bearing seizure.

1910.217(h)(5)

Brake monitoring.

1910.217(h)(5)(i)

Presses operated in the PSDI mode shall be equipped with a brake monitor that meets the requirements of paragraphs (b)(13) and (b)(14) of this section. In addition, the brake monitor shall be adjusted during installation certification to prevent successive stroking of the press if increases in stopping time cause an increase in the safety distance above that required by paragraph (h)(9)(v) of this section.

..1910.217(h)(5)(ii)

1910.217(h)(5)(ii)

Once the PSDI safety system has been certified/validated, adjustment of the brake monitor shall not be done without prior approval of the validation organization for both the brake monitor adjustment and the corresponding adjustment of the safety distance. The validation organization shall in its installation validation, state that in what circumstances, if any, the employer has advance approval for adjustment, when prior oral approval is appropriate and when prior approval must be in writing. The adjustment shall be done under the supervision of an authorized person whose qualifications include knowledge of safety distance requirements and experience with the brake system and its adjustment. When brake wear or other factors extend press stopping time beyond the limit permitted by the brake monitor, adjustment, repair, or maintenance shall be performed on the brake or other press system element that extends the stopping time.

1910.217(h)(5)(iii)

The brake monitor setting shall allow an increase of no more than 10 percent of the longest stopping time for the press, or 10 milliseconds, whichever is longer, measured at the top of the stroke.

1910.217(h)(6)

Cycle control and control systems.

1910.217(h)(6)(i)

The control system on presses used in the PSDI mode shall meet the applicable requirements of paragraphs (b)(7), (b)(8), (b)(13), and (c)(5) of this section.

1910.217(h)(6)(ii)

The control system shall incorporate a means of dynamically monitoring for decoupling of the rotary position indicating mechanism drive from the crankshaft. This monitor shall stop slide motion and prevent successive press strokes if decoupling occurs, or if the monitor itself fails.

..1910.217(h)(6)(iii)

1910.217(h)(6)(iii)

The mode selection means of paragraph (b)(1)(iii) of this section shall have at least one position for selection of the PSDI mode. Where more than one interruption of the light sensing field is used in the initiation of a stroke, either the mode selection means must have one position for each function, or a separate selection means shall be provided which becomes operable when the PSDI mode is selected.

Selection of PSDI mode and the number of interruptions/withdrawals of the light sensing field required to initiate a press cycle shall be by means capable of supervision by the employer.

1910.217(h)(6)(iv)

A PSDI set-up/reset means shall be provided which requires an overt action by the operator, in addition to PSDI mode selection, before operation of the press by means of PSDI can be started.

1910.217(h)(6)(v)

An indicator visible to the operator and readily seen by the employer shall be provided which shall clearly indicate that the system is set-up for cycling in the PSDI mode.

1910.217(h)(6)(vi)

The control system shall incorporate a timer to deactivate PSDI when the press does not stroke within the period of time set by the timer. The timer shall be manually adjustable, to a maximum time of 30 seconds. For any timer setting greater than 15 seconds, the adjustment shall be made by the use of a special tool available only to authorized persons. Following a deactivation of PSDI by the timer, the system shall make it necessary to reset the set-up/reset means in order to reactivate the PSDI mode.

..1910.217(h)(6)(vii)

1910.217(h)(6)(vii)

Reactivation of PSDI operation following deactivation of the PSDI mode from any other cause, such as activation of the red color stop control required by paragraph (b)(7)(ii) of this section, interruption of the presence sensing field, opening of an interlock, or reselection of the number of sensing field interruptions/withdrawals required to cycle the press, shall require resetting of the set-up/reset means.

1910.217(h)(6)(viii)

The control system shall incorporate an automatic means to prevent initiation or continued operation in the PSDI mode unless the press drive motor is energized in the forward direction of crankshaft rotation.

1910.217(h)(6)(ix)

The control design shall preclude any movement of the slide caused by operation of power on, power off, or selector switches, or from checks for proper operations as required by paragraph (h)(6)(xiv) of this section.

1910.217(h)(6)(x)

All components and subsystems of the control system shall be designed to operate together to provide total control system compliance with the requirements of this section.

1910.217(h)(6)(xi)

Where there is more than one operator of a press used for PSDI, each operator shall be protected by a separate, independently functioning, presence sensing device. The control system shall require that each sensing field be interrupted the selected number of times prior to initiating a stroke. Further, each operator shall be provided with a set-up/reset means that meets the requirements of paragraph (h)(6) of this section, and which must be actuated to initiate operation of the press in the PSDI mode.

..1910.217(h)(6)(xii)

1910.217(h)(6)(xii)

[Reserved]

1910.217(h)(6)(xiii)

The Control system shall incorporate interlocks for supplemental guards, if used, which will prevent stroke initiation or will stop a stroke in progress if any supplemental guard fails or is deactivated.

1910.217(h)(6)(xiv)

The control system shall perform checks for proper operation of all cycle control logic element switches and contacts at least once each cycle. Control elements shall be checked for correct status after power "on" and before the initial PSDI stroke.

1910.217(h)(6)(xv)

The control system shall have provisions for an "inch" operating means meeting the requirements of paragraph (b)(7)(iv) of this section. Die-setting shall not be done in the PSDI mode. Production shall not be done in the "inch" mode.

1910.217(h)(6)(xvi)

The control system shall permit only a single stroke per initiation command.

..1910.217(h)(6)(xvii)

1910.217(h)(6)(xvii)

Controls with internally stored programs (e.g., mechanical, electro-mechanical, or electronic) shall meet the requirements of paragraph (b)(13) of this section, and shall default to a predetermined safe condition in the event of any single failure within the system. Programmable controllers which meet the requirements for controls with internally stored programs stated above shall be permitted only if all logic elements affecting the safety system and point of operation safety are internally stored and protected in such a manner that they cannot be altered or manipulated by the user to an unsafe condition.

1910.217(h)(7)

Environmental requirements. Control components shall be selected, constructed, and connected together in such a way as to withstand expected operational and environmental stresses, at least including those outlined in Appendix A. Such stresses shall not so affect the control system as to cause unsafe operation.

1910.217(h)(8)

Safety system.

1910.217(h)(8)(i)

Mechanical power presses used in the PSDI mode shall be operated under the control of a safety system which, in addition to meeting the applicable requirements of paragraphs (b)(13) and (c)(5) and other applicable provisions of this section, shall function such that a single failure or single operating error shall not cause injury to personnel from point of operation hazards.

1910.217(h)(8)(ii)

The safety system shall be designed, constructed, and arranged as an integral total system, including all elements of the press, the controls, the safeguarding and any required supplemental safeguarding, and their interfaces with the operator and that part of the environment which has effect on the protection against point of operation hazards.

..1910.217(h)(9)

1910.217(h)(9)

Safeguarding the point of operation.

1910.217(h)(9)(i)

The point of operation of presses operated in the PSDI mode shall be safeguarded in accordance with the requirements of paragraph (c) of this section, except that the safety distance requirements of paragraph (h)(9)(v) of this section shall be used for PSDI operation.

1910.217(h)(9)(ii)

1910.217(h)(9)(ii)(A)

PSDI shall be implemented only by use of light curtain (photo- electric) presence sensing devices which meet the requirements of paragraph (c)(3)(iii)(c) of this section unless the requirements of the following paragraph have been met.

1910.217(h)(9)(ii)(B)

Alternatives to photo-electric light curtains may be used for PSDI when the employer can demonstrate, through tests and analysis by the employer or the manufacturer, that the alternative is as safe as the photo-electric light curtain, that the alternative meets the conditions of this section, has the same long term reliability as light curtains and can be integrated into the entire safety system as provided for in this section. Prior to use, both the employer and manufacturer must certify that these requirements and all the other applicable requirements of this section are met and these certifications must be validated by an OSHA-recognized third-party validation organization to meet these additional requirements and all the other applicable requirements of paragraphs (a) through (h) and Appendix A of this section. Three months prior to the operation of any alternative system, the employer must notify the OSHA Directorate of Safety Standards programs of the name of the system to be installed, the manufacturer and the OSHA-recognized third-party validation organization immediately. Upon request, the employer must make available to that office all tests and analyses for OSHA review.

..1910.217(h)(9)(iii)

1910.217(h)(9)(iii)

Individual sensing fields of presence sensing devices used to initiate strokes in the PSDI mode shall cover only one side of the press.

1910.217(h)(9)(iv)

Light curtains used for PSDI operation shall have minimum object sensitivity not to exceed one and one-fourth inches (31.75 mm). Where light curtain object sensitivity is user-adjustable, either discretely or continuously, design features shall limit the minimum object sensitivity adjustment not to exceed one and one-fourth inches (31.75 mm). Blanking of the sensing field is not permitted.

1910.217(h)(9)(v)

The safety distance (Ds) from the sensing field of the presence sensing device to the point of operation shall be greater than or equal to the distance determined by the formula:

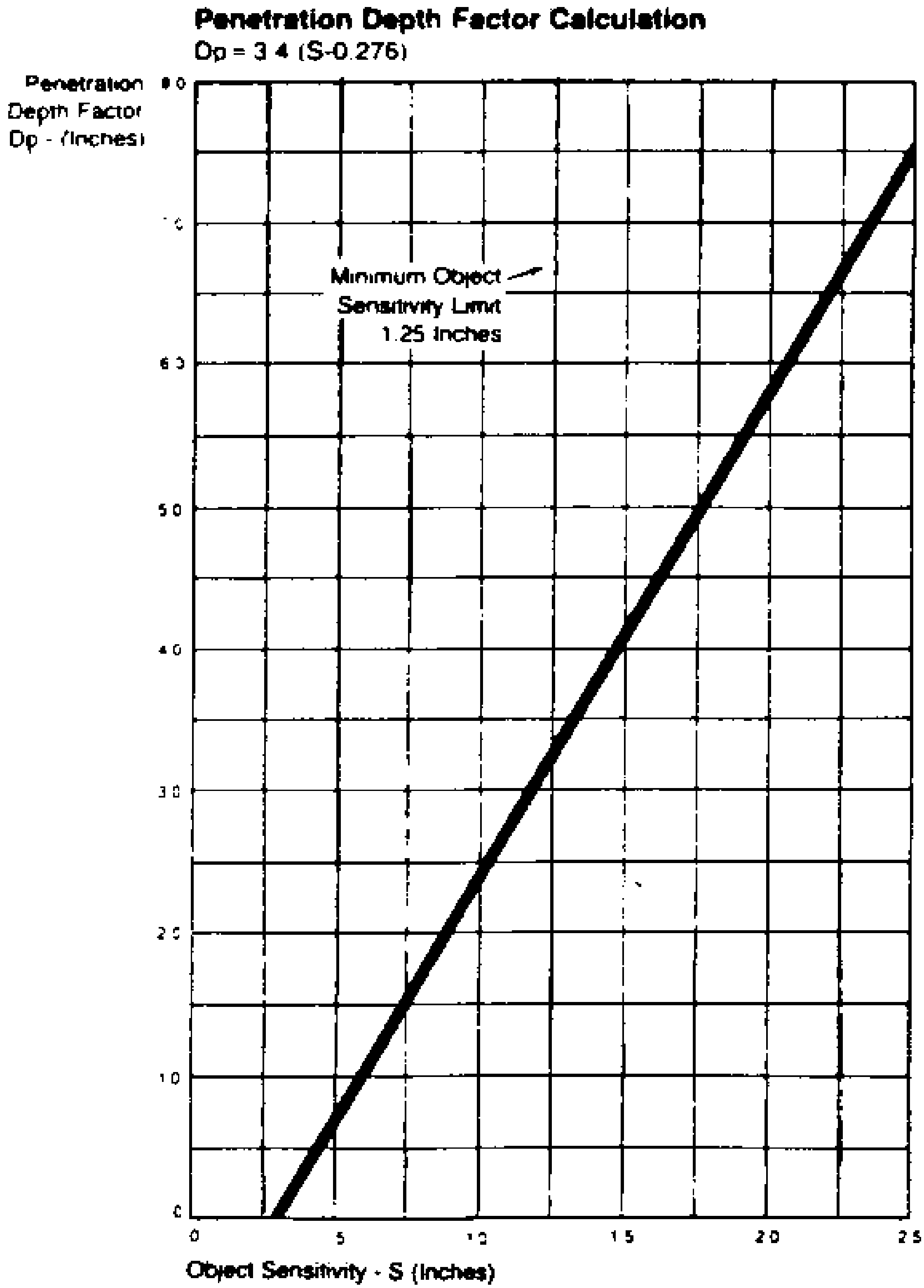
Ds = Hs X (Ts + Tp + Tr + 2Tm) + Dp

Where:

Ds = Minimum safety distance.
Hs = Hand speed constant of 63 inches per second (1.6 m/s).
Ts = Longest press stopping time, in seconds, computed by taking averages of multiple measurements at each of three positions (45 degrees, 60 degrees, and 90 degrees) of crankshaft angular position; the longest of the three averages is the stopping time to use. (Ts is defined as the sum of the kinetic energy dissipation time plus the pneumatic/magnetic/hydraulic reaction time of the clutch/brake operating mechanism(s).)
Tp = Longest presence sensing device response time, in seconds.
Tr = Longest response time, in seconds, of all interposing control elements between the presence sensing device and the clutch/brake operating mechanism(s).
Tm = Increase in the press stopping time at the top of the stroke, in seconds, allowed by the brake monitor for brake wear. The time increase allowed shall be limited to no more than 10 percent of the

longest press stopping time measured at the top of the stroke, or 10 milliseconds, whichever is longer.

Dp = Penetration depth factor, required to provide for possible penetration through the presence sensing field by fingers or hand before detection occurs. The penetration depth factor shall be determined from Graph h-1 using the minimum object sensitivity size.



Penetration Depth Factor Calculation
Dp = 3.4 (S-0.276)
Penetration Depth Factor Dp - (Inches)
Minimum Object Sensitivity Limit 1.25 Inches
Object Sensitivity - S (Inches)

1910.217(h)(9)(vi)

The presence sensing device location shall either be set at each tool change and set-up to provide at least the minimum safety distance, or fixed in location to provide a safety distance greater than or equal to the minimum safety distance for all tooling set-ups which are to be used on that press.

1910.217(h)(9)(vii)

Where presence sensing device location is adjustable, adjustment shall require the use of a special tool available only to authorized persons.

..1910.217(h)(9)(viii)

1910.217(h)(9)(viii)

Supplemental safeguarding shall be used to protect all areas of access to the point of operation which are unprotected by the PSDI presence sensing device. Such supplemental safeguarding shall consist of either additional light curtain (photo-electric) presence sensing devices or other types of guards which meet the requirements of paragraphs (c) and (h) of this section.

1910.217(h)(9)(viii)(A)

Presence sensing devices used as supplemental safeguarding shall not initiate a press stroke, and shall conform to the requirements of paragraph (c)(3)(iii) and other applicable provisions of this section, except that the safety distance shall comply with paragraph (h)(9)(v) of this section.

1910.217(h)(9)(viii)(B)

Guards used as supplemental safeguarding shall conform to the design, construction and application requirements of paragraph (c)(2) of this section, and shall be interlocked with the press control to prevent press PSDI operation if the guard fails, is removed, or is out of position.

1910.217(h)(9)(ix)

Barriers shall be fixed to the press frame or bolster to prevent personnel from passing completely through the sensing field, where safety distance or press configuration is such that personnel could pass through the PSDI presence sensing field and assume a position where the point of operation could be accessed without detection by the PSDI presence sensing device. As an alternative, supplemental presence sensing devices used only in the safeguard mode may be provided. If used, these devices shall be located so as to detect all operator locations and positions not detected by the PSDI sensing field, and shall prevent stroking or stop a stroke in process when any supplemental sensing field(s) are interrupted.

..1910.217(h)(9)(x)

1910.217(h)(9)(x)

Hand tools. Where tools are used for feeding, removal of scrap, lubrication of parts, or removal of parts that stick on the die in PSDI operations:

1910.217(h)(9)(x)(A)

The minimum diameter of the tool handle extension shall be greater than the minimum object sensitivity of the presence sensing device(s) used to initiate press strokes; or

1910.217(h)(9)(x)(B)

The length of the hand tool shall be such as to ensure that the operator's hand will be detected for any safety distance required by the press set-ups.

1910.217(h)(10)

Inspection and maintenance.

1910.217(h)(10)(i)

Any press equipped with presence sensing devices for use in PSDI, or for supplemental safeguarding on presses used in the PSDI mode, shall be equipped with a test rod of diameter specified by the presence sensing device manufacturer to represent the minimum object sensitivity of the sensing field. Instructions for use of the test rod shall be noted on a label affixed to the presence sensing device.

1910.217(h)(10)(ii)

The following checks shall be made at the beginning of each shift and whenever a die change is made.

..1910.217(h)(10)(ii)(A)

1910.217(h)(10)(ii)(A)

A check shall be performed using the test rod according to the presence sensing device manufacturer's instructions to determine that the presence sensing device used for PSDI is operational.

1910.217(h)(10)(ii)(B)

The safety distance shall be checked for compliance with (h)(9)(v) of this section.

1910.217(h)(10)(ii)(C)

A check shall be made to determine that all supplemental safeguarding is in place. Where presence sensing devices are used for supplemental safeguarding, a check for proper operation shall be performed using the test rod according to the presence sensing device manufacturer's instructions.

1910.217(h)(10)(ii)(D)

A check shall be made to assure that the barriers and/or supplemental presence sensing devices required by paragraph (h)(9)(ix) of this section are operating properly.

1910.217(h)(10)(ii)(E)

A system or visual check shall be made to verify correct counterbalance adjustment for die weight according to the press manufacturer's instructions, when a press is equipped with a slide counterbalance system.

..1910.217(h)(10)(iii)

1910.217(h)(10)(iii)

When presses used in the PSDI mode have flywheel or bullgear running on crankshaft mounted journals and bearings, or a flywheel mounted on back shaft journals and bearings, periodic inspections following the press manufacturer's recommendations shall be made to ascertain that bearings are in good working order, and that automatic lubrication systems for these bearings (if automatic lubrication is provided) are supplying proper lubrication. On presses with provision for manual lubrication of flywheel or bullgear bearings, lubrication shall be provided according to the press manufacturer's recommendations.

1910.217(h)(10)(iv)

Periodic inspections of clutch and brake mechanisms shall be performed to assure they are in proper operating condition. The press manufacturer's recommendations shall be followed.

1910.217(h)(10)(v)

When any check of the press, including those performed in accordance with the requirements of paragraphs (h)(10)(ii), (iii) or (iv) of this section, reveals a condition of noncompliance, improper adjustment, or failure, the press shall not be operated until the condition has been corrected by adjustment, replacement, or repair.

1910.217(h)(10)(vi)

It shall be the responsibility of the employer to ensure the competence of personnel caring for, inspecting, and maintaining power presses equipped for PSDI operation, through initial and periodic training.

1910.217(h)(11)

Safety system certification/validation.

1910.217(h)(11)(i)

Prior to the initial use of any mechanical press in the PSDI mode, two sets of certification and validation are required:

..1910.217(h)(11)(i)(A)

1910.217(h)(11)(i)(A)

The design of the safety system required for the use of a press in the PSDI mode shall be certified and validated prior to installation. The manufacturer's certification shall be validated by an OSHA-recognized third-party validation organization to meet all applicable requirements of paragraphs (a) through (h) and Appendix A of this section.

1910.217(h)(11)(i)(B)

Alter a press has been equipped with a safety system whose design has been certified and validated in accordance with paragraph (h)(11)(i) of this section, the safety system installation shall be certified by the employer, and then shall be validated by an OSHA-recognized third-party validation organization to meet all applicable requirements of paragraphs (a) through (h) and Appendix A of this section.

1910.217(h)(11)(ii)

At least annually thereafter, the safety system on a mechanical power press used in the PSDI mode shall be recertified by the employer and revalidated by an OSHA-recognized third-party validation organization to meet all applicable requirements of paragraphs (a) through (h) and Appendix A of this section. Any press whose safety system has not been recertified and revalidated within the preceding 12 months shall be removed from service in the PSDI mode until the safety system is recertified and revalidated.

..1910.217(h)(11)(iii)

1910.217(h)(11)(iii)

A label shall be affixed to the press as part of each installation certification/validation and the most recent recertification/revalidation. The label shall indicate the press serial number, the minimum safety distance (Ds) required by paragraph (h)(9)(v) of this section, the fulfillment of design certification/validation, the employer's signed certification, the identification of the OSHA-recognized third-party validation organization, its signed validation, and the date the certification/validation and recertification/revalidation are issued.

1910.217(h)(11)(iv)

Records of the installation certification and validation and the most recent recertification and revalidation shall be maintained for each safety system equipped press by the employer as long as the press is in use. The records shall include the manufacture and model number of each component and subsystem, the calculations of the safety distance as required by paragraph (h)(9)(v) of this section, and the stopping time measurements required by paragraph (h)(2)(ii) of this section. The most recent records shall be made available to OSHA upon request.

1910.217(h)(11)(v)

The employer shall notify the OSHA-recognized third-party validation organization within five days whenever a component or a subsystem of the safety system fails or modifications are made which may affect the safety of the system. The failure of a critical component shall necessitate the removal of the safety system from service until it is recertified and revalidated, except recertification by the employer without revalidation is permitted when a non-critical component or subsystem is replaced by one of the same manufacture and design as the original, or determined by the third-party validation organization to be equivalent by similarity analysis, as set forth in Appendix A.

..1910.217(h)(11)(vi)

1910.217(h)(11)(vi)

The employer shall notify the OSHA-recognized third-party validation organization within five days of the occurrence of any point of operation injury while a press is used in the PSDI mode. This is in addition to the report of injury required by paragraph (g) of this section; however, a copy of that report may be used for this purpose.

1910.217(h)(12)

Die setting and work set-up.

1910.217(h)(12)(i)

Die setting on presses used in the PSDI mode shall be performed in accordance with paragraphs (d) and (h) of this section.

1910.217(h)(12)(ii)

The PSDI mode shall not be used for die setting or set-up. An alternative manual cycle initiation and control means shall be supplied for use in die setting which meets the requirements of paragraph (b)(7) of this section.

1910.217(h)(12)(iii)

Following a die change, the safety distance, the proper application of supplemental safeguarding, and the slide counterbalance adjustment (if the press is equipped with a counterbalance) shall be checked and maintained by authorized persons whose qualifications include knowledge of the safety distance, supplemental safe-guarding requirements, and the manufacturer's specifications for counterbalance adjustment. Adjustment of the location of the PSDI presence sensing device shall require use of a special tool available only to the authorized persons.

..1910.217(h)(13)

1910.217(h)(13)

Operator training.

1910.217(h)(13)(i)

The operator training required by paragraph (f)(2) of this section shall be provided to the employee before the employee initially operates the press and as needed to maintain competence, but not less than annually thereafter. It shall include instruction relative to the following items for presses used in the PSDI mode.

1910.217(h)(13)(i)(A)

The manufacturer's recommended test procedures for checking operation of the presence sensing device. This shall include the use of the test rod required by paragraph (h)(10)(i) of this section.

1910.217(h)(13)(i)(B)

The safety distance required.

1910.217(h)(13)(i)(C)

The operation, function and performance of the PSDI mode.

1910.217(h)(13)(i)(D)

The requirements for hand tools that may be used in the PSDI mode.

1910.217(h)(13)(i)(E)

The severe consequences that can result if he or she attempts to circumvent or by-pass any of the safe-guard or operating functions of the PSDI system.

1910.217(h)(13)(ii)

The employer shall certify that employees have been trained by preparing a certification record which includes the identity of the person trained, the signature of the employer or the person who conducted the training, and the date the training was completed. The certification record shall be prepared at the completion of training and shall be maintained on file for the duration of the employee's employment. The certification record shall be made available upon request to the Assistant Secretary for Occupational Safety and Health.

[39 FR 32502, June 27, 1974. as amended at 39 FR 41846, Dec. 23, 1974; 40 FR 3982, Jan. 27, 1975; 43 FR 49750, Oct. 24, 1978; 45 FR 8594, Feb. 8. 1980; 49 FR 18295, Apr. 30, 1984; 51 FR 34561, Sept. 29, 1986; 53 FR 8353, Mar. 14, 1988; 54 FR 24333, June 7, 1989; 61 FR 5507, Feb. 13, 1996; 61 FR 9227, March 7, 1996]

Regulations (Standards - 29 CFR)
Mandatory requirements for certification/validation of safety systems for presence sensing device initiation of mechanical power presses - 1910.217 App A

• **Part Number:**	1910
• **Part Title:**	Occupational Safety and Health Standards
• **Subpart**:	O
• **Subpart Title:**	Machinery and Machine Guarding
• **Standard Number:**	1910.217 App A
• **Title:**	Mandatory requirements for certification/validation of safety systems for presence sensing device initiation of mechanical power presses

Purpose

The purpose of the certification/validation of safety systems for presence sensing device initiation (PSDI) of mechanical power presses is to ensure that the safety systems are designed, installed, and maintained in accordance with all applicable requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A.

General

The certification/validation process shall utilize an independent third-party validation organization recognized by OSHA in accordance with the requirements specified in Appendix C of this section.

While the employer is responsible for assuring that the certification/validation requirements In 1910.217(h)(11) are fulfilled, the design certification of PSDI safety systems may be initiated by manufacturers, employers, and/or their representatives. The term "manufacturers" refers to the manufacturer of any of the components of the safety system. An employer who assembles a PSDI safety system would be a manufacturer as well as employer for purposes of this standard and Appendix.

The certification/validation process includes two stages. For design certification, in the first stage, the manufacturer (which can be an employer) certifies that the PSDI safety system meets the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A, based on appropriate design criteria and tests. In the second stage. the OSHA-recognized third-party validation organization validates that the PSDI safety system meets the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A and the manufacturer's certification by reviewing the manufacturer's design and test data and performing any additional reviews required by this standard or which it believes appropriate.

For installation certification/validation and annual recertification/revalidation, in the first stage the employer certifies or recertifies that the employer is installing or utilizing a PSDI safety system validated as meeting the design requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A by an OSHA-recognized third-party validation organization and that the installation, operation and maintenance meet the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A. In the second stage. the OSHA-recognized third-party validation organization validates or revalidates that the PSDI safety system installation meets the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A and the employer's certification, by reviewing that the PSDI safety system has been certified; the employer's certification, designs and tests, if any; the installation, operation, maintenance and training; and by performing any additional tests and reviews which the validation organization believes is necessary.

Summary

The certification/validation of safety systems for PSDI shall consider the press, controls, safeguards, operator, and environment as an integrated system which shall comply with all of the requirements in 29 CFR 1910.217 (a) through (h) and this Appendix A. The certification/validation process shall verify that the safety system complies with the OSHA safety requirements as follows:

A. Design Certification/Validation

1. The major parts, components and subsystems used shall be defined by part number or serial number, as appropriate, and by manufacturer to establish the configuration of the system.

2. The identified parts, components and subsystems shall be certified by the manufacturer to be able to withstand the functional and operational environments of the PSDI safety system.

3. The total system design shall be certified by the manufacturer as complying with all requirements in 29 CFR 1910.217 (a) through (h) and this Appendix A.

4. The third-party validation organization shall validate the manufacturer's certification under paragraphs 2 and 3.

B. Installation Certification/Validation

1. The employer shall certify that the PSDI safety system has been design certified and validated, that the installation meets the operational and environmental requirements specified by the manufacturer, that the installation drawings are accurate, and that the installation meets the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A. (The operational and installation requirements of the PSDI safety system may vary for different applications.)

2. The third-party validation organization shall validate the employer's certifications that the PSDI safety system is design certified and validated, that the installation meets the installation and environmental requirements specified by the manufacturer, and that the installation meets the requirements of 29 CFR 1910.217 (a) through (h) and this Appendix A.

C. Recertification/Revalidation

1. The PSDI safety system shall remain under certification/validation for the shorter of one year or until the system hardware is changed, modified or refurbished, or operating conditions are changed (including environmental, application or facility changes), or a failure of a critical component has occurred.

2. Annually, or after a change specified in paragraph 1., the employer shall inspect and recertify the installation as meeting the requirements set forth under B., Installation Certification/Validation.

3. The third-party validation organization, annually or after a change specified in paragraph 1., shall validate the employer's certification that the requirements of paragraph B., Installation Certification/Validation have been met.

(NOTE: Such changes in operational conditions as die changes or press relocations not involving disassembly or revision to the safety system would not require recertification/revalidation.)

Certification/Validation Requirements

A. General Design Certification/Validation Requirements

1. Certification/Validation Program Requirements. The manufacturer shall certify and the OSHA-recognized third-party validation organization shall validate that:

(a) The design of components, subsystems, software and assemblies meets OSHA performance requirements and are ready for the intended use; and

(b) The performance of combined subsystems meets OSHA's operational requirements.

2. Certification/Validation Program Level of Risk Evaluation Requirements. The manufacturer shall evaluate and certify, and the OSHA-recognized third-party validation organization shall validate, the design and operation of the safety system by determining conformance with the following:

a. The safety system shall have the ability to sustain a single failure or a single operating error and not cause injury to personnel from point of operation hazards. Acceptable design features shall demonstrate, in the following order or precedence, that:

(1) No single failure points may cause injury; or

(2) Redundancy, and comparison and/or diagnostic checking, exist for the critical items that may cause injury, and the electrical, electronic, electromechanical and mechanical parts and components are selected so that they can withstand operational and external environments. The safety factor and/or derated percentage shall be specifically noted and complied with.

b. The manufacturer shall design, evaluate, test and certify, and the third-party validation organization shall evaluate and validate, that the PSDI safety system meets appropriate requirements in the following areas.

(1) Environmental Limits:

(a) Temperature

(b) Relative humidity

(c) Vibration

(d) Fluid compatibility with other materials

(2) Design Limits

(a) Power requirements

(b) Power transient tolerances

(c) Compatibility of materials used

(d) Material stress tolerances and limits

(e) Stability to long term power fluctuations

(f) Sensitivity to signal acquisition

(g) Repeatability of measured parameter without inadvertent initiation of a press stroke

(h) Operational life of components in cycles, hours, or both

(i) Electromagnetic tolerance to:

(1) Specific operational wave lengths; and

(2) Externally generated wave lengths

(3) New Design Certification/Validation. Design certification/validation for a new safety system, i.e., a new design or new integration of specifically identified components and subsystems, would entail a single certification/validation which would be applicable to all identical safety systems. It would not be necessary to repeat the tests on individual safety systems of the same manufacture or design. Nor would it be necessary to repeat these tests in the case of modifications where determined by the manufacturer and validated by the third-party validation organization to be equivalent by similarity analysis. Minor modifications not affecting the safety of the system may be made by the manufacturer without revalidation.

Substantial modifications would require testing as a new safety system, as deemed necessary by the validation organization.

B. Additional Detailed Design Certification/Validation Requirements

1. General. The manufacturer or the manufacturer's representative shall certify to and submit to an OSHA-recognized third-party validation

organization the documentation necessary to demonstrate that the PSDI safety system design is in full compliance with the requirements of 29 CFR 1910.217(a)-(h) and this Appendix A, as applicable, by means of analysis, tests, or combination of both, establishing that the following additional certification/validation requirements are fulfilled.

2. Reaction Times. For the purpose of demonstrating compliance with the reaction time required by 1910.217(h), the tests shall use the following definitions and requirements:

a. "Reaction time" means the time, in seconds, it takes the signal, required to activate/deactivate the system, to travel through the system, measured from the time of signal initiation to the time the function being measured is completed.

b. "Full stop" or "No movement of the slide or ram" means when the crankshaft rotation has slowed to two or less revolutions per minute, just before stopping completely.

c. "Function completion" means for, electrical, electromechanical and electronic devices, when the circuit produces a change of state in the output element of the device.

d. When the change of state is motion, the measurement shall be made at the completion of the motion.

e. The generation of the test signal introduced into the system for measuring reaction time shall be such that the Initiation time can be established with an error of less than 0.5 percent of the reaction time measured.

f. The instrument used to measure reaction time shall be calibrated to be accurate to within 0.001 second.

3. Compliance with 1910.21 7(h)(2)(ii). For compliance with these requirements, the average value of the stopping time, Ts, shall be the arithmetic mean of at least 25 stops for each stop angle initiation measured with the brake and/or clutch unused, 50 percent worn, and 90 percent worn. The recommendations of the brake system manufacturer shall be used to simulate or estimate the brake wear. The manufacturer's recommended minimum lining depth shall be identified and documented, and an evaluation made that the minimum depth will not be exceeded before the next (annual) recertification/revalidation. A correlation of the brake and/or clutch degradation based on the above tests and/or estimates shall be made and documented. The results shall document the conditions under which the brake and/or clutch will and will not comply with the

requirement. Based upon this determination, a scale shall be developed to indicate the allowable 10 percent of the stopping time at the top of the stroke for slide or ram overtravel due to brake wear. The scale shall be marked to indicate that brake adjustment and/or replacement is required. The explanation and use of the scale shall be documented.

The test specification and procedure shall be submitted to the validation organization for review and validation prior to the test. The validation organization representative shall witness at least one set of tests.

4. Compliance with 1910.217(h)(5)(iii) and (h)(9)(v). Each reaction time required to calculate the Safety Distance, including the brake monitor setting, shall be documented in separate reaction time tests. These tests shall specify the acceptable tolerance band sufficient to assure that tolerance build-up will not render the safety distances unsafe.

a. Integrated test of the press fully equipped to operate in the PSDI mode shall be conducted to establish the total system reaction time.

b. Brakes which are the adjustable type shall be adjusted properly before the test.

5. Compliance with 1910.21 7(h)(2)(iii).

a. Prior to conducting the brake system test required by paragraph (h)(2)(ii), a visual check shall be made of the springs. The visual check shall include a determination that the spring housing or rod does not show damage sufficient to degrade the structural integrity of the unit, and the spring does not show any tendency to interleave.

b. Any detected broken or unserviceable springs shall be replaced before the test is conducted. The test shall be considered successful If the stopping time remains within that which is determined by paragraph (h)(9)(v) for the safety distance setting. If the increase in press stopping time exceeds the brake monitor setting limit defined in paragraph (h)(5)(iii), the test shall be considered unsuccessful, and the cause of the excessive stopping time shall be investigated. It shall be ascertained that the springs have not been broken and that they are functioning properly.

6. Compliance with 1910.21 7(h)(7).

a. Tests which are conducted by the manufacturers of electrical components to establish stress, life, temperature and loading limits must be tests which are in compliance with the provisions of the National Electrical Code.

b. Electrical and/or electronic cards or boards assembled with discreet components shall be considered a subsystem and shall require separate testing that the subsystems do not degrade in any of the following conditions:

(1) Ambient temperature variation from -20 deg. C to +50 deg. C.

(2) Ambient relative humidity of 99 percent.

(3) Vibration of 45G for one millisecond per stroke when the item is to be mounted on the press frame.

(4) Electromagnetic interference at the same wavelengths used for the radiation sensing field, at the power line frequency fundamental and harmonics, and also from outogenous radiation due to system switching.

(5) Electrical power supply variations of + or - 15 percent.

c. The manufacturer shall specify the test requirements and procedures from existing consensus tests in compliance with the provisions of the National Electrical Code.

d. Tests designed by the manufacturer shall be made available upon request to the validation organization. The validation organization representative shall witness at least one set of each of these tests.

7. Compliance with 1910.21 7(h)(9)(iv).

a. The manufacturer shall design a test to demonstrate that the prescribed minimum object sensitivity of the presence sensing device is met.

b. The test specifications and procedures shall be made available upon request to the validation organization.

8. Compliance with 1910.217(h)(9)(x).

a. The manufacturer shall design a test(s) to establish the hand tool extension diameters allowed for variations in minimum object sensitivity response.

b. The test(s) shall document the range of object diameter sizes which will produce both single and double break conditions.

c The test(s) specifications and procedures shall be made available upon request to the validation organization.

9. Integrated Tests Certification/Validation

a. The manufacturer shall design a set of integrated tests to demonstrate compliance with the following requirements:

Sections 1910.217(h)(6) (ii); (iii); (iv); (v); (vi); (vii); (viii); (ix); (xi); (xii); (xiii); (xiv); (xv); and (xvii).

b. The integrated test specifications and procedures shall be made available to the validation organization.

10. Analysis.

a. The manufacturer shall submit to the validation organization the technical analysis such as Hazard Analysis, Failure Mode and Effect Analysis, Stress Analysis, Component and Material Selection Analysis, Fluid Compatibility, and/or other analyses which may be necessary to demonstrate, compliance with the following requirements:

Sections 1910.217(h)(8) (i) and (ii); (h)(2)(ii) and (iii); (h)(3)(i) (A) and (C), and (ii); (h)(5) (i), (ii) and (iii); (h)(6) (i), (iii), (iv), (vi), (vii), (viii), (ix), (x), (xi), (xiii), (xiv), (xv), (xvi), and (xvii); (h)(7) (i) and (ii); (h)(9) (iv), (v), (viii), (ix) and (x); (h)(10) (i) and (ii).

11. Types of Tests Acceptable for Certification/Validation.

a. Test results obtained from development testing may be used to certify/validate the design.

b. The test results shall provide the engineering data necessary to establish confidence that the hardware and software will meet specifications, the manufacturing process has adequate quality control and the data acquired was used to establish processes, procedures, and test levels supporting subsequent hardware design, production, installation and maintenance.

12. Validation for Design Certification/Validation. If, after review of all documentation, tests, analyses, manufacturer's certifications, and any additional tests which the third-party validation organization believes are necessary, the third-party validation organization determines that the PSDI safety system is in full compliance with the applicable requirements of 29 CFR 1910.217(a) through (h) and this Appendix A, it shall validate the manufacturer's certification that it so meets the stated requirements.

C. Installation Certification/Validation Requirements

1. The employer shall evaluate and test the PSDI system installation, shall submit to the OSHA-recognized third-party validation organization the necessary supporting documentation, and shall certify that the requirements of 1910.217(a) through (h) and this Appendix A have been met and that the installation is proper.

2. The OSHA-recognized third-party validation organization shall conduct tests, and/or review and evaluate the employer's installation tests, documentation and representations. If it so determines, it shall validate the employer's certification that the PSDI safety system is in full conformance with all requirements of 29 CFR 1910.217(a) through (h) and this Appendix A.

D. Recertification/Revalidation Requirements

1. A PSDI safety system which has received installation certification/validation shall undergo recertification/revalidation the earlier of:

a. Each time the systems hardware is significantly changed, modified, or refurbished;

b. Each time the operational conditions are significantly changed (including environmental, application or facility changes, but excluding such changes as die changes or press relocations not involving revision to the safety system);

c. When a failure of a significant component has occurred or a change has been made which may affect safety; or

d. When one year has elapsed since the installation certification/validation or the last recertification/revalidation.

2. Conduct or recertification/revalidation. The employer shall evaluate and test the PSDI safety system installation, shall submit to the OSHA-recognized third-party validation organization the necessary supporting documentation, and shall recertify that the requirements of 1910.217(a) through (h) and this Appendix are being met. The documentation shall include, but not be limited to, the following items:

a. Demonstration of a thorough inspection of the entire press and PSDI safety system to ascertain that the installation, components and safeguarding have not been changed, modified or tampered with since the installation certification/validation or last recertification/revalidation was made.

b. Demonstrations that such adjustments as may be needed (such as to the brake monitor setting) have been accomplished with proper changes made in the records and on such notices as are located on the press and safety system.

c. Demonstration that review has been made of the reports covering the design certification/validation, the installation certification/validation, and all recertification/revalidations, in order to detect any degradation to an unsafe condition, and that necessary changes have been made to restore the safety system to previous certification/validation levels.

3. The OSHA-recognized third-party validation organization shall conduct tests, and/or review and evaluate the employer's installation, tests, documentation and representations. If It so determines, It shall revalidate the employer's recertification that the PSDI system is in full conformance with all requirements of 29 CFR 1910.217(a) through (h) and this Appendix A.

[53 FR 8358, Mar. 14, 1988]

Regulations (Standards - 29 CFR)
Nonmandatory guidelines for certification/validation of safety systems for presence sensing device initiation of mechanical power presses - 1910.217 App B

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.217 App B
- **Title:** Nonmandatory guidelines for certification/validation of safety systems for presence sensing device initiation of mechanical power presses

Objectives

This Appendix provides employers, manufacturers, and their representatives, with nonmandatory guidelines for use in developing certification documents. Employers and manufacturers are encouraged to recommend other approaches if there is a potential for improving safety and reducing cost. The guidelines apply to certification/validation activity from design evaluation through the completion of the installation test and the annual recertification/revalidation tests.

General Guidelines

A. The certification/validation process should confirm that hazards identified by hazard analysis, (HA), failure mode effect analysis (FMEA), and other system analyses have been eliminated by design or reduced to an acceptable level through the use of appropriate design features, safety devices, warning devices, or special procedures. The certification/validation process should also confirm that residual hazards identified by operational analysis are addressed by warning, labeling safety instructions or other appropriate means.

B. The objective of the certification/validation program is to demonstrate and document that the system satisfies specification and operational requirements for safe operations.

Quality Control

The safety attributes of a certified/validated PSDI safety system are more likely to be maintained if the quality of the system and its parts, components and subsystem is consistently controlled. Each manufacturer supplying parts, components, subsystems, and assemblies needs to maintain the quality of the product, and each employer needs to maintain the system in a non-degraded condition.

Analysis Guidelines

A. Certification/validation of hardware design below the system level should be accomplished by test and/or analysis.

B. Analytical methods may be used in lieu of, in combination with, or in support of tests to satisfy specification requirements.

C. Analyses may be used for certification/validation when existing data are available or when test is not feasible.

D. Similarity analysis may be used in lieu of tests where it can be shown that the article is similar in design, manufacturing process, and quality control to another article that was previously certified/validated in accordance with equivalent or more stringent criteria. If previous design, history and application are considered to be similar, but not equal to or more exacting than earlier experiences, the additional or partial certification/validation tests should concentrate on the areas of changed or increased requirements.

Analysis Reports

The analysis reports should identify: (1) The basis for the analysis; (2) the hardware or software items analyzed; (3) conclusions; (4) safety factors; and (5) limit of the analysis. The assumptions made during the analysis should be clearly stated and a description of the effects of these assumptions on the conclusions and limits should be included.

Certification/validation by similarity analysis reports should identify, in addition to the above, application of the part, component or subsystem for which certification/validation is being sought as well as data from previous usage establishing adequacy of the item. Similarity analysis should not be accepted when the internal and external stresses on the item being certified/validated are not defined.

Usage experience should also include failure data supporting adequacy of the design.

[53 FR 8360, Mar. 14, 1988]

Regulations (Standards - 29 CFR)
Mandatory requirements for OSHA recognition of third-party validation organizations for the PSDI standard - 1910.217 App C

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.217 App C
- **Title:** Mandatory requirements for OSHA recognition of third-party validation organizations for the PSDI standard

This Appendix prescribes mandatory requirements and procedures for OSHA recognition of third-party validation organizations to validate employer and manufacturer certifications that their equipment and practices meet the requirements of the PSDI standard. The scope of the Appendix includes the three categories of certification/validation required by the PSDI standard: Design Certification/Validation, Installation Certification/Validation, and Annual Recertification/Revalidation.

If further detailing of these provisions will assist the validation organization or OSHA in this activity, this detailing will be done through appropriate OSHA Program Directives.

I. Procedure for OSHA Recognition of Validation Organizations

A. Applications

1. Eligibility. a. Any person or organization considering itself capable of conducting a PSDI-related third-party validation function may apply for OSHA recognition.

b. However, in determining eligibility for a foreign-based third-party validation organization, OSHA shall take into consideration whether there is reciprocity of treatment by the foreign government after consultation with relevant U.S. government agencies.

2. Content of application. a. The application shall identify the scope of the validation activity for which the applicant wishes to be recognized, based on one of the following alternatives:

(1) Design Certification/Validation, Installation Certification/Validation, and Annual Recertification/Revalidation;

(2) Design Certification/Validation only; or

(3) Installation/Certification/Validation and Annual Recertification/Revalidation.

b. The application shall provide information demonstrating that it and any validating laboratory utilized meet the qualifications set forth in section II of this Appendix.

c. The applicant shall provide information demonstrating that it and any validating laboratory utilized meet the program requirements set forth in section III of this Appendix.

d. The applicant shall identify the test methods it or the validating laboratory will use to test or judge the components and operations of the PSDI safety system required to be tested by the PSDI standard and Appendix A, and shall specify the reasons the test methods are appropriate.

e. The applicant may include whatever enclosures, attachments, or exhibits the applicant deems appropriate. The application need not be submitted on a Federal form.

f. The applicant shall certify that the information submitted is accurate.

3. Filing office location. The application shall be filed with: PSDI Certification/Validation Program, Office of Variance Determination, Occupational Safety and Health Administration, U.S. Department of Labor, Room N3653, 200 Constitution Avenue, NW., Washington, DC 20210.

4. Amendments and withdrawals. a. An application may be revised by an applicant at any time prior to the completion of the final staff recommendation.

b. An application may be withdrawn by an applicant, without prejudice, at any time prior to the final decision bY the Assistant Secretary in paragraph I.B.8.b.(4) of this Appendix.

B. Review and Decision Process

1. Acceptance and field inspection. All applications submitted will be accepted by OSHA, and their receipt acknowledged in writing. After receipt of an application, OSHA may request additional information if it believes information relevant to the requirements for recognition have been omitted. OSHA may inspect the facilities of the third-party validation organization and any validating laboratory, and while there shall review any additional documentation underlying the application. A report shall be

made of each field inspection.

2. Requirements for recognition. The requirements for OSHA recognition of a third-party validation organization for the PSDI standard are that the program has fulfilled the requirements of section II of this Appendix for qualifications and of section III of this Appendix for program requirements, and the program has identified appropriate test and analysis methods to meet the requirements of the PSDI standard and Appendix A.

3. Preliminary approval. If, after review of the application, any additional information, and the inspection report, the applicant and any validating laboratory appear to have met the requirements for recognition, a written recommendation shall be submitted by the responsible OSHA personnel to the Assistant Secretary to approve the application with a supporting explanation.

4. Preliminary disapproval. If, after review of the application, additional information, and inspection report, the applicant does not appear to have met the requirements for recognition, the Director of the PSDI certification/validation program shall notify the applicant in writing, listing the specific requirements of this Appendix which the applicant has not met, and the reasons.

5. Revision of application. After receipt of a notification of preliminary disapproval the applicant may submit a revised application for further review by OSHA pursuant to subsection I.B. of this Appendix or any request that the original application be submitted to the Assistant Secretary with a statement of reasons supplied by the applicant as to why the application should be approved.

6. Preliminary decision by Assistant Secretary. a. The Assistant Secretary, or a special designee for this purpose, will make a preliminary decision whether the applicant has met the requirements for recognition based on the completed application file and the written staff recommendation, as well as the statement of reasons by the applicant if there is a recommendation of disapproval.

b. This preliminary decision will be sent to the applicant and subsequently published in the FEDERAL REGISTER.

7. Public review and comment period. a. The FEDERAL REGISTER notice of preliminary decision will provide a period of not less than 60 calendar days for the written comments on the applicant's fulfillment of the requirements for recognition. The application, supporting documents, staff recommendation, statement of applicant's reasons, and any comments received, will be available for public inspection in the OSHA Docket

Office.

b. If the preliminary decision is in favor of recognition, a member of the public, or if the preliminary decision is against recognition, the applicant may request a public hearing by the close of the comment period, if it supplies detailed reasons and evidence challenging the basis of the Assistant Secretary's preliminary decision and justifying the need for a public hearing to bring out evidence which could not be effectively supplied through written submissions.

8. Final decision by Assistant Secretary - a. Without hearing. If there are no valid requests for a hearing, based on the application, supporting documents, staff recommendation, evidence and public comment, the Assistant Secretary shall issue the final decision (including reasons) of the Department of Labor on whether the applicant has demonstrated by a preponderance of the evidence that it meets the requirements for recognition.

b. After hearing. If there is a valid request for a hearing pursuant to paragraph I.B.7.b. of this Appendix, the following procedures will be used:

(1) The Assistant Secretary will issue a notice of hearing before an administrative law judge of the Department of Labor pursuant to the rules specified in 29 CFR Part 1905, Subpart C.

(2) After the hearing, pursuant to Subpart C, the administrative law judge shall issue a decision (including reasons) based on the application, the supporting documentation, the staff recommendation, the public comments and the evidence submitted during the hearing (the record), stating whether it has been demonstrated, based on a preponderance of evidence, that the applicant meets the requirements for recognition. If no exceptions are filed, this is the final decision of the Department of Labor.

(3) Upon issuance of the decision, any party to the hearing may file exceptions within 20 days pursuant to subpart C. If exceptions are filed, the administrative law judge shall forward the decision, exceptions and record to the assistant secretary for the final decision on the application.

(4) The Assistant Secretary shall review the record, the decision by the administrative law judge, and the exceptions. based on this, the assistant secretary shall issue the final decision (including reasons) of the department of labor stating whether the applicant has demonstrated by a preponderance of evidence that it meets the requirements for recognition.

b. Publication. a notification of the final decision shall be published in the FEDERAL REGISTER.

C. Terms and Conditions of Recognition, Renewal and Revocation

1. The following terms and conditions shall be part of every recognition:

a. The recognition of any validation organization will be evidenced by a letter of recognition from OSHA. the letter will provide the specific details of the scope of the OSHA recognition as well as any conditions imposed by OSHA, including any Federal monitoring requirements.

b. The recognition of each validation organization will be valid for five years, unless terminated before or renewed after the expiration of the period. The dates of the period of recognition will be stated in the recognition letter.

c. The recognized validation organization shall continue to satisfy all the requirements of this appendix and the letter of recognition during the period of recognition.

2. A recognized validation organization may change a test method of the PSDI safety system certification/validation program by notifying the Assistant Secretary of the change, certifying that the revised method will be at least as effective as the prior method, and providing the supporting data upon which its conclusions are based.

3. A recognized validation organization may renew its recognition by filing a renewal request at the address in paragraph I.A.3. of this Appendix, above, not less than 180 calendar days, nor more than one year, before the expiration date of its current recognition. When a recognized validation organization has filed such a renewal request, its current recognition will not expire until a final decision has been made on the request. The renewal request will be processed in accordance with subsection I.B. of this Appendix, above, except that a reinspection is not required but may be performed by OSHA. A hearing will be granted to an objecting member of the public if evidence of failure to meet the requirements of this Appendix is supplied to OSHA.

4. A recognized validation organization may apply to OSHA for an expansion of its current recognition to cover other categories of PSDI certification/validation in addition to those included in the current recognition. The application for expansion will be acted upon and processed by OSHA in accordance with subsection I.B. of this Appendix, subject to the possible reinspection exception. If the validation organization has been recognized for more than one year, meets the

requirements for expansion of recognition, and there is no evidence that the recognized validation organization has not been following the requirements of this Appendix and the letter of recognition, an expansion will normally be granted. A hearing will be granted to an objecting member of the public only if evidence of failure to meet the requirements of this Appendix is supplied to OSHA.

5. A recognized validation organization may voluntarily terminate its recognition, either in its entirety or with respect to any area covered in its recognition, by giving written notice to OSHA at any time. The written notice shall indicate the termination date. A validation organization may not terminate its installation certification and recertification validation functions earlier than either one year from the date of the written notice, or the date on which another recognized validation organization is able to perform the validation of installation certification and recertification.

6. a. OSHA may revoke its recognition of a validation organization if its program either has failed to continue to satisfy the requirements of this Appendix or its letter of recognition, has not been performing the validation functions required by the PSDI standard and Appendix A, or has misrepresented itself in its applications. Before proposing to revoke recognition, the Agency will notify the recognized validation organization of the basis of the proposed revocation and will allow rebuttal or correction of the alleged deficiencies. If the deficiencies are not corrected, OSHA may revoke recognition, effective in 60 days, unless the validation organization requests a hearing within that time.

b. If a hearing is requested, it shall be held before an administrative law judge of the Department of Labor pursuant to the rules specified in 29 CFR Part 1905, Subpart C.

c. The parties shall be OSHA and the recognized validation organization. The decision shall be made pursuant to the procedures specified in paragraphs I.B.8.b.(2) through (4) of this Appendix except that the burden of proof shall be on OSHA to demonstrate by a preponderance of the evidence that the recognition should be revoked because the validation organization either is not meeting the requirements for recognition, has not been performing the validation functions required by the PSDI standard and Appendix A, or has misrepresented itself in its applications.

D. Provisions of OSHA Recognition

Each recognized third-party validation organization and its validating laboratories shall:

1. Allow OSHA to conduct unscheduled reviews or on-site audits of it or the validating laboratories on matters relevant to PSDI, and cooperate in the conduct of these reviews and audits;

2. Agree to terms and conditions established by OSHA in the grant of recognition on matters such as exchange of data, submission of accident reports, and assistance in studies for improving PSDI or the certification/validation process.

II. Qualifications

The third-party validation organization, the validating laboratory, and the employees of each shall meet the requirements set forth in this section of this Appendix.

A. Experience of Validation Organization

1. The third-party validation organization shall have legal authority to perform certification/validation activities.

2. The validation organization shall demonstrate competence and experience in either power press design, manufacture or use, or testing, quality control or certification/validation of equipment comparable to power presses and associated control systems.

3. The validation organization shall demonstrate a capability for selecting, reviewing, and/or validating appropriate standards and test methods to be used for validating the certification of PSDI safety systems, as well as for reviewing judgements on the safety of PSDI safety systems and their conformance with the requirements of this section.

4. The validating organization may utilize the competence, experience, and capability of its employees to demonstrate this competence, experience and capability.

B. Independence of Validation Organization

1. The validation organization shall demonstrate that:

a. It is financially capable to conduct the work;

b. It is free of direct influence or control by manufacturers, suppliers, vendors, representatives of employers and employees, and employer or employee organizations; and

c. Its employees are secure from discharge resulting from pressures from manufacturers, suppliers, vendors, employers or employee representatives.

2. A validation organization may be considered independent even if it has ties with manufacturers, employers or employee representatives if these ties are with at least two of these three groups; it has a board of directors (or equivalent leadership responsibilities for the certification/validation activities) which includes representatives of the three groups; and it has a binding commitment of funding for a period of three years or more.

C. Validating Laboratory

The validation organization's laboratory (which organizationally may be a part of the third-party validation organization):

1. Shall have legal authority to perform the validation of certification;

2. Shall be free of operational control and influence of manufacturers, suppliers, vendors, employers, or employee representatives that would impair its integrity of performance; and

3. Shall not engage in the design, manufacture, sale, promotion, or use of the certified equipment.

D. Facilities and Equipment

The validation organization's validating laboratory shall have available all testing facilities and necessary test and inspection equipment relevant to the validation of the certification of PSDI safety systems, installations and operations.

E. Personnel

The validation organization and the validating laboratory shall be adequately staffed by personnel who are qualified by technical training and/or experience to conduct the validation of the certification of PSDI safety systems.

1. The validation organization shall assign overall responsibility for the validation of PSDI certification to an Administrative Director. Minimum requirements for this position are a Bachelor's degree and five years professional experience, at least one of which shall have been in responsible charge of a function in the areas of power press design or manufacture or a broad range of power press use, or in the areas of testing, quality control, or certification/validation of equipment comparable to power presses or their associated control systems.

2. The validating laboratory, if a separate organization from the validation organization, shall assign technical responsibility for the validation of PSDI certification to a Technical Director. Minimum requirements for this position are a Bachelor's degree in a Technical field and five years of professional experience, at least one of which shall have been in responsible charge of a function in the area of testing, quality control or certification/validation of equipment comparable to power presses or their associated control systems.

3. If the validation organization and the validating laboratory are the same organization, the administrative and technical responsibilities may be combined In a single position, with minimum requirements as described in E.1. and 2. for the combined position.

4. The validation organization and validating laboratory shall have adequate administrative and technical staffs to conduct the validation of the certification of PSDI safety systems.

F. Certification/Validation Mark or Logo

1. The validation organization or the validating laboratory shall own a registered certification/validation mark or logo.

2. The mark or logo shall be suitable for incorporation into the label required by paragraph (h)(11)(iii) of this section.

III. Program Requirements

A. Test and Certification/Validation Procedures

1. The validation organization and/or validating laboratory shall have established written procedures for test and certification/validation of PSDI safety systems. The procedures shall be based on pertinent OSHA standards and test methods, or other publicly available standards and test methods generally recognized as appropriate in the field, such as national consensus standards or published standards of professional societies or trade associations.

2. The written procedures for test and certification/validation of PSDI systems, and the standards and test methods on which they are based, shall be reproducible and be available to OSHA and to the public upon request.

B. Test Reports

1. A test report shall be prepared for each PSDI safety system that is tested. The test report shall be signed by a technical staff

representative and the Technical Director.

2. The test report shall include the following:

a. Name of manufacturer and catalog or model number of each subsystem or major component.

b. Identification and description of test methods or procedures used. (This may be through reference to published sources which describe the test methods or procedures used.)

c. Results of all tests performed.

d. All safety distance calculations.

3. A copy of the test report shall be maintained on file at the validation organization and/or validating laboratory, and shall be available to OSHA upon request.

C. Certification/Validation Reports

1. A certification/validation report shall for which the certification is validated. The certification/validation report shall be signed by the Administrative Director and the Technical Director.

2. The certification/validation report shall include the following:

a. Name of manufacturer and catalog or model number of each subsystem or major component.

b. Results of all tests which serve as the basis for the certification.

c. All safety distance calculations.

d. Statement that the safety system conforms with all requirements of the PSDI standard and Appendix A.

3. A copy of the certification/validation report shall be maintained on file at the validation organization and/or validating laboratory, and shall be available to the public upon request.

4. A copy of the certification/validation report shall be submitted to OSHA within 30 days of its completion.

D. Publications System

The validation organization shall make available upon request a list of PSDI safety systems which have been certified/validated by the program.

E. Follow-up Activities

1. The validation organization or validating laboratory shall have a follow-up system for inspecting or testing manufacturer's production of design certified/validated PSDI safety system components and subassemblies where deemed appropriate by the validation organization.

2. The validation organization shall notify the appropriate product manufacturer(s) of any reports from employers of point of operation injuries which occur while a press is operated in a PSDI mode.

F. Records

The validation organization or validating laboratory shall maintain a record of each certification/validation of a PSDI safety system, including manufacturer and/or employer certification documentation, test and working data, test report, certification/validation report, any follow-up inspections or testing, and reports of equipment failures, any reports of accidents involving the equipment, and any other pertinent information. These records shall be available for inspection by OSHA and OSHA State Plan offices.

G. Dispute Resolution Procedures

1. The validation organization shall have a reasonable written procedure for acknowledging and processing appeals or complaints from program participants (manufacturers, producers, suppliers, vendors and employers) as well as other interested parties (employees or their representatives, safety personnel, government agencies, etc.), concerning certification or validation.

2. The validation organization may charge any complainant the reasonable charge for repeating tests needed for the resolution of disputes.

[53 FR 8361, Mar. 14, 1988]

Regulations (Standards - 29 CFR)
Nonmandatory supplementary information - 1910.217 App D

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.217 App D
- **Title:** Nonmandatory supplementary information

This Appendix provides nonmandatory supplementary information and guidelines to assist in the understanding and use of 29 CFR 1910.217(h) to allow presence sensing device initiation (PSDI) of mechanical power presses. Although this Appendix as such is not mandatory, it references sections and requirements which are made mandatory by other parts of the PSDI standard and appendices.

1. General

OSHA intends that PSDI continue to be prohibited where present state-of-the-art technology will not allow it to be done safely. Only part revolution type mechanical power presses are approved for PSDI. Similarly, only presses with a configuration such that a person's body cannot completely enter the bed area are approved for PSDI.

2. Brake and Clutch

Flexible steel band brakes do not possess a long-term reliability against structural failure as compared to other types of brakes, and therefore are not acceptable on presses used in the PSDI mode of operation.
Fast and consistent stopping times are important to safety for the PSDI mode of operation. Consistency of braking action is enhanced by high brake torque. The requirement in paragraph (h)(2)(ii) defines a high torque capability which should ensure fast and consistent stopping times.

Brake design parameters important to PSDI are high torque, low moment of inertia, low air volume (if pneumatic) mechanisms, non-interleaving engagement springs, and structural integrity which is enhanced by over-design. The requirement in paragraph (h)(2)(iii) reduces the possibility of significantly increased stopping time if a spring breaks.

As an added precaution to the requirements in paragraph (h)(2)(iii), brake adjustment locking means should be secured. Where brake springs are externally accessible, lock nuts or other means may be provided to reduce the possibility of backing off of the compression nut which holds the springs In place.

3. Pneumatic Systems

Elevated clutch/brake air pressure results in longer stopping time. The requirement in paragraph (h)(3)(i)(C) is intended to prevent degradation in stopping speed from higher air pressure. Higher pressures may be permitted, however, to increase clutch torque to free "jammed" dies, provided positive measures are provided to prevent the higher pressure at other times.

4. Flywheels and Bearings

Lubrication of bearings is considered the single greatest deterrent to their failure. The manufacturer's recommended procedures for maintenance and inspection should be closely followed.

5. Brake Monitoring

The approval of brake monitor adjustments, as required in paragraph (h)(5)(ii), is not considered a recertification, and does not necessarily involve an on-site inspection by a representative of the validation organization. It is expected that the brake monitor adjustment normally could be evaluated on the basis of the effect on the safety system certification/validation documentation retained by the validation organization.

Use of a brake monitor does not eliminate the need for periodic brake inspection and maintenance to reduce the possibility of catastrophic failures.

6. Cycle Control and Control Systems

The PSDI set-up/reset means required by paragraph (h)(6)(iv) may be initiated by the actuation of a special momentary pushbutton or by the actuation of a special momentary pushbutton and the initiation of a first stroke with two hand controls.

It would normally be preferable to limit the adjustment of the time required in paragraph (h)(6)(vi) to a maximum of 15 seconds. However, where an operator must do many operations outside the press, such as lubricating, trimming, deburring, etc., a longer interval up to 30 seconds is permitted.

When a press is equipped for PSDI operation, it is recommended that the presence sensing device be active as a guarding device in other production modes. This should enhance the reliability of the device and ensure that it remains operable.

An acceptable method for interlocking supplemental guards as required by paragraph (h)(6)(xiii) would be to incorporate the supplemental guard and the PSDI presence sensing device into a hinged arrangement in which the alignment of the presence sensing device serves, in effect, as the interlock. If the supplemental guards are moved, the presence sensing device would become misaligned and the press control would be deactivated. No extra micro switches or interlocking sensors would be required. Paragraph (h)(6)(xv) of the standard requires that the control system have provisions for an "inch" operating means; that die-setting not be done in the PSDI mode; and that production not be done in the "inch" mode. It should be noted that the sensing device would be by-passed in the "inch" mode. For that reason, the prohibitions against die-setting in the PSDI mode, and against production in the "inch" mode are cited to emphasize that "inch" operation is of reduced safety and is not compatible with PSDI or other production modes.

7. Environmental Requirements

It is the intent of paragraph (h)(7) that control components be provided with inherent design protection against operating stresses and environmental factors affecting safety and reliability.

8. Safety system

The safety system provision continues the concept of paragraph (b)(13) that the probability of two independent failures in the length of time required to make one press cycle is so remote as to be a negligible risk factor in the total array of equipment and human factors. The emphasis is on an integrated total system including all elements affecting point of operation safety.

It should be noted that this does not require redundancy for press components such as structural elements, clutch/brake mechanisms, plates, etc., for which adequate reliability may be achieved by proper design, maintenance, and inspection.

9. Safeguarding the Point of Operation

The intent of paragraph (h)(9)(iii) is to prohibit use of mirrors to "bend" a single light curtain sensing field around corners to cover more than one side of a press. This prohibition is needed to increase the reliability of the presence sensing device in initiating a stroke only when the desired work motion has been completed.

"Object sensitivity" describes the capability of a presence sensing device to detect an object in the sensing field, expressed as the linear measurement of the smallest interruption which can be detected at any point in the field. Minimum object sensitivity describes the largest acceptable size of the interruption in the sensing field. A minimum object sensitivity of one and one fourth inches (31.75 mm) means that a one and one-fourth inch (31.75 mm) diameter object will be continuously detected at all locations in the sensing field.

In deriving the safety distance required in paragraph (h)(9)(v), all stopping time measurements should be made with clutch/brake air pressure regulated to the press manufacturer's recommended value for full clutch torque capability. The stopping time measurements should be made with the heaviest upper die that is planned for use in the press. If the press has a slide counterbalance system, it is important that the counterbalance be adjusted correctly for upper die weight according to the manufacturer's instructions. While the brake monitor setting is based on the stopping time it actually measures, i.e., the normal stopping time at the top of the stroke, it is important that the safety distance be computed from the longest stopping time measured at any of the indicated three downstroke stopping positions listed in the explanation of Ts. The use in the formula of twice the stopping time increase, Tm, allowed by the brake monitor for brake wear allows for greater increases in the downstroke stopping time than occur in normal stopping time at the top of the stroke.

10. Inspection and Maintenance. [Reserved]

11. Safety System Certification/Validation

Mandatory requirements for certification/validation of the PSDI safety system are provided in Appendix A and Appendix C to this standard. Nonmandatory supplementary information and guidelines relating to certification/validation of the PSDI safety system are provided to Appendix B to this standard.

[53 FR 8364, Mar. 14, 1988; 61 FR 9227, March 7, 1996]

Regulations (Standards - 29 CFR)
Forging machines. - 1910.218

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.218
- **Title:** Forging machines.

1910.218(a)

General requirements –

1910.218(a)(1)

Use of lead. The safety requirements of this subparagraph apply to lead casts or other use of lead in the forge shop or die shop.

1910.218(a)(1)(i)

Thermostatic control of heating elements shall be provided to maintain proper melting temperature and prevent overheating.

1910.218(a)(1)(ii)

Fixed or permanent lead pot installations shall be exhausted.

1910.218(a)(1)(iii)

Portable units shall be used only in areas where good, general room ventilation is provided.

1910.218(a)(1)(iv)

Personal protective equipment (gloves, goggles, aprons, and other items) shall be worn.

1910.218(a)(1)(v)

A covered container shall be provided to store dross skimmings.

1910.218(a)(1)(vi)

Equipment shall be kept clean, particularly from accumulations of yellow lead oxide.

..1910.218(a)(2)

1910.218(a)(2)

Inspection and maintenance. It shall be the responsibility of the employer to maintain all forge shop equipment in a condition which will insure continued safe operation. This responsibility includes:

1910.218(a)(2)(i)

Establishing periodic and regular maintenance safety checks and keeping certification records of these inspections which include the date of inspection, the signature of the person who performed the inspection and the serial number, or other identifier, for the forging machine which was inspected.

1910.218(a)(2)(ii)

Scheduling and recording the inspection of guards and point of operation protection devices at frequent and regular intervals. Recording of inspections shall be in the form of a certification record which includes the date the inspection was performed, the signature of the person who performed the inspection and the serial number, or other identifier, of the equipment inspected.

1910.218(a)(2)(iii)

Training personnel for the proper inspection and maintenance of forging machinery and equipment.

1910.218(a)(2)(iv)

All overhead parts shall be fastened or protected in such a manner that they will not fly off or fall in event of failure.

..1910.218(a)(3)

1910.218(a)(3)

Hammers and presses.

1910.218(a)(3)(i)

All hammers shall be positioned or installed in such a manner that they remain on or are anchored to foundations sufficient to support them according to applicable engineering standards.

1910.218(a)(3)(ii)

All presses shall be installed in such a manner that they remain where they are positioned or they are anchored to foundations sufficient to support them according to applicable engineering standards.

TABLE O-11 - STRENGTH AND DIMENSIONS FOR WOOD RAM PROPS

Size of timber, inches(1)	Square inches in cross section	Minimum allowable crushing strength parallel to grain, p.s.i. (2)	Maximum static load within short column range(3)	Safety factor	Maximum recommended weight of forging hammer for timber used	Maximum allowable length of timber, inches
4 X 4	16	5,000	80,000	10	8,000	44
6 X 6	36	5,000	180,000	10	18,000	66
8 X 8	64	5,000	320,000	10	32,000	88
10 X 10	100	5,000	500,000	10	50,000	100
12 X 12	144	5,000	720,000	10	72,000	132

Footnote(1) Actual dimension.

Footnote(2) Adapted from U.S. Department of Agriculture Technical Bulletin 479. Hardwoods recommended are those whose ultimate crushing strengths in compression parallel to grain are 5,000 p.s.i. (pounds per square inch) or greater.

Footnote(3) Slenderness ratio formula for short columns is L/d=11, where L=length of timber in inches and d=least dimension in inches; this ratio should not exceed 11.

1910.218(a)(3)(iii)

Means shall be provided for disconnecting the power to the machine and for locking out or rendering cycling controls inoperable.

1910.218(a)(3)(iv)

The ram shall be blocked when dies are being changed or other work is being done on the hammer. Blocks or wedges shall be made of material the strength and construction of which should meet or exceed the specifications and dimensions shown in Table O-11.

1910.218(a)(3)(v)

Tongs shall be of sufficient length to clear the body of the worker in case of kickback, and shall not have sharp handle ends.

1910.218(a)(3)(vi)

Oil swabs, or scale removers, or other devices to remove scale shall be provided. These devices shall be long enough to enable a man to reach the full length of the die without placing his hand or arm between the dies.

1910.218(a)(3)(vii)

Material handling equipment shall be of adequate strength, size, and dimension to handle diesetting operations safely.

..1910.218(a)(3)(viii)

1910.218(a)(3)(viii)

A scale guard of substantial construction shall be provided at the back of every hammer, so arranged as to stop flying scale.

1910.218(a)(3)(ix)

A scale guard of substantial construction shall be provided at the back of every press, so arranged as to stop flying scale.

1910.218(b)

Hammers, general –

1910.218(b)(1)

Keys. Die keys and shims shall be made from a grade of material that will not unduly crack or splinter.

1910.218(b)(2)

Foot operated devices. All foot operated devices (i.e., treadles, pedals, bars, valves, and switches) shall be substantially and effectively protected from unintended operation.

1910.218(c)

Presses. All manually operated valves and switches shall be clearly identified and readily accessible.

1910.218(d)

Power-driven hammers –

1910.218(d)(1)

Safety cylinder head. Every steam or airhammer shall have a safety cylinder head to act as a cushion if the rod should break or pullout of the ram.

..1910.218(d)(2)

1910.218(d)(2)

Shutoff valve. Steam hammers shall be provided with a quick closing emergency valve in the admission pipeline at a convenient location. This valve shall be closed and locked in the off position while the hammer is being adjusted, repaired, or serviced, or when the dies are being changed.

1910.218(d)(3)

Cylinder draining. Steam hammers shall be provided with a means of cylinder draining, such as a self-draining arrangement or a quick-acting drain cock.

1910.218(d)(4)

Pressure pipes. Steam or air piping shall conform to the specifications of American National Standard ANSI B31.1.0-1967, Power Piping with Addenda issued before April 28, 1971, which is incorporated by reference as specified in Sec. 1910.6.

1910.218(e)

Gravity hammers –

1910.218(e)(1)

Air-lift hammers.

1910.218(e)(1)(i)

Air-lift hammers shall have a safety cylinder head as required in paragraph (d)(1) of this section.

1910.218(e)(1)(ii)

Air-lift hammers shall have an air shutoff valve as required in paragraph (d)(2) of this section.

1910.218(e)(1)(iii)

Air-lift hammers shall be provided with two drain cocks: one on main head cylinder, and one on clamp cylinder.

..1910.218(e)(1)(iv)

1910.218(e)(1)(iv)

Air piping shall conform to the specifications of the ANSI B31.1.0-1967, Power Piping with Addenda issued before April 28, 1971, which is incorporated by reference as specified in Sec. 1910.6.

1910.218(e)(2)

Board drophammers.

1910.218(e)(2)(i)

A suitable enclosure shall be provided to prevent damaged or detached boards from falling. The board enclosure shall be securely fastened to the hammer.

1910.218(e)(2)(ii)

All major assemblies and fittings which can loosen and fall shall be properly secured in place.

1910.218(f)

Forging presses –

1910.218(f)(1)

Mechanical forging presses. When dies are being changed or maintenance is being performed on the press, the following shall be accomplished:

1910.218(f)(1)(i)

The power to the press shall be locked out.

1910.218(f)(1)(ii)

The flywheel shall be at rest.

1910.218(f)(1)(iii)

The ram shall be blocked with a material the strength of which shall meet or exceed the specifications or dimensions shown in Table O-11.

1910.218(f)(2)

Hydraulic forging presses. When dies are being changed or maintenance is being performed on the press, the following shall be accomplished:

..1910.218(f)(2)(i)

1910.218(f)(2)(i)

The hydraulic pumps and power apparatus shall be locked out.

1910.218(f)(2)(ii)

The ram shall be blocked with a material the strength of which shall meet or exceed the specifications or dimensions shown in Table O-11.

1910.218(g)

Trimming presses –

1910.218(g)(1)

Hot trimming presses. The requirements of paragraph (f)(1) of this section shall also apply to hot trimming presses.

1910.218(g)(2)

Cold trimming presses. Cold trimming presses shall be safeguarded in accordance with 1910.217(c).

1910.218(h)

Upsetters –

1910.218(h)(1)

General requirements. All upsetters shall be installed so that they remain on their supporting foundations.

1910.218(h)(2)

Lockouts. Upsetters shall be provided with a means for locking out the power at its entry point to the machine and rendering its cycling controls inoperable.

1910.218(h)(3)

Manually operated controls. All manually operated valves and switches shall be clearly identified and readily accessible.

..1910.218(h)(4)

1910.218(h)(4)

Tongs. Tongs shall be of sufficient length to clear the body of the worker in case of kickback, and shall not have sharp handle ends.

1910.218(h)(5)

Changing dies. When dies are being changed, maintenance performed, or any work done on the machine, the power to the upsetter shall be locked out, and the flywheel shall be at rest.

1910.218(i)

Other forging equipment –

1910.218(i)(1)

Boltheading. The provisions of paragraph (h) of this section shall apply to boltheading.

1910.218(i)(2)

Rivet making. The provisions of paragraph (h) of this section shall apply to rivet making.

1910.218(j)

Other forge facility equipment-

1910.218(j)(1)

Billet shears. A positive-type lockout device for disconnecting the power to the shear shall be provided.

1910.218(j)(2)

Saws. Every saw shall be provided with a guard of not less than one-eighth inch sheet metal positioned to stop flying sparks.

1910.218(j)(3)

Conveyors. Conveyor power transmission equipment shall be guarded in accordance with ANSI B20.1-1957, Safety Code for Conveyors, Cableways, and Related Equipment, which is incorporated by reference as specified in Sec. 1910.6.

..1910.218(j)(4)

1910.218(j)(4)

Shot blast. The cleaning chamber shall have doors or guards to protect operators.

1910.218(j)(5)

Grinding. Personal protective equipment shall be used in grinding operations, and equipment shall be used and maintained in accordance with ANSI B7.1-1970, Safety Code for the Use, Care, and Protection of Abrasive Wheels, which is incorporated by reference as specified in Sec. 1910.6, and with 1910.215.

[39 FR 23502, June 27, 1974, as amended at 49 FR 5323, Feb. 10, 1984; 51 FR 34561, Sept. 29, 1986; 61 FR 9227, March 7, 1996]

Regulations (Standards - 29 CFR)
Mechanical power-transmission apparatus. - 1910.219

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** O
- **Subpart Title:** Machinery and Machine Guarding
- **Standard Number:** 1910.219
- **Title:** Mechanical power-transmission apparatus.

1910.219(a)

General requirements.

1910.219(a)(1)

This section covers all types and shapes of power-transmission belts, except the following when operating at two hundred and fifty (250) feet per minute or less:

1910.219(a)(1)(i)

Flat belts one (1) inch or less in width,

1910.219(a)(1)(ii)

flat belts two (2) inches or less in width which are free from metal lacings or fasteners,

1910.219(a)(1)(iii)

round belts one-half (1/2) inch or less in diameter; and

1910.219(a)(1)(iv)

single strand V-belts, the width of which is thirteen thirty-seconds (13/32) inch or less.

1910.219(a)(2)

Vertical and inclined belts (paragraphs (e) (3) and (4) of this section) if not more than two and one-half (2 1/2) inches wide and running at a speed of less than one thousand (1,000) feet per minute, and if free from metal lacings or fastenings may be guarded with a nip-point belt and pulley guard.

..1910.219(a)(3)

1910.219(a)(3)

For the Textile Industry, because of the presence of excessive deposits of lint, which constitute a serious fire hazard, the sides and face sections only of nip-point belt and pulley guards are required, provided the guard shall extend at least six (6) inches beyond the rim of the pulley on the in-running and off-running sides of the belt and at least two (2) inches away from the rim and face of the pulley in all other directions.

1910.219(a)(4)

This section covers the principal features with which power transmission safeguards shall comply.

1910.219(b)

Prime-mover guards –

1910.219(b)(1)

Flywheels. Flywheels located so that any part is seven (7) feet or less above floor or platform shall be guarded in accordance with the requirements of this subparagraph:

1910.219(b)(1)(i)

With an enclosure of sheet, perforated, or expanded metal, or woven wire;

1910.219(b)(1)(ii)

With guard rails placed not less than fifteen (15) inches nor more than twenty (20) inches from rim. When flywheel extends into pit or is within 12 inches of floor, a standard toeboard shall also be provided;

1910.219(b)(1)(iii)

When the upper rim of flywheel protrudes through a working floor, it shall be entirely enclosed or surrounded by a guardrail and toeboard.

..1910.219(b)(1)(iv)

1910.219(b)(1)(iv)

For flywheels with smooth rims five (5) feet or less in diameter, where the preceding methods cannot be applied, the following may be used: A disk attached to the flywheel in such manner as to cover the spokes of the wheel on the exposed side and present a smooth surface and edge, at the same time providing means for periodic inspection. An open space, not exceeding four (4) inches in width, may be left between the outside edge of the disk and the rim of the wheel if desired, to facilitate turning the wheel over. Where a disk is used, the keys or other dangerous projections not covered by disk shall be cut off or covered. This subdivision does not apply to flywheels with solid web centers.

1910.219(b)(1)(v)

Adjustable guard to be used for starting engine or for running adjustment may be provided at the flywheel of gas or oil engines. A slot opening for jack bar will be permitted.

1910.219(b)(1)(vi)

Wherever flywheels are above working areas, guards shall be installed having sufficient strength to hold the weight of the flywheel in the event of a shaft or wheel mounting failure.

1910.219(b)(2)

Cranks and connecting rods. Cranks and connecting rods, when exposed to contact, shall be guarded in accordance with paragraphs (m) and (n) of this section, or by a guardrail as described in paragraph (o)(5) of this section.

1910.219(b)(3)

Tail rods or extension piston rods. Tail rods or extension piston rods shall be guarded in accordance with paragraphs (m) and (o) of this section, or by a guardrail on sides and end, with a clearance of not less than fifteen (15) nor more than twenty (20) inches when rod is fully extended.

..1910.219(c)

1910.219(c)

Shafting –

1910.219(c)(1)

Installation.

1910.219(c)(1)(i)

Each continuous line of shafting shall be secured in position against excessive endwise movement.

1910.219(c)(1)(ii)

Inclined and vertical shafts, particularly inclined idler shafts, shall be securely held in position against endwise thrust.

1910.219(c)(2)

Guarding horizontal shafting.

1910.219(c)(2)(i)

All exposed parts of horizontal shafting seven (7) feet or less from floor or working platform, excepting runways used exclusively for oiling, or running adjustments, shall be protected by a stationary casing enclosing shafting completely or by a trough enclosing sides and top or sides and bottom of shafting as location requires.

1910.219(c)(2)(ii)

Shafting under bench machines shall be enclosed by a stationary casing, or by a trough at sides and top or sides and bottom, as location requires. The sides of the trough shall come within at least six (6) inches of the underside of table, or if shafting is located near floor within six (6) inches of floor. In every case the sides of trough shall extend at least two (2) inches beyond the shafting or protuberance.

..1910.219(c)(3)

1910.219(c)(3)

Guarding vertical and inclined shafting. Vertical and inclined shafting seven (7) feet or less from floor or working platform, excepting maintenance runways, shall be enclosed with a stationary casing in accordance with requirements of paragraphs (m) and (o) of this section.

1910.219(c)(4)

Projecting shaft ends.

1910.219(c)(4)(i)

Projecting shaft ends shall present a smooth edge and end and shall not project more than one-half the diameter of the shaft unless guarded by nonrotating caps or safety sleeves.

1910.219(c)(4)(ii)

Unused keyways shall be filled up or covered.

1910.219(c)(5)

Power-transmission apparatus located in basements. All mechanical power transmission apparatus located in basements, towers, and rooms used exclusively for power transmission equipment shall be guarded in accordance with this section, except that the requirements for safeguarding belts, pulleys, and shafting need not be complied with when the following requirements are met:

1910.219(c)(5)(i)

The basement, tower, or room occupied by transmission equipment is locked against unauthorized entrance.

1910.219(c)(5)(ii)

The vertical clearance in passageways between the floor and power transmission beams, ceiling, or any other objects, is not less than five feet six inches (5 ft. 6 in.).

..1910.219(c)(5)(iii)

1910.219(c)(5)(iii)

The intensity of illumination conforms to the requirements of ANSI A11.1-1965 (R-1970), which is incorporated by reference as specified in Sec. 1910.6.

1910.219(c)(5)(iv)

[Reserved]

1910.219(c)(5)(v)

The route followed by the oiler is protected in such manner as to prevent accident.

1910.219(d)

Pulleys –

1910.219(d)(1)

Guarding. Pulleys, any parts of which are seven (7) feet or less from the floor or working platform, shall be guarded in accordance with the standards specified in paragraphs (m) and (o) of this section. Pulleys serving as balance wheels (e.g., punch presses) on which the point of contact between belt and pulley is more than six feet six inches (6 ft. 6 in.) from the floor or platform may be guarded with a disk covering the spokes.

1910.219(d)(2)

Location of pulleys.

1910.219(d)(2)(i)

Unless the distance to the nearest fixed pulley, clutch, or hanger exceeds the width of the belt used, a guide shall be provided to prevent the belt from leaving the pulley on the side where insufficient clearance exists.

1910.219(d)(2)(ii)

[Reserved]

..1910.219(d)(3)

1910.219(d)(3)

Broken pulleys. Pulleys with cracks, or pieces broken out of rims, shall not be used.

1910.219(d)(4)

Pulley speeds. Pulleys intended to operate at rim speed in excess of manufacturers normal recommendations shall be specially designed and carefully balanced for the speed at which they are to operate.

1910.219(e)

Belt, rope, and chain drives –

1910.219(e)(1)

Horizontal belts and ropes.

1910.219(e)(1)(i)

Where both runs of horizontal belts are seven (7) feet or less from the floor level, the guard shall extend to at least fifteen (15) inches above the belt or to a standard height (see Table O-12), except that where both runs of a horizontal belt are 42 inches or less from the floor, the belt shall be fully enclosed in accordance with paragraphs (m) and (o) of this section.

1910.219(e)(1)(ii)

In powerplants or power-development rooms, a guardrail may be used in lieu of the guard required by subdivision (i) of this subparagraph.

..1910.219(e)(2)

1910.219(e)(2)

Overhead horizontal belts.

1910.219(e)(2)(i)

Overhead horizontal belts, with lower parts seven (7) feet or less from the floor or platform, shall be guarded on sides and bottom in accordance with paragraph (o)(3) of this section.

1910.219(e)(2)(ii)

Horizontal overhead belts more than seven (7) feet above floor or platform shall be guarded for their entire length under the following conditions:

1910.219(e)(2)(ii)(a)

If located over passageways or work places and traveling 1,800 feet or more per minute.

1910.219(e)(2)(ii)(b)

If center to center distance between pulleys is ten (10) feet or more.

1910.219(e)(2)(ii)(c)

If belt is eight (8) inches or more in width.

1910.219(e)(2)(iii)

Where the upper and lower runs of horizontal belts are so located that passage of persons between them would be possible, the passage shall be either:

1910.219(e)(2)(iii)(a)

Completely barred by a guardrail or other barrier in accordance with paragraphs (m) and (o) of this section; or

..1910.219(e)(2)(iii)(b)

1910.219(e)(2)(iii)(b)

Where passage is regarded as necessary, there shall be a platform over the lower run guarded on either side by a railing completely filled in with wire mesh or other filler, or by a solid barrier. The upper run shall be so guarded as to prevent contact therewith either by the worker or by objects carried by him. In powerplants only the lower run of the belt need be guarded.

1910.219(e)(2)(iv)

Overhead chain and link belt drives are governed by the same rules as overhead horizontal belts and shall be guarded in the same manner as belts.

1910.219(e)(3)

Vertical and inclined belts.

1910.219(e)(3)(i)

Vertical and inclined belts shall be enclosed by a guard conforming to standards in paragraphs (m) and (o) of this section.

1910.219(e)(3)(ii)

All guards for inclined belts shall be arranged in such a manner that a minimum clearance of seven (7) feet is maintained between belt and floor at any point outside of guard.

1910.219(e)(4)

Vertical belts. Vertical belts running over a lower pulley more than seven (7) feet above floor or platform shall be guarded at the bottom in the same manner as horizontal overhead belts, if conditions are as stated in paragraphs (e)(2)(ii) (a) and (c) of this section.

..1910.219(e)(5)

1910.219(e)(5)

Cone-pulley belts.

1910.219(e)(5)(i)

The cone belt and pulley shall be equipped with a belt shifter so constructed as to adequately guard the nip point of the belt and pulley. If the frame of the belt shifter does not adequately guard the nip point of the belt and pulley, the nip point shall be further protected by means of a vertical guard placed in front of the pulley and extending at least to the top of the largest step of the cone.

1910.219(e)(5)(ii)

If the belt is of the endless type or laced with rawhide laces, and a belt shifter is not desired, the belt will be considered guarded if the nip point of the belt and pulley is protected by a nip point guard located in front of the cone extending at least to the top of the largest step of the cone, and formed to show the contour of the cone in order to give the nip point of the belt and pulley the maximum protection.

1910.219(e)(5)(iii)

If the cone is located less than 3 feet from the floor or working platform, the cone pulley and belt shall be guarded to a height of 3 feet regardless of whether the belt is endless or laced with rawhide.

1910.219(e)(6)

Belt tighteners.

1910.219(e)(6)(i)

Suspended counterbalanced tighteners and all parts thereof shall be of substantial construction and securely fastened; the bearings shall be securely capped. Means must be provided to prevent tightener from falling, in case the belt breaks.

1910.219(e)(6)(ii)

Where suspended counterweights are used and not guarded by location, they shall be so encased as to prevent accident.

..1910.219(f)

1910.219(f)

Gears, sprockets, and chains –

1910.219(f)(1)

Gears. Gears shall be guarded in accordance with one of the following methods:

1910.219(f)(1)(i)

By a complete enclosure; or

1910.219(f)(1)(ii)

By a standard guard as described in paragraph (o) of this section, at least seven (7) feet high extending six (6) inches above the mesh point of the gears; or

1910.219(f)(1)(iii)

By a band guard covering the face of gear and having flanges extended inward beyond the root of the teeth on the exposed side or sides. Where any portion of the train of gears guarded by a band guard is less than six (6) feet from the floor a disk guard or a complete enclosure to the height of six (6) feet shall be required.

1910.219(f)(2)

Hand-operated gears. Paragraph (f)(1) of this section does not apply to hand-operated gears used only to adjust machine parts and which do not continue to move after hand power is removed. However, the guarding of these gears is highly recommended.

1910.219(f)(3)

Sprockets and chains. All sprocket wheels and chains shall be enclosed unless they are more than seven (7) feet above the floor or platform. Where the drive extends over other machine or working areas, protection against falling shall be provided. This subparagraph does not apply to manually operated sprockets.

..1910.219(f)(4)

1910.219(f)(4)

Openings for oiling. When frequent oiling must be done, openings with hinged or sliding self-closing covers shall be provided. All points not readily accessible shall have oil feed tubes if lubricant is to be added while machinery is in motion.

1910.219(g)

Guarding friction drives. The driving point of all friction drives when exposed to contact shall be guarded, all arm or spoke friction drives and all web friction drives with holes in the web shall be entirely enclosed, and all projecting belts on friction drives where exposed to contact shall be guarded.

1910.219(h)

Keys, setscrews, and other projections.

1910.219(h)(1)

All projecting keys, setscrews, and other projections in revolving parts shall be removed or made flush or guarded by metal cover. This subparagraph does not apply to keys or setscrews within gear or sprocket casings or other enclosures, nor to keys, setscrews, or oilcups in hubs of pulleys less than twenty (20) inches in diameter where they are within the plane of the rim of the pulley.

1910.219(h)(2)

It is recommended, however, that no projecting setscrews or oilcups be used in any revolving pulley or part of machinery.

1910.219(i)

Collars and couplings –

1910.219(i)(1)

Collars. All revolving collars, including split collars, shall be cylindrical, and screws or bolts used in collars shall not project beyond the largest periphery of the collar.

..1910.219(i)(2)

1910.219(i)(2)

Couplings. Shaft couplings shall be so constructed as to present no hazard from bolts, nuts, setscrews, or revolving surfaces. Bolts, nuts, and setscrews will, however, be permitted where they are covered with safety sleeves or where they are used parallel with the shafting and are countersunk or else do not extend beyond the flange of the coupling.

1910.219(j)

Bearings and facilities for oiling. All drip cups and pans shall be securely fastened.

1910.219(k)

Guarding of clutches, cutoff couplings, and clutch pulleys –

1910.219(k)(1)

Guards. Clutches, cutoff couplings, or clutch pulleys having projecting parts, where such clutches are located seven (7) feet or less above the floor or working platform, shall be enclosed by a stationary guard constructed in accordance with this section. A "U" type guard is permissible.

1910.219(k)(2)

Engine rooms. In engine rooms a guardrail, preferably with toeboard, may be used instead of the guard required by paragraph (k)(1) of this section, provided such a room is occupied only by engine room attendants.

..1910.219(l)

1910.219(l)

Belt shifters, clutches, shippers, poles, perches, and fasteners –

1910.219(l)(1)

Belt shifters.

1910.219(l)(1)(i)

Tight and loose pulleys on all new installations made on or after August 31, 1971, shall be equipped with a permanent belt shifter provided with mechanical means to prevent belt from creeping from loose to tight pulley. It is recommended that old installations be changed to conform to this rule.

1910.219(l)(1)(ii)

Belt shifter and clutch handles shall be rounded and be located as far as possible from danger of accidental contact, but within easy reach of the operator. Where belt shifters are not directly located over a machine or bench, the handles shall be cut off six feet six inches (6 ft. 6 in.) above floor level.

1910.219(l)(2)

Belt shippers and shipper poles. The use of belt poles as substitutes for mechanical shifters is not recommended.

1910.219(l)(3)

Belt perches. Where loose pulleys or idlers are not practicable, belt perches in form of brackets, rollers, etc., shall be used to keep idle belts away from the shafts.

1910.219(l)(4)

Belt fasteners. Belts which of necessity must be shifted by hand and belts within seven (7) feet of the floor or working platform which are not guarded in accordance with this section shall not be fastened with metal in any case, nor with any other fastening which by construction or wear will constitute an accident hazard.

..1910.219(m)

1910.219(m)

Standard guards-general requirements –

1910.219(m)(1)

Materials.

1910.219(m)(1)(i)

Standard conditions shall be secured by the use of the following materials. Expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened to floor or to frame of machine.

1910.219(m)(1)(ii)

All metal should be free from burrs and sharp edges.

1910.219(m)(2)

Methods of manufacture.

1910.219(m)(2)(i)

Expanded metal, sheet or perforated metal, and wire mesh shall be securely fastened to frame.

1910.219(n)

[Reserved]

1910.219(o)

Approved materials –

1910.219(o)(1)

Minimum requirements. The materials and dimensions specified in this paragraph shall apply to all guards, except horizontal overhead belts, rope, cable, or chain guards more than seven (7) feet above floor, or platform.

1910.219(o)(1)(i)

[Reserved]

1910.219(o)(1)(i)(a)

All guards shall be rigidly braced every three (3) feet or fractional part of their height to some fixed part of machinery or building structure. Where guard is exposed to contact with moving equipment additional strength may be necessary.

..1910.219(o)(2)

1910.219(o)(2)

Wood guards.

1910.219(o)(2)(i)

Wood guards may be used in the woodworking and chemical industries, in industries where the presence of fumes or where manufacturing conditions would cause the rapid deterioration of metal guards; also in construction work and in locations outdoors where extreme cold or extreme heat make metal guards and railings undesirable. In all other industries, wood guards shall not be used.

1910.219(o)(3)

Guards for horizontal overhead belts.

1910.219(o)(3)(i)

Guards for horizontal overhead belts shall run the entire length of the belt and follow the line of the pulley to the ceiling or be carried to the nearest wall, thus enclosing the belt effectively. Where belts are so located as to make it impracticable to carry the guard to wall or ceiling, construc tion of guard shall be such as to enclose completely the top and bottom runs of belt and the face of pulleys.

1910.219(o)(3)(ii)

[Reserved]

..1910.219(o)(3)(iii)

1910.219(o)(3)(iii)

Suitable reinforcement shall be provided for the ceiling rafters or overhead floor beams, where such is necessary, to sustain safely the weight and stress likely to be imposed by the guard. The interior surface of all guards, by which is meant the surface of the guard with which a belt will come in contact, shall be smooth and free from all projections of any character, except where construction demands it; protruding shallow roundhead rivets may be used. Overhead belt guards shall be at least one-quarter wider than belt which they protect, except that this clearance need not in any case exceed six (6) inches on each side. Overhead rope drive and block and roller-chain-drive guards shall be not less than six (6) inches wider than the drive on each side. In overhead silent chain-drive guards where the chain is held from lateral displacement on the sprockets, the side clearances required on drives of twenty (20) inch centers or under shall be not less than one-fourth inch from the nearest moving chain part, and on drives of over twenty (20) inch centers a minimum of one-half inch from the nearest moving chain part.

1910.219(o)(4)

Guards for horizontal overhead rope and chain drives. Overhead-rope and chain-drive guard construction shall conform to the rules for overhead-belt guard.

1910.219(o)(5)

Guardrails and toeboards.

1910.219(o)(5)(i)

Guardrail shall be forty-two (42) inches in height, with midrail between top rail and floor.

1910.219(o)(5)(ii)

Posts shall be not more than eight (8) feet apart; they are to be permanent and substantial, smooth, and free from protruding nails, bolts, and splinters. If made of pipe, the post shall be one and one-fourth (1 1/4) inches inside diameter, or larger. If made of metal shapes or bars, their section shall be equal in strength to that of one and one-half (1 1/2) by one and one-half (1 1/2) by three-sixteenths (3/16) inch angle iron. If made of wood, the posts shall be two by four (2 X 4) inches or larger. The upper rail shall be two by four (2 X 4) inches, or two one by four (1 X 4) strips, one at the top and one at the side of posts. The midrail may be one by four (1 X 4) inches or more. Where panels are fitted with expanded metal or wire mesh as noted in Table O-12 the middle rails may be omitted. Where guard is exposed to contact with moving equipment, additional strength may be necessary.

..1910.219(o)(5)(iii)

1910.219(o)(5)(iii)

Toeboards shall be four (4) inches or more in height, of wood, metal, or of metal grill not exceeding one (1) inch mesh.

1910.219(p)

Care of equipment –

1910.219(p)(1)

General. All power-transmission equipment shall be inspected at intervals not exceeding 60 days and be kept in good working condition at all times.

1910.219(p)(2)

Shafting.

1910.219(p)(2)(i)

Shafting shall be kept in alignment, free from rust and excess oil or grease.

1910.219(p)(2)(ii)

Where explosives, explosive dusts, flammable vapors or flammable liquids exist, the hazard of static sparks from shafting shall be carefully considered.

1910.219(p)(3)

Bearings. Bearings shall be kept in alignment and properly adjusted.

1910.219(p)(4)

Hangers. Hangers shall be inspected to make certain that all supporting bolts and screws are tight and that supports of hanger boxes are adjusted properly.

1910.219(p)(5)

Pulleys.

1910.219(p)(5)(i)

Pulleys shall be kept in proper alignment to prevent belts from running off.

..1910.219(p)(6)

1910.219(p)(6)

Care of belts.

1910.219(p)(6)(i)

[Reserved]

1910.219(p)(6)(ii)

Inspection shall be made of belts, lacings, and fasteners and such equipment kept in good repair.

1910.219(p)(7)

Lubrication. The regular oilers shall wear tight-fitting clothing. Machinery shall be oiled when not in motion, wherever possible.

[39 FR 23502, June 27, 1974, as amended at 43 FR 49750, Oct. 24, 1978; 43 FR 51760; Nov. 7, 1978; 49 FR 5323, Feb. 10, 1984; 61 FR 9227, March 7, 1996]

Introduction

This manual has been prepared as an aid to employers, employees, machine manufacturers, machine guard designers and fabricators, and all others with an interest in protecting workers against the hazards of moving machine parts. It identifies the major mechanical motions and the general principles of safeguarding them. Current applications of each technique are shown in accompanying illustrations of specific operations and machines. The methods described here may be transferred, with due care, to different machines with similar hazards. To determine whether or not safeguarding meets the requirements of the standard, any mechanical motion that threatens a worker's safety should not remain unguarded.

The approaches to machine safeguarding discussed in this manual are not the only solutions which meet the requirements of the standard. Why? Because practical solutions to safeguarding moving machine parts are as numerous as the people working on them. No publication could keep pace with all of these solutions or attempt to depict them all.

In machine safeguarding, as in other regulated areas of the American workplace, to a certain extent OSHA standards govern function and practice. This text, however, is not a substitute for the standards. It is a manual of basic technical information and workable ideas which the employer may use as a guide to achieve compliance. It offers an overview of the machine safeguarding problem in the industrial setting, an assortment of solutions in popular use, and a challenge to all whose work involves machines

Many readers of this manual already have the judgment, knowledge, and skill to develop effective answers to problems yet unsolved. Innovators are encouraged to find here stimulation to eliminate mechanical hazards facing America's workers today.

Chapter 1 - Basics of Machine Safeguarding

Basics of Machine Safeguarding

Crushed hands and arms, severed fingers, blindness -- the list of possible machinery-related injuries is as long as it is horrifying. There seem to be as many hazards created by moving machine parts as there are types of machines. Safeguards are essential for protecting workers from needless and preventable injuries.

A good rule to remember is: Any machine part, function, or process which many cause injury must be safeguarded. When the operation of a machine or accidental contact with it can injure the operator or others in the vicinity, the hazards must be either controlled or eliminated.

This manual describes the various hazards of mechanical motion and presents some techniques for protecting workers from these hazards. General information covered in this chapter includes -- where mechanical hazards occur, the hazards created by different kinds of motions and the requirements for effective safeguards, as well as a brief discussion of nonmechanical hazards.

Where Mechanical Hazards Occur

Dangerous moving parts in three basic areas require safeguarding:

The point of operation: that point where work is performed on the material, such as cutting, shaping, boring, or forming of stock.

Power transmission apparatus: all components of the mechanical system which transmit energy to the part of the machine performing the work. These components include flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks, and gears.

Other moving parts: all parts of the machine which move while the machine is working. These can include reciprocating, rotating, and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

Hazardous Mechanical Motions and Actions

A wide variety of mechanical motions and actions may present hazards to the worker. These can include the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic in varying combinations to nearly all machines, and recognizing them is the first step toward protecting workers from the danger they present.

The basic types of hazardous mechanical motions and actions are:

Motions

- rotating (including in-running nip points)
- reciprocating
- transversing

Actions

- cutting
- punching
- shearing
- bending

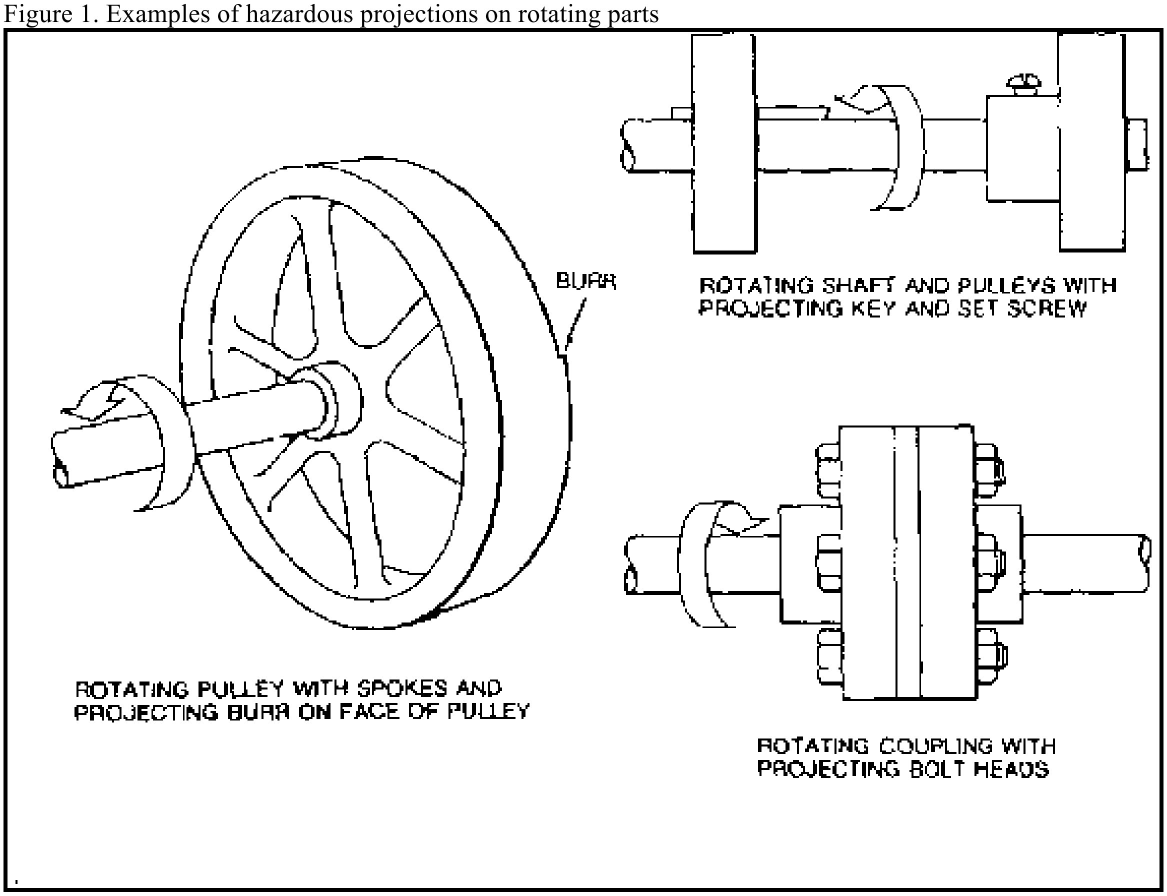
We will briefly examine each of these basic types in turn.

Motions

Rotating motion can be dangerous; even smooth, slowly rotating shafts can grip clothing, and through mere skin contact force an arm or hand into a dangerous position. Injuries due to contact with rotating parts can be severe.

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, meshing gears, and horizontal or vertical shafting are some examples of common rotating mechanisms which may be hazardous. The danger increases when projections such as set screws, bolts, nicks, abrasions, and projecting keys or set screws are exposed on rotating parts, as shown in Figure 1.

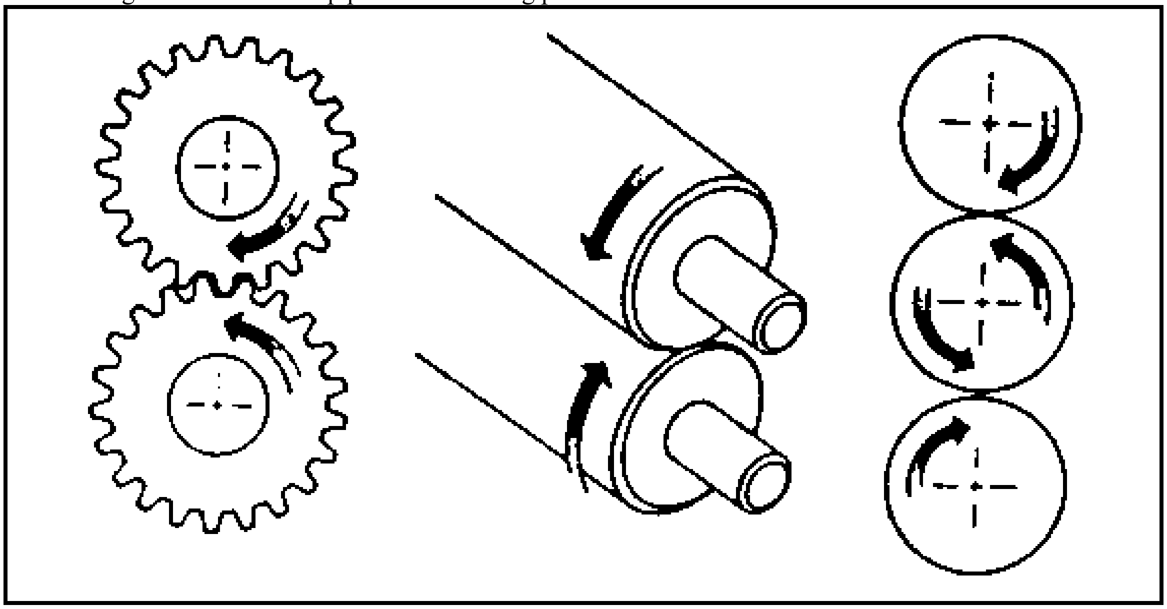
Figure 1. Examples of hazardous projections on rotating parts



In-running nip point hazards are caused by the rotating parts on machinery. There are three main types of in-running nips.

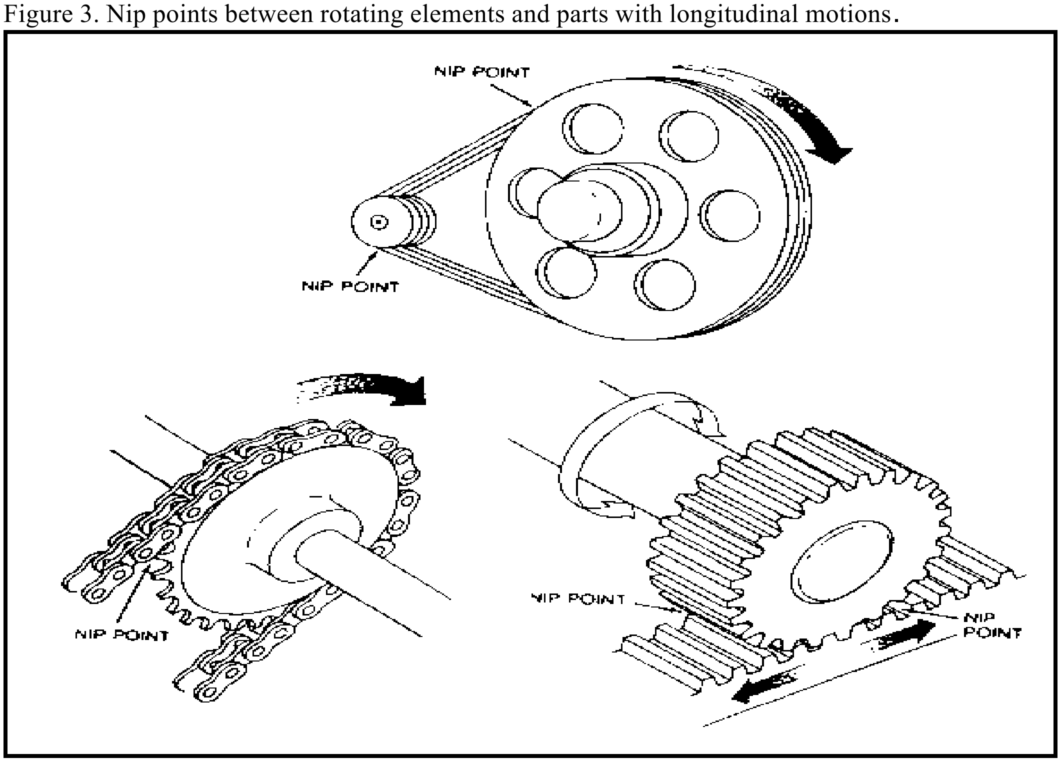
Parts can rotate in opposite directions while their axes are parallel to each other. These parts may be in contact (producing a nip point) or in close proximity. In the latter case the stock fed between the rolls produces the nip points. This danger is common on machines with intermeshing gears, rolling mills, and calenders. See Figure 2.

Figure 2. Common nip points on rotating parts



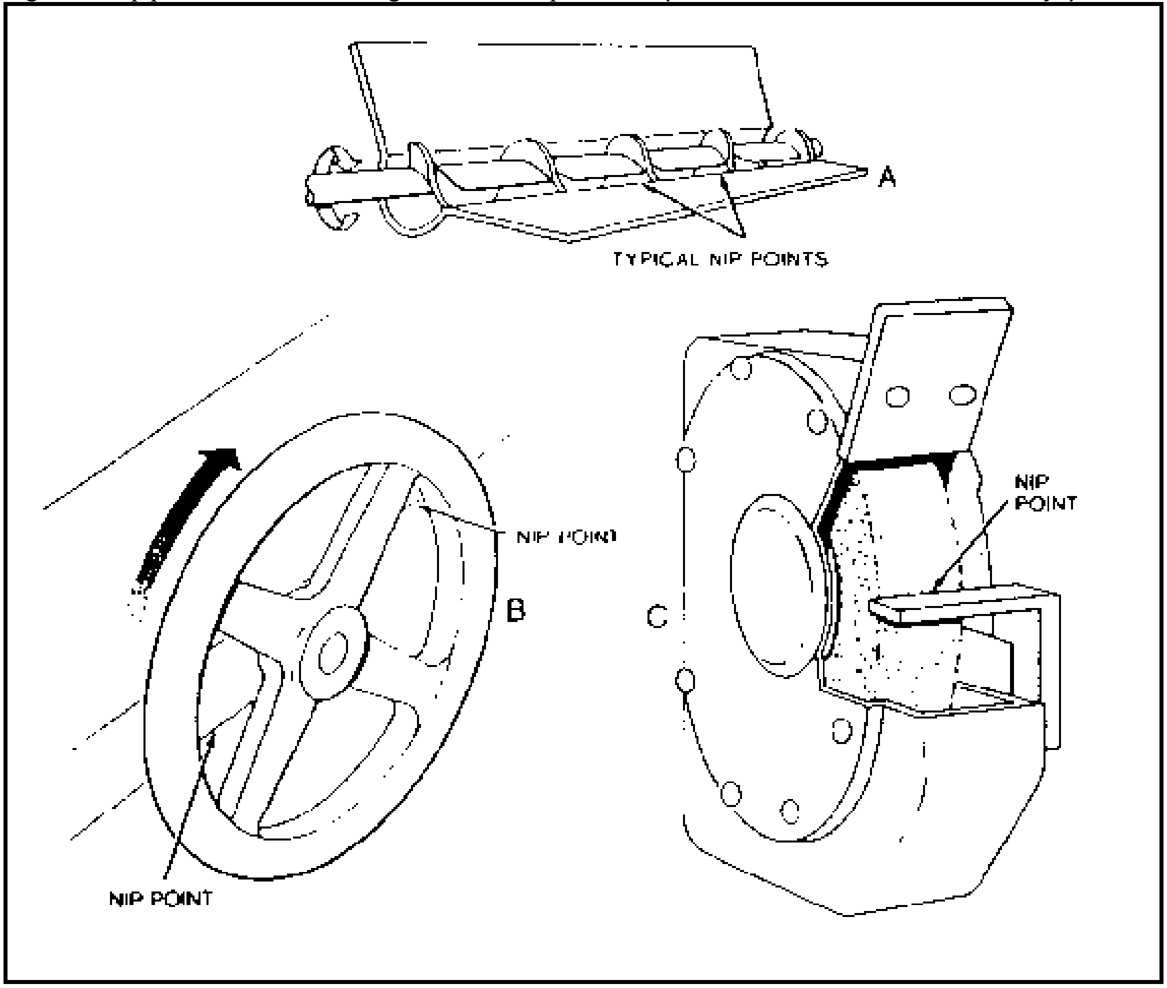
Nip points are also created between rotating and tangentially moving parts. Some examples would be: the point of contact between a power transmission belt and its pulley, a chain and a sprocket, and a rack and pinion. See Figure 3.

Figure 3. Nip points between rotating elements and parts with longitudinal motions.

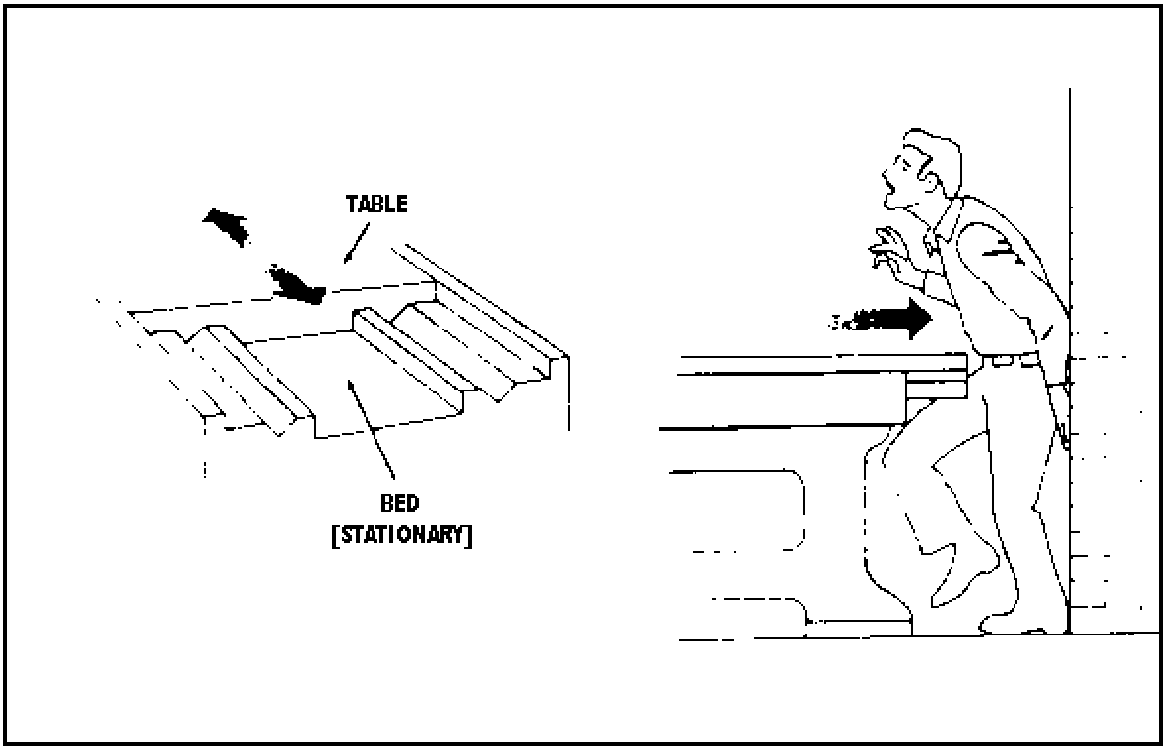


Nip points can occur between rotating and fixed parts which create a shearing, crushing, or abrading action. Examples are: spoked handwheels or flywheels, screw conveyors, or the periphery of an abrasive wheel and an incorrectly adjusted work rest. See Figure 4.

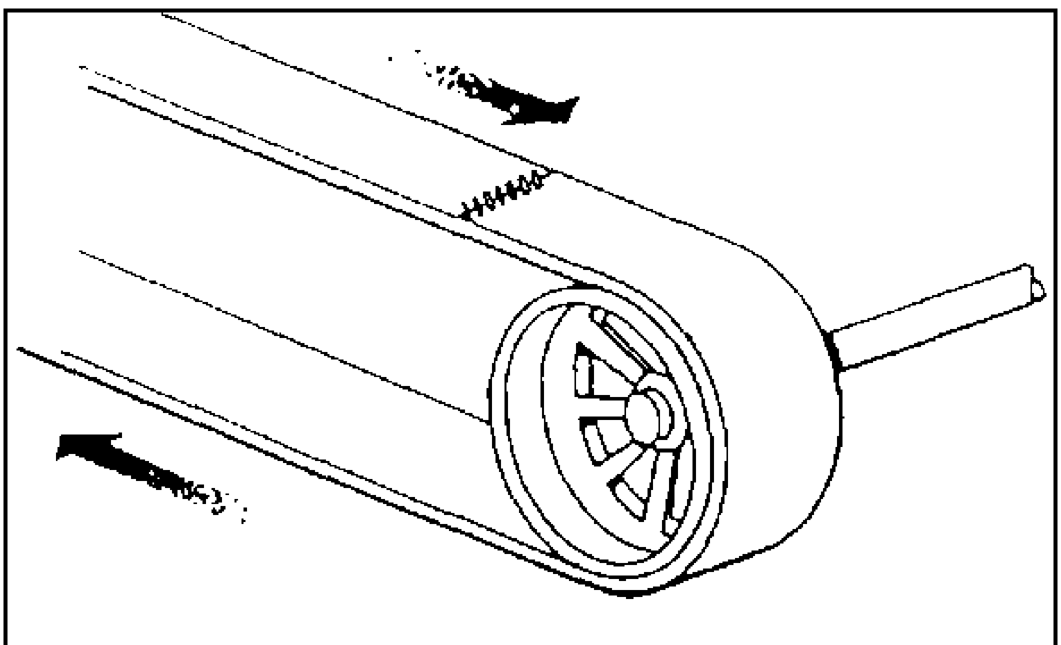
Figure 4. Nip points between rotating machine components ; (A - cover removed for clarity.)



Reciprocating motions may be hazardous because, during the back-and-forth or up-and-down motion, a worker may be struck by or caught between a moving and a stationary part. See Figure 5 for an example of a reciprocating motion.



Transverse motion (movement in a straight, continuous line) creates a hazard because a worker may be struck or caught in a pinch or shear point by the moving part. See Figure 6.



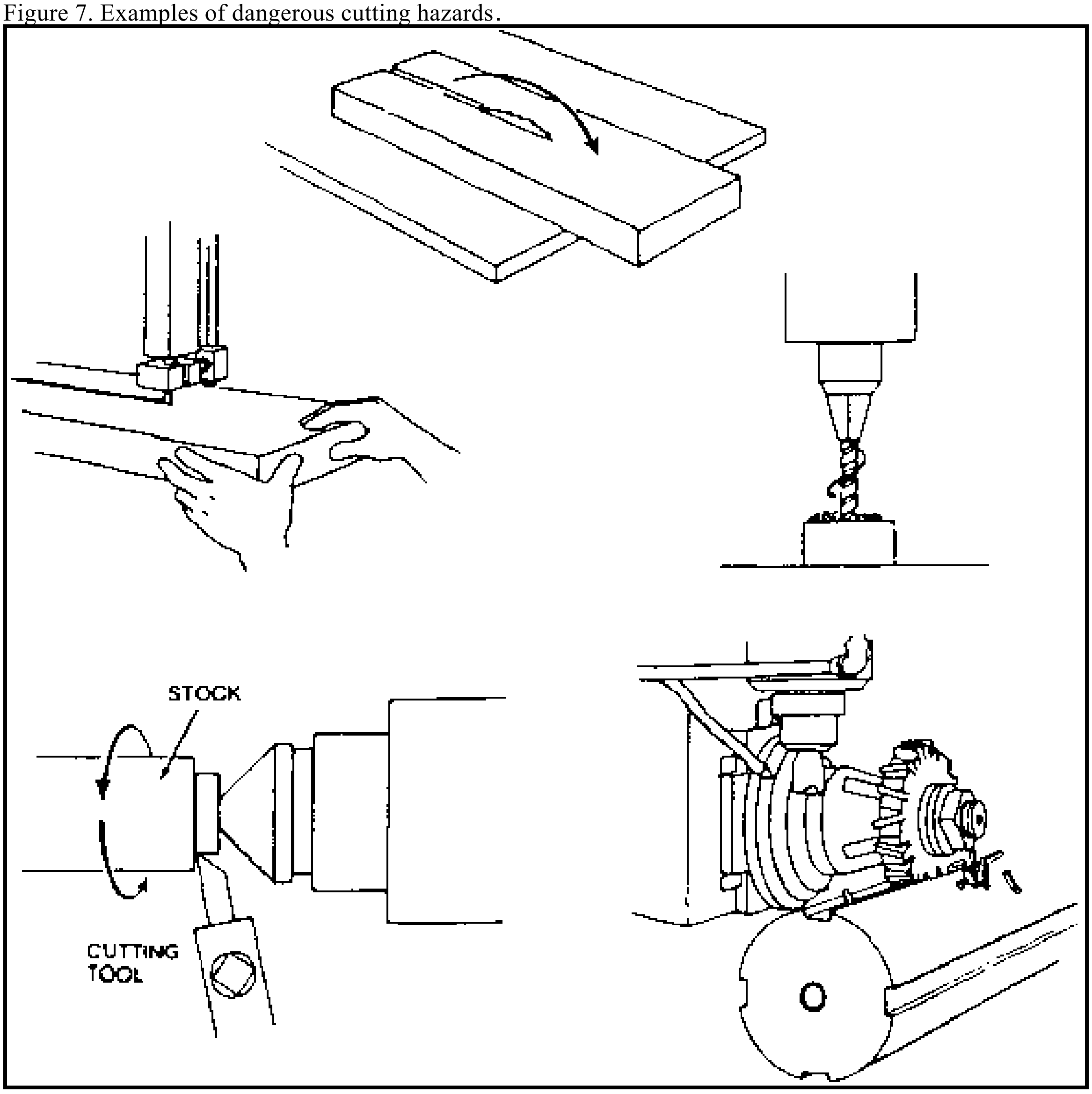
TRANSVERSE MOTION OF BELT

Actions

Cutting action may involve rotating, reciprocating, or transverse motion. The danger of cutting action exists at the point of operation where finger, arm and body injuries can occur and where flying chips or scrap material can strike the head, particularly in the area of the eyes or face. Such hazards are present at the point of operation in cutting wood, metal, or other materials.

Examples of mechanisms involving cutting hazards include bandsaws, circular saws, boring or drilling machines, turning machines (lathes), or milling machines. See Figure 7.

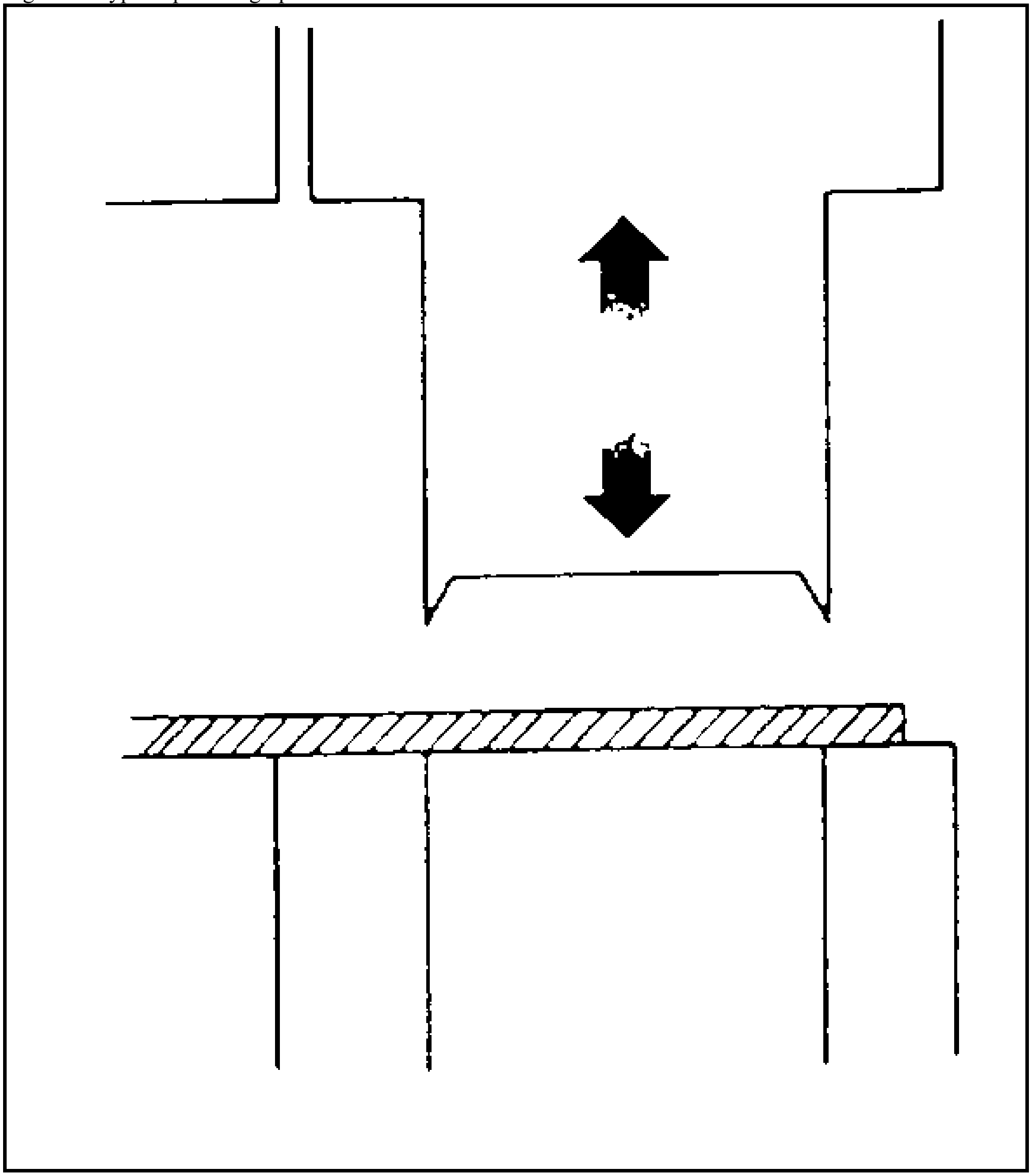
Figure 7. Examples of dangerous cutting hazards.



Punching action results when power is applied to a slide (ram) for the purpose of blanking, drawing, or stamping metal or other materials. The danger of this type of action occurs at the point of operation where stock is inserted, held, and withdrawn by hand.

Typical machines used for punching operations are power presses and iron workers. See Figure 8.

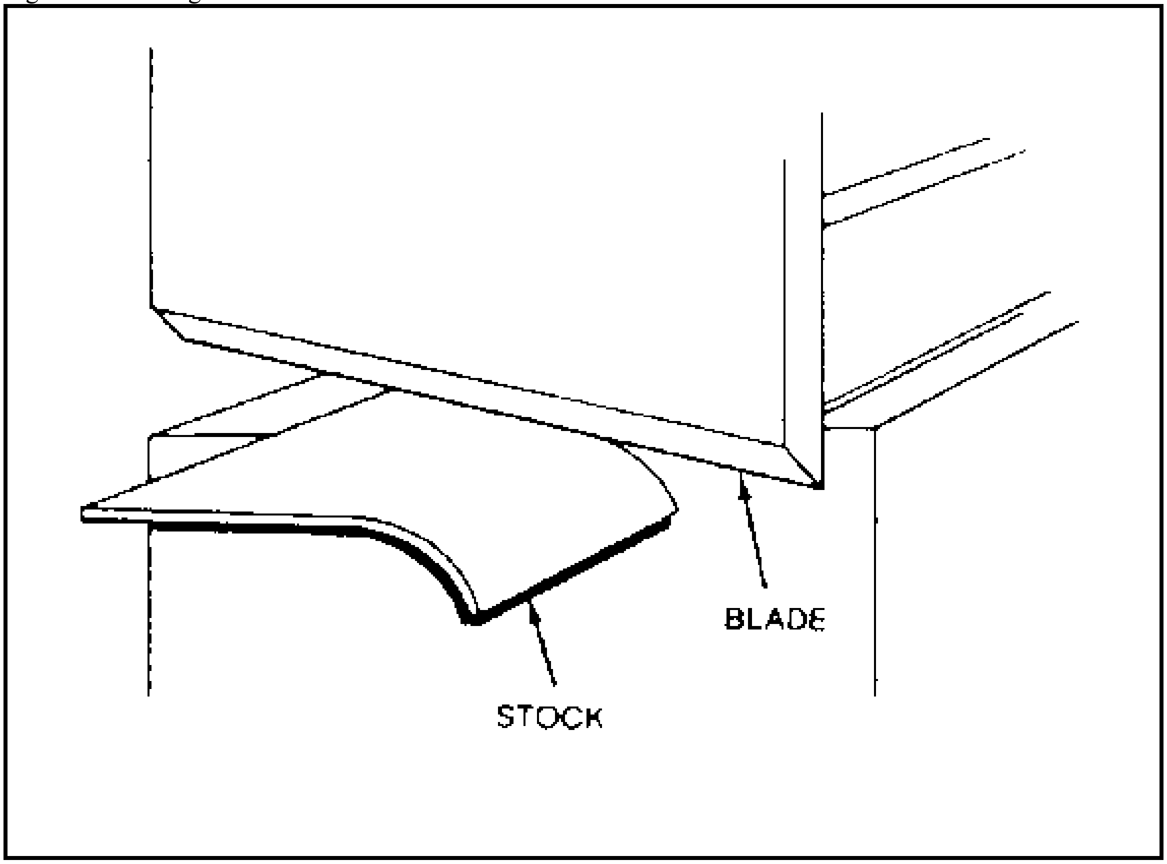
Figure 8. Typical punching operation.



Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials. A hazard occurs at the point of operation where stock is actually inserted, held, and withdrawn.

Examples of machines used for shearing operations are mechanically, hydraulically, or pneumatically powered shears. See Figure 9.

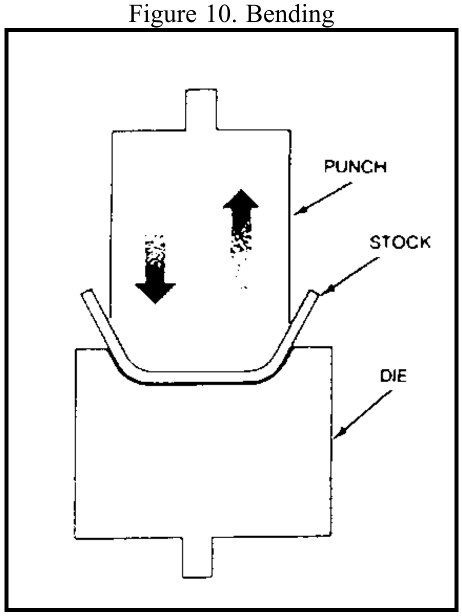
Figure 9. Shearing



Bending action results when power is applied to a slide in order to draw or stamp metal or other materials. A hazard occurs at the point of operation where stock is inserted, held, and withdrawn.

Equipment that uses bending action includes power presses, press brakes, and tubing benders. See Figure 10.

Figure 10. Bending



Requirements for Safeguards

What must a safeguard do to protect workers against mechanical hazards? Safeguards must meet these minimum general requirements:

Prevent contact: The safeguard must prevent hands, arms, and any other part of a worker's body from making contact with dangerous moving parts. A good safeguarding system eliminates the possibility of the operator or another worker placing parts of their bodies near hazardous moving parts.

Secure: Workers should not be able to easily remove or tamper with the safeguard, because a safeguard that can easily be made ineffective is no safeguard at all. Guards and safety devices should be made of durable material that will withstand the conditions of normal use. They must be firmly secured to the machine.

Protect from falling objects: The safeguard should ensure that no objects can fall into moving parts. A small tool which is dropped into a cycling machine could easily become a projectile that could strike and injure someone.

Create no new hazards: A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.

Create no interference: Any safeguard which impedes a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.

Allow safe lubrication: If possible, one should be able to lubricate the machine without removing the safeguards. Locating oil reservoirs outside the guard, with a line leading to the lubrication point, will reduce the need for the operator or maintenance worker to enter the hazardous area.

Nonmechanical Hazards

While this manual concentrates attention on concepts and techniques for safeguarding mechanical motion, machines obviously present a variety of other hazards which cannot be ignored. Full discussion of these matters is beyond the scope of this publication, but some nonmechanical hazards are briefly mentioned below to remind the reader of things other than safeguarding moving parts that can affect the safe operation of machines.

All power sources for machines are potential sources of danger. When using electrically powered or controlled machines, for instance, the equipment as well as the electrical system itself must be properly grounded. Replacing frayed, exposed, or old wiring will also help to protect the operator and others from electrical shocks or electrocution. High pressure systems, too, need careful inspection and maintenance to prevent possible failure from pulsation, vibration, or leaks. Such a failure could cause, among other things, explosions or flying objects.

Machines often produce noise (unwanted sound) which can result in a number of hazards to workers. Noise can startle and disrupt concentration, and can interfere with communications, thus hindering the worker's safe job performance. Research has linked noise to a whole range of harmful health effects, from hearing loss and aural pain to nausea, fatigue, reduced muscle control, and emotional disturbance. Engineering controls such as the use of sound-dampening materials, and personal protective equipment, such as ear plugs and muffs, can help control the harmful effects of noise. Also, administrative controls that involve removing the worker from the noise source can be an effective measure when feasible.

Because some machines require the use of cutting fluids, coolants, and other potentially harmful substances, operators, maintenance workers, and others in the vicinity may need protection. These substances can cause ailments ranging from dermatitis to serious illnesses and disease. Specially constructed safeguards, ventilation, and protective equipment and clothing are possible temporary solutions to the problem of machinery-related chemical hazards until these hazards can be better controlled or eliminated from the workplace.

Training

Even the most elaborate safeguarding system cannot offer effective protection unless the worker knows how to use it and why. Specific and detailed training is therefore a crucial part of any effort to provide safeguarding against machine-related hazards. Thorough operator training should involve instruction or hands-on training in the following:

1. a description and identification of the hazards associated with particular machines;
2. the safeguards themselves, how they provide protection, and the hazards for which they are intended;
3. how to use the safeguards and why;
4. how and under what circumstances safeguards can be removed, and by whom (in most cases, repair or maintenance personnel only); and
5. what to do (e.g., contact the supervisor) if a safeguard is damaged, missing, or unable to provide adequate protection.

This kind of safety training is necessary for new operators and maintenance or setup personnel, when any new or altered safeguards are put in service, or when workers are assigned to a new machine or operation.

Protective Clothing and Personal Protective Equipment

Engineering controls, that eliminate the hazard at the source and do not rely on the worker's behavior for their effectiveness offer the best and most reliable means of safeguarding. Therefore, engineering controls must be the employer's first choice for eliminating machine hazards. But whenever engineering controls are not available or are not fully capable of protecting the employee (an extra measure of protection is necessary), operators must wear protective clothing or personal protective equipment.

If it is to provide adequate protection, the protective clothing and equipment selected must always be:

1. appropriate for the particular hazards;
2. maintained in good condition;
3. properly stored when not in use, to prevent damage or loss; and
4. kept clean, fully functional, and sanitary.

Protective clothing is, of course, available for different parts of the body. Hard hats can protect the head from the impact of bumps and falling objects when the worker is handling stock; caps and hair nets can help keep the worker's hair from being caught in machinery. If machine coolants could splash or particles could fly into the operator's eyes or face, then face shields, safety goggles, glasses, or similar kinds of protection might be necessary. Hearing protection may be needed when workers operate noisy machines. To guard the trunk of the body from cuts or impacts from heavy or rough-edged stock, there are certain protective coveralls, jackets, vests, aprons, and full-body suits. Workers can protect their hands and arms from the same kinds of injury with special sleeves and gloves. Safety shoes and boots, or other acceptable foot guards, can shield the feet against injury in case the worker needs to handle heavy stock which might drop.

It is important to note that protective clothing and equipment can create hazards. A protective glove which can become caught between rotating parts, or a respirator facepiece which hinders the wearer's vision, for example, require alertness and continued attentiveness whenever they are used.

Other parts of the worker's clothing may present additional safety hazards. For example, loose-fitting shirts might possibly become entangled in rotating spindles or other kinds of moving machinery. Jewelry, such as bracelets and rings, can catch on machine parts or stock and lead to serious injury by pulling a hand into the danger area.

Chapter 2 –

Methods of Machine Safeguarding

There are many ways to safeguard machines. The type of operation, the size or shape of stock, the method of handling, the physical layout of the work area, the type of material, and production requirements or limitations will help to determine the appropriate safeguarding method for the individual machine.

As a general rule, power transmission apparatus is best protected by fixed guards that enclose the danger areas. For hazards at the point of operation, where moving parts actually perform work on stock, several kinds of safeguarding may be possible. One must always choose the most effective and practical means available.

We can group safeguards under five general classifications.

1. Guards
    - A. Fixed
    - B. Interlocked
    - C. Adjustable
    - D. Self-adjusting

2. Devices
    - A. Presence Sensing
        - (1) Photoelectrical (optical)
        - (2) Radiofrequency (capacitance)
        - (3) Electromechanical
    - B. Pullback
    - C. Restraint
    - D. Safety Controls
        - (1) Safety trip control
            - (a) Pressure-sensitive body bar
            - (b) Safety tripod
            - (c) Safety tripwire cable
        - (2) Two-hand control
        - (3) Two-hand trip
    - E. Gates
        - (1) Interlocked
        - (2) Other

3. Location/Distance

4. Potential Feeding and Ejection Methods to Improve Safety for the Operator
    - A. Automatic feed
    - B. Semi-automatic feed
    - C. Automatic ejection
    - D. Semi-automatic ejection
    - E. Robot

5. Miscellaneous Aids
    - A. Awareness barriers
    - B. Miscellaneous protective shields
    - C. Hand-feeding tools and holding fixtures

Guards

Guards are barriers which prevent access to danger areas. There are four general types of guards:

Fixed: As its name implies, a fixed guard is a permanent part of the machine. It is not dependent upon moving parts to perform its intended function. It may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material that is substantial enough to withstand whatever impact it may receive and to endure prolonged use. This guard is usually preferable to all other types because of its relative simplicity and permanence.

Examples of fixed guards...

In Figure 11, a fixed guard on a power press completely encloses the point of operation. The stock is fed through the side of the guard into the die area, with the scrap stock exiting on the opposite side.

Figure 11. Fixed guard on power press.

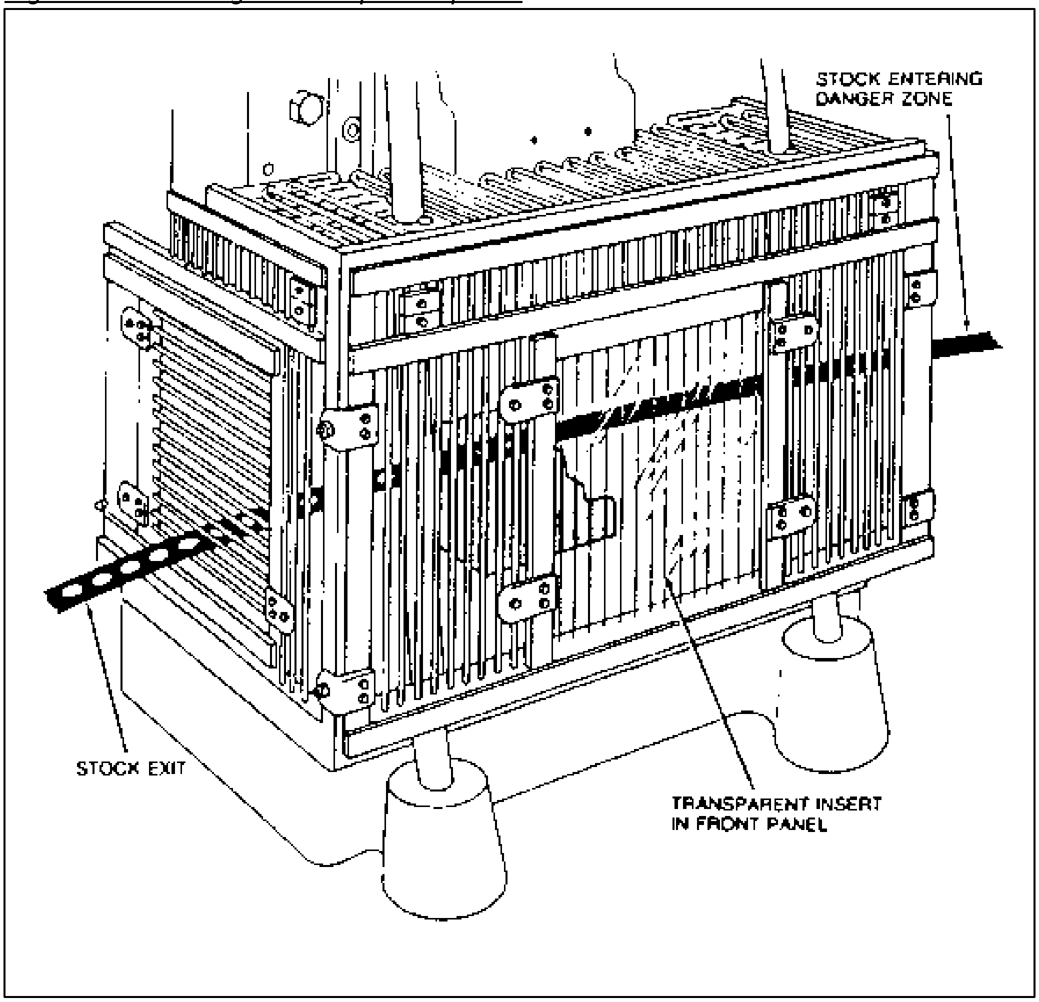


Figure 12 shows a fixed guard that protects the operator from a mechanism that folds cartons. This guard would not normally be removed except to perform maintenance on the machine. Figure 13 shows a fixed enclosure guard shielding the belt and pulley of a power transmission unit. An inspection panel is provided on top in order to minimize the need for removing the guard. To remain effective, the inspection panel cannot be removed while the mechanism is in operation.

In Figure 14, fixed enclosure guards are shown on a bandsaw. These guards protect the operator from the turning wheels and moving saw blade. Normally, the only time for the guards to be opened or removed would be for a blade change or maintenance. It is very important that they be securely fastened while the saw is in use.

Figure 12. Fixed guard on egg carton folding machine.

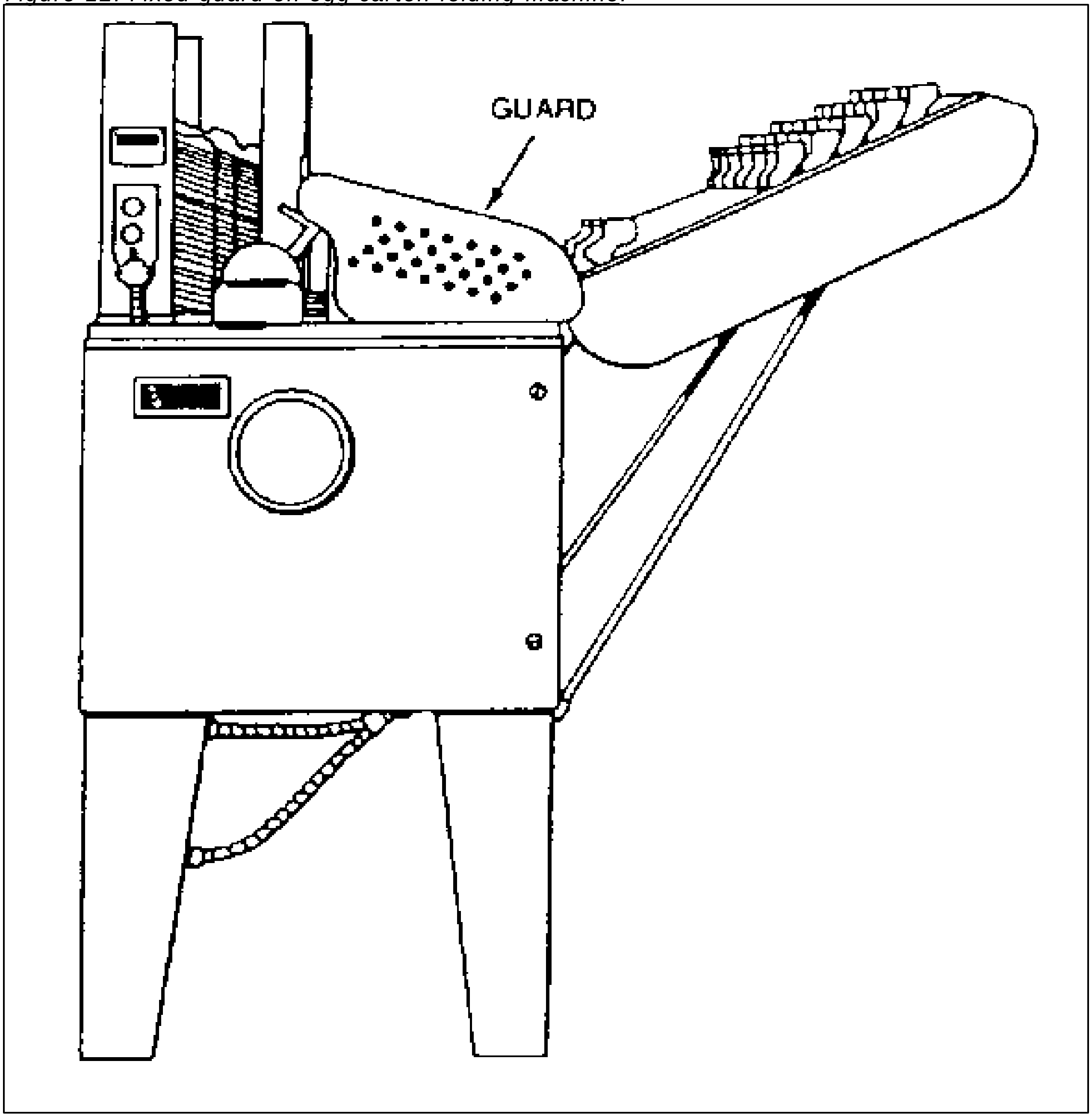


Figure 13. Fixed guard enclosing belt and pulleys.

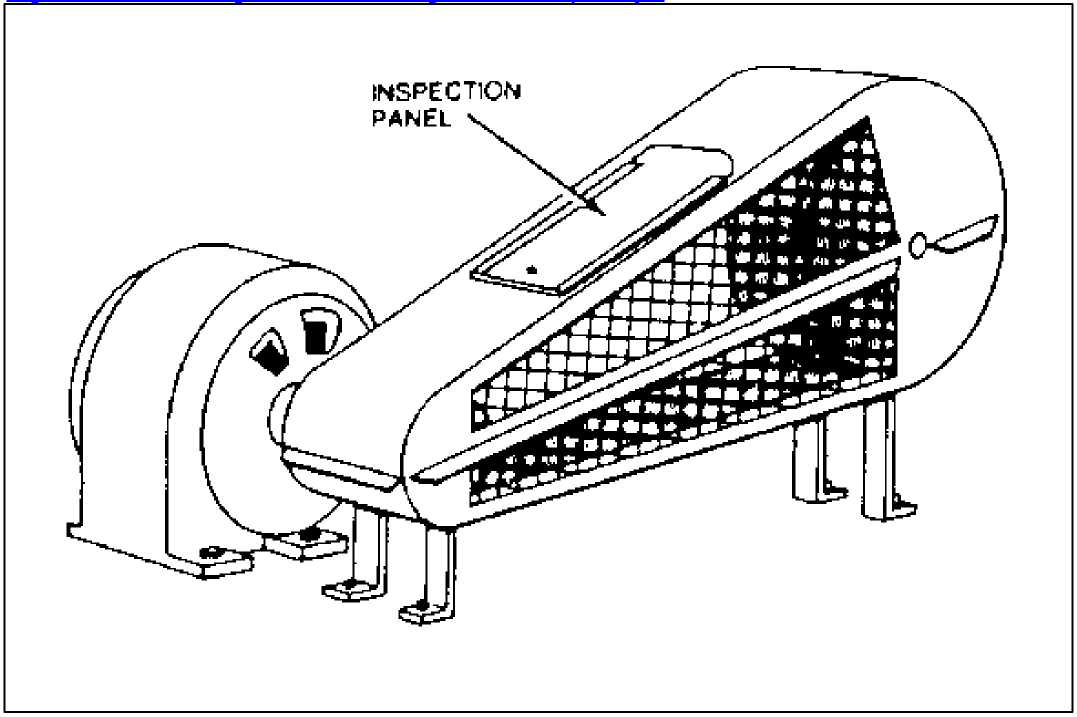
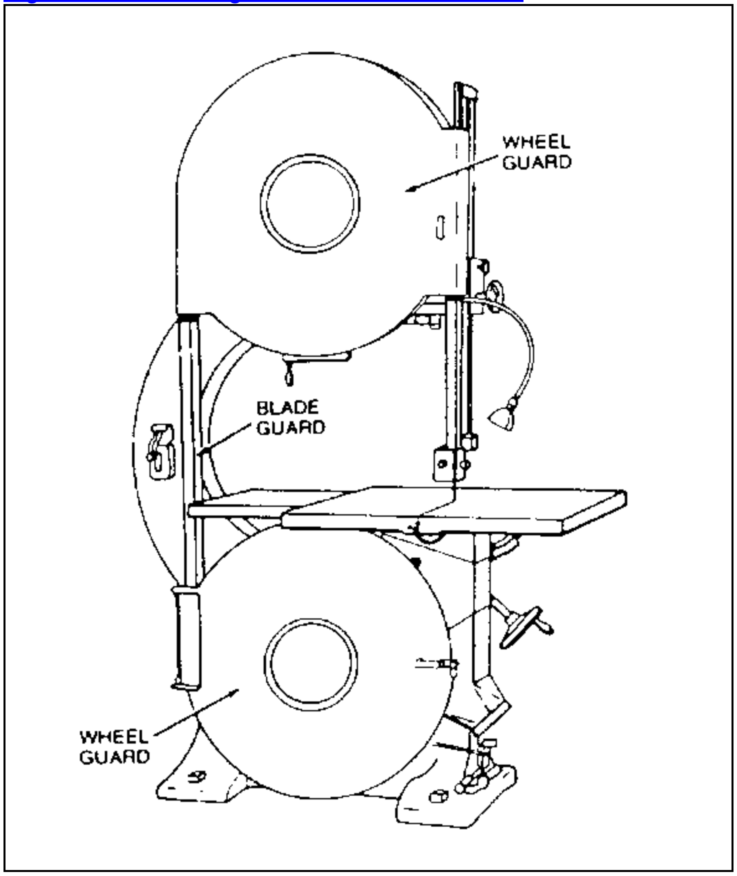


Figure 14. Fixed guards on a band saw.



A fixed guard is shown on a veneer clipper in Figure 15. This guard acts as a barrier, protecting fingers from exposure to the blade. Note the side view of the curved portion of the guard.

Figure 15. Fixed guards on veneer clipper.

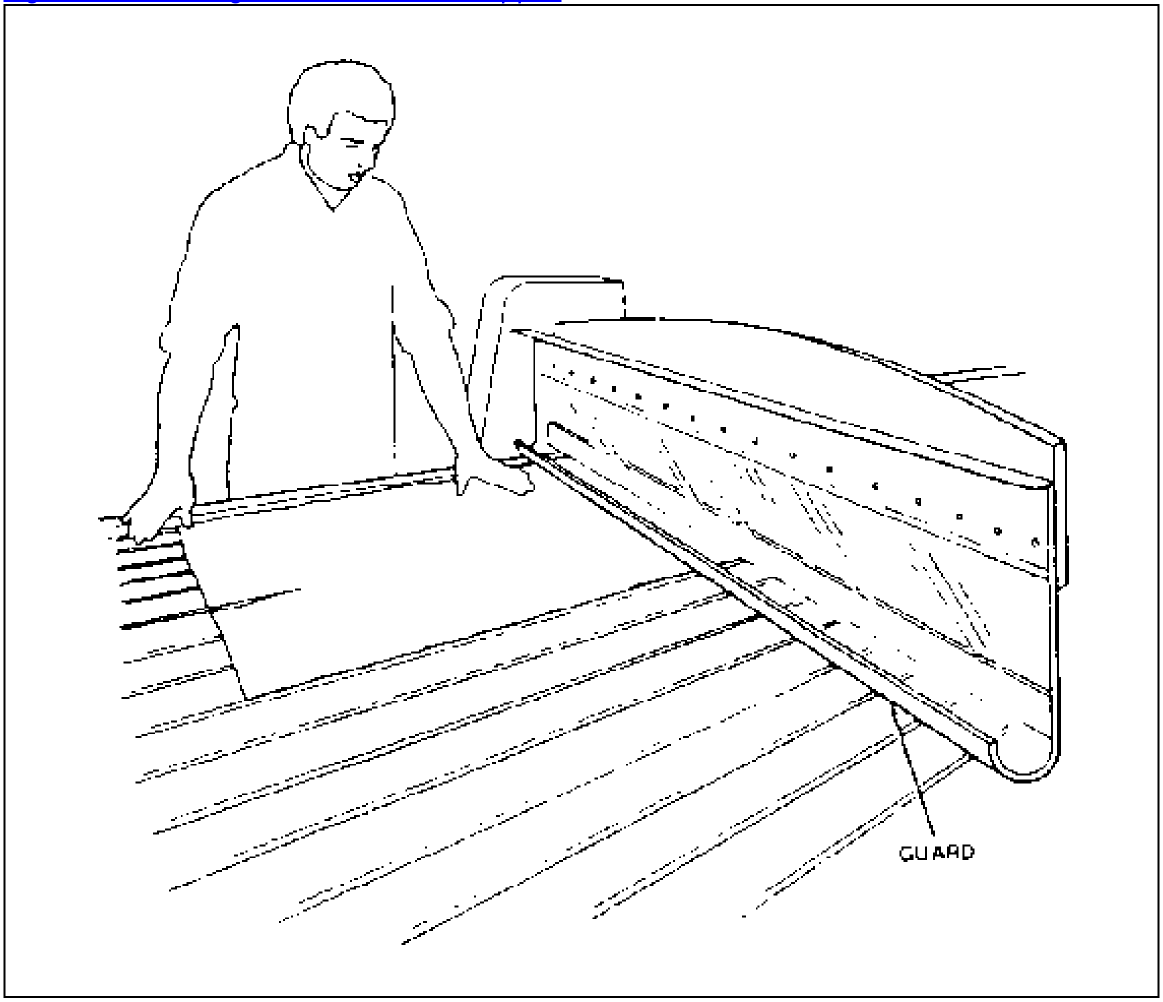
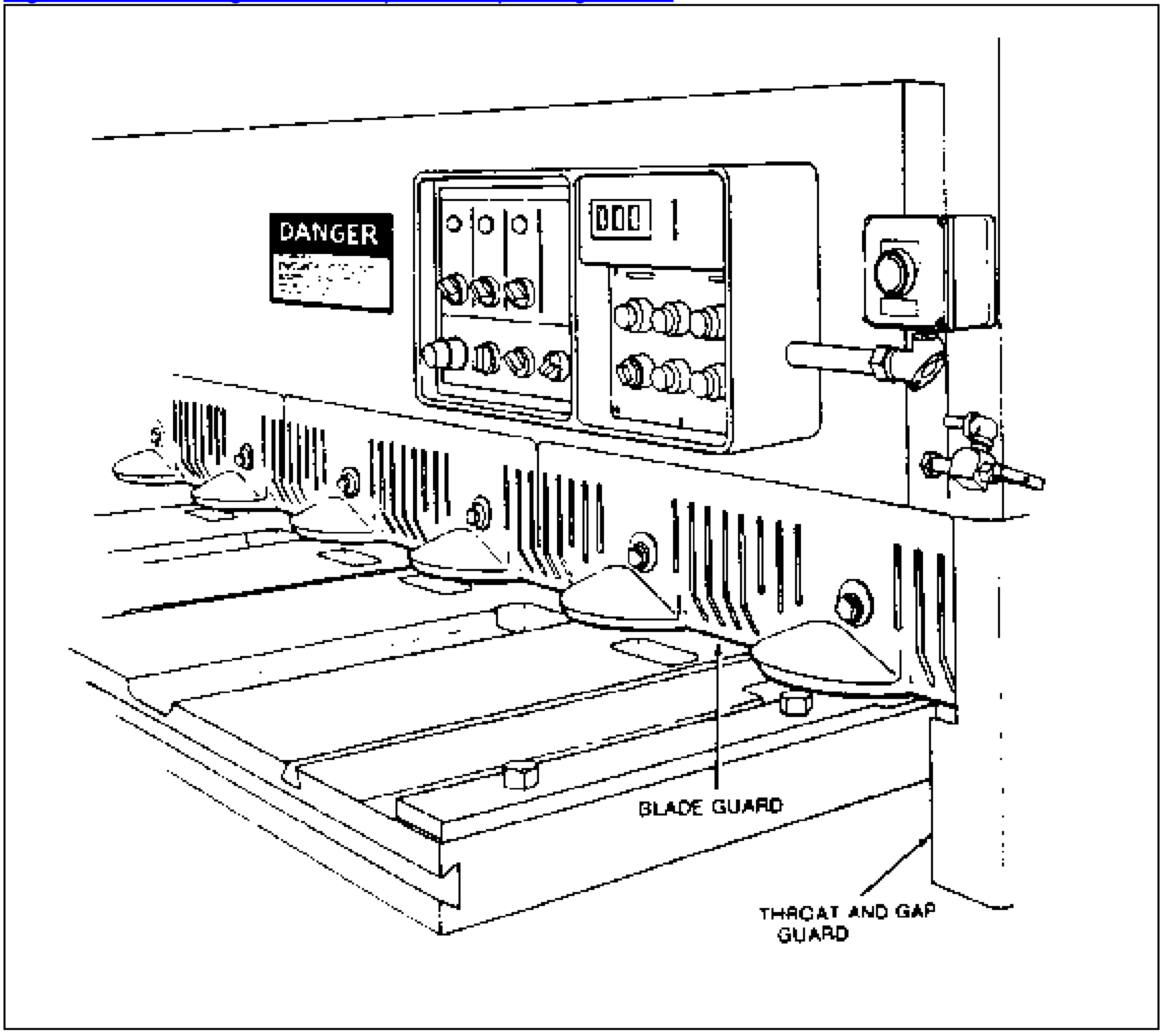


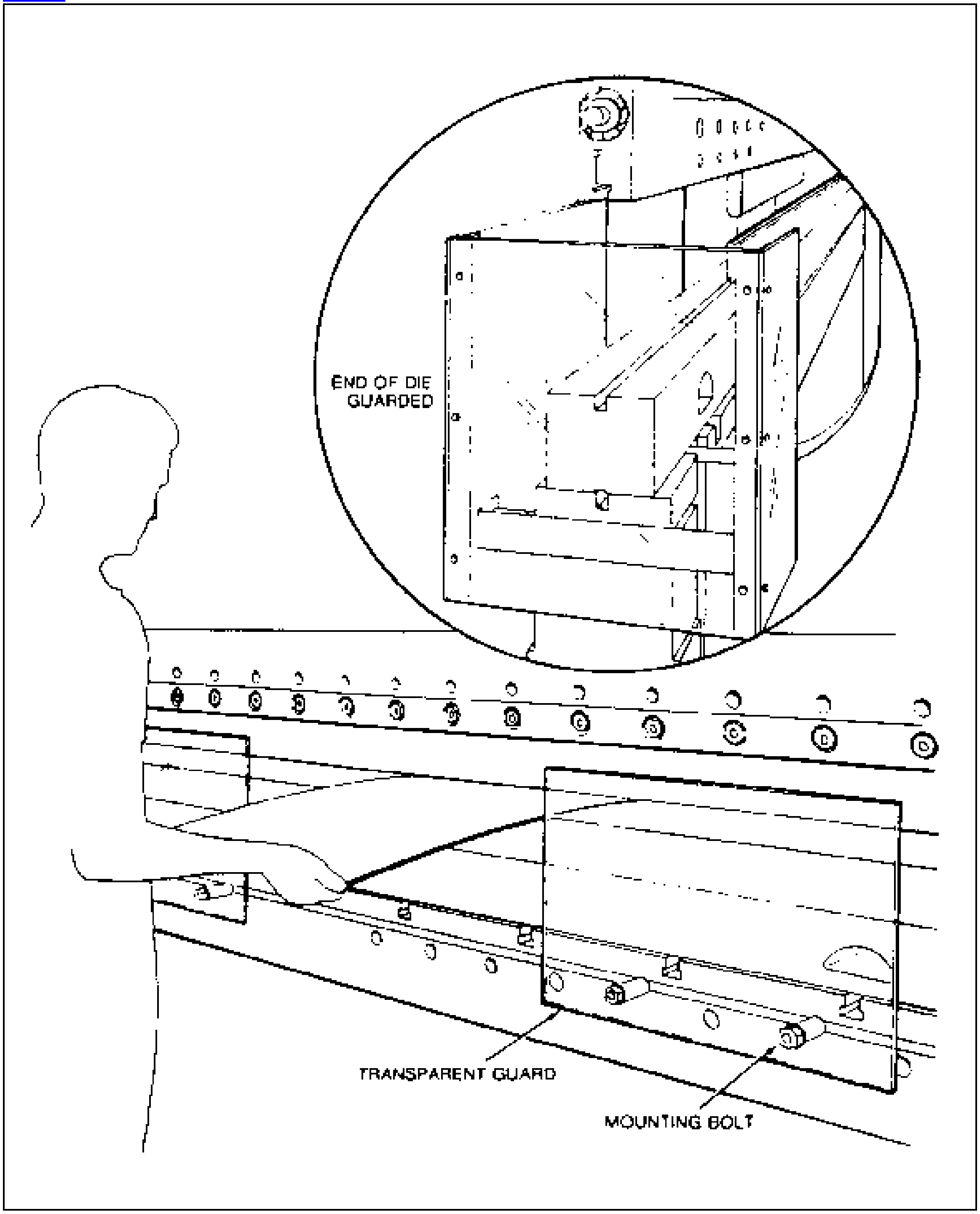
Figure 16 shows both a fixed blade guard and a throat and gap guard on a power squaring shear. These guards should be removed only for maintenance or blade changes.

Figure 16. Fixed guard on a power squaring shear.



In Figure 17, a transparent, fixed barrier guard is being used on a press brake to protect the operator from the unused portions of the die. This guard is easy to install or remove.

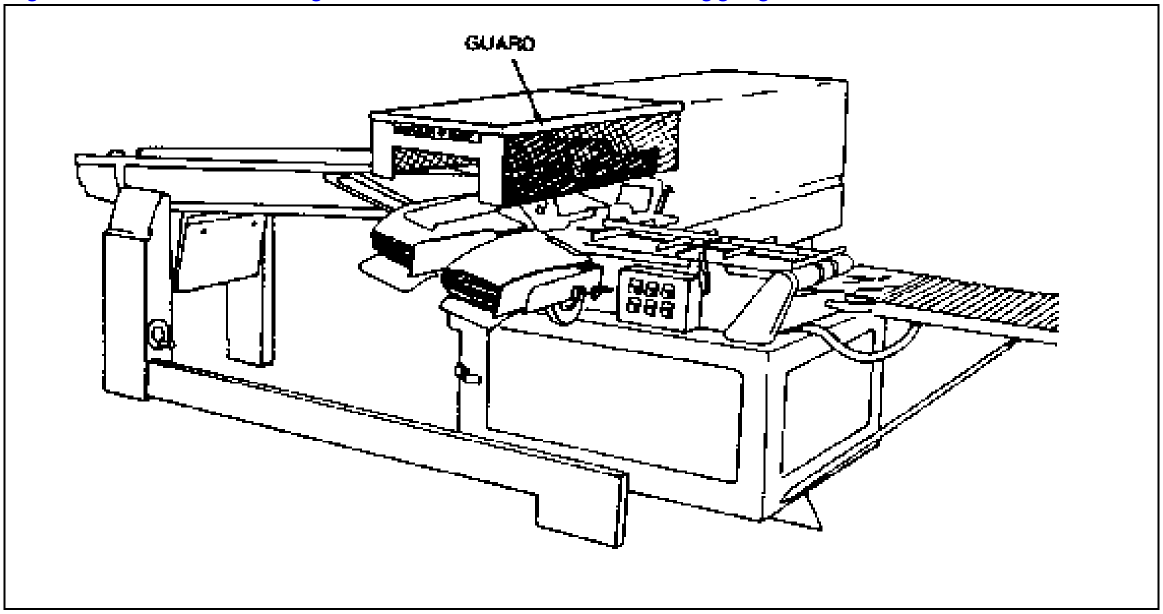
Figure 17. Fixed guard providing protection from unused portion of die on a press brake.



Interlocked: When this type of guard is opened or removed, the tripping mechanism and/or power automatically shuts off or disengages, and the machine cannot cycle or be started until the guard is back in place.
An interlocked guard may use electrical, mechanical, hydraulic, or pneumatic power or any combination of these. Interlocks should not prevent "inching" by remote control if required. Replacing the guard should not automatically restart the machine. To be effective, all movable guards should be interlocked to prevent occupational hazards. (See also Figure 13.)

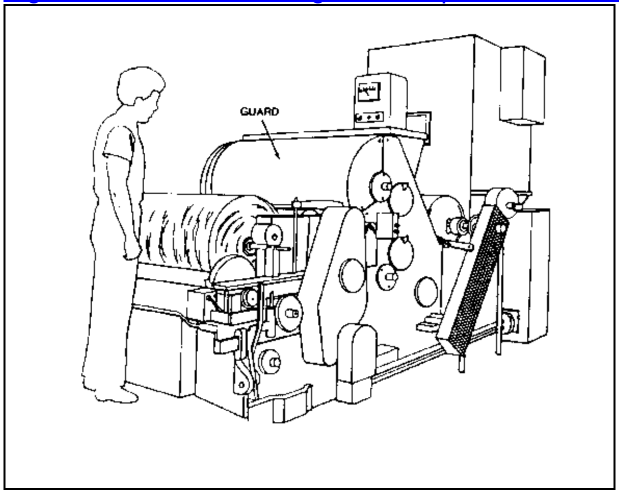
Figure 18 shows an interlocked barrier guard mounted on an automatic bread bagging machine. When the guard is removed, the machine will not function.

Figure 18. Interlocked guard on automatic bread bagging machine



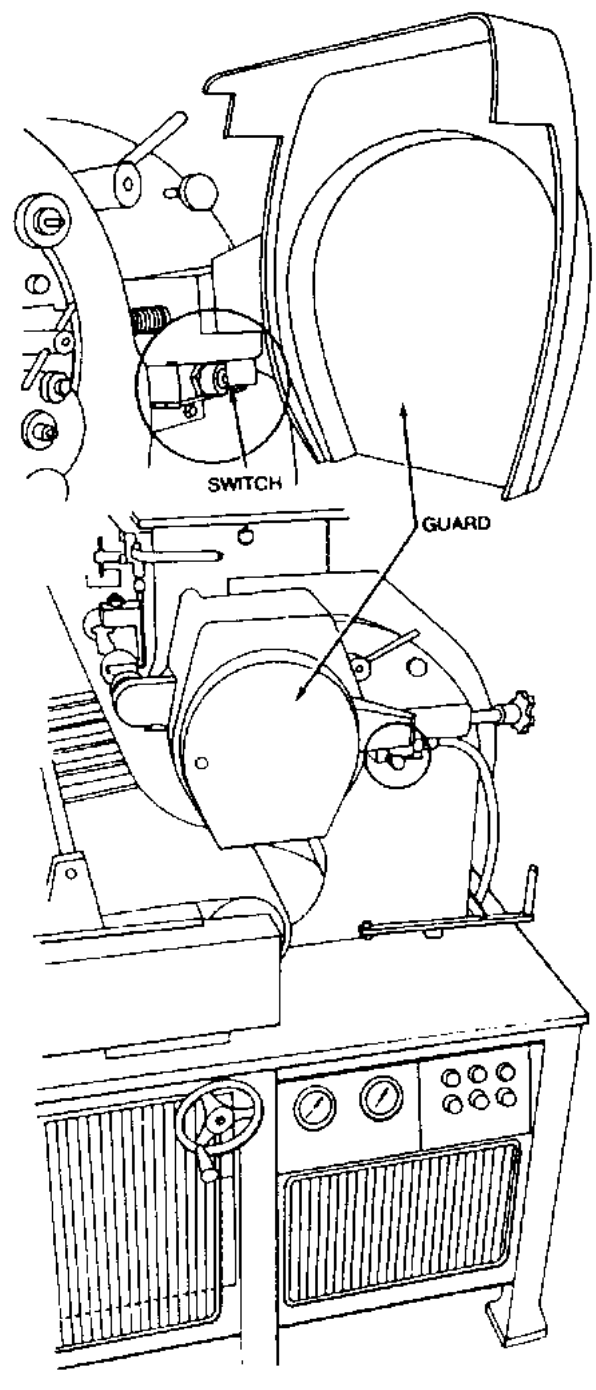
In Figure 19, the beater mechanism of a picker machine (used in the textile industry) is covered by an interlocked barrier guard. This guard cannot be raised while the machine is running, nor can the machine be restarted with the guard in the raised position.

Figure 19. Interlocked guard on picker machine



In Figure 20, an interlocked guard covers the rotating cylinder of the dividing head of a roll make-up machine used for making hamburger and hot-dog rolls.

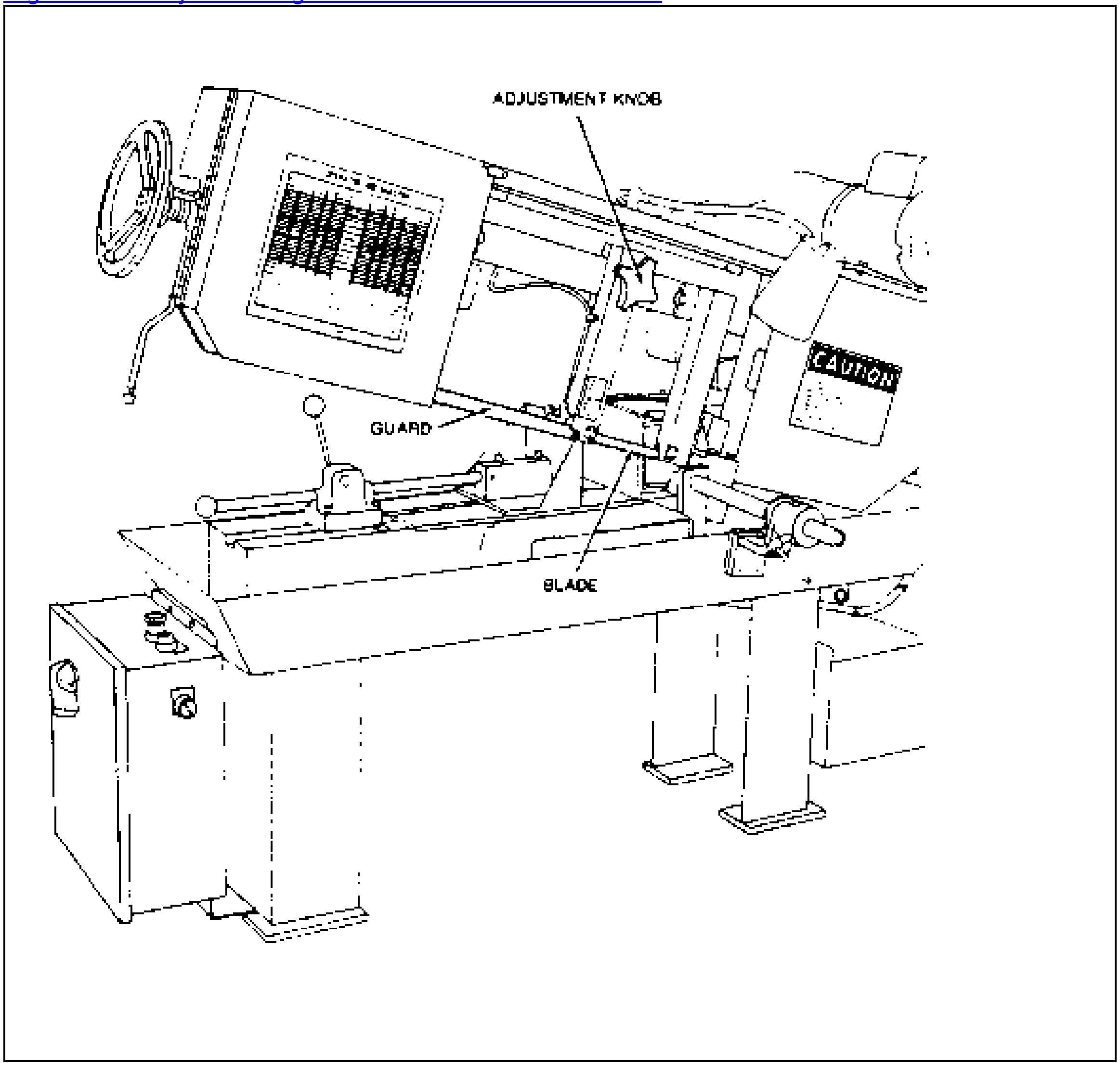
Figure 20. Interlocked guard on roll make-up machine



Adjustable: Adjustable guards are useful because they allow flexibility in accommodating various sizes of stock.

Figure 21 shows a bandsaw with an adjustable guard to protect the operator from the unused portion of the blade. This guard can be adjusted according to the size of stock.

Figure 21. Adjustable guard on horizontal bandsaw.



In Figure 22, the bars adjust to accommodate the size and shape of the stock. Figures 23 and 24 show guards that can be adjusted according to the thickness of the stock.

Figure 22. Adjustable guard on power press.

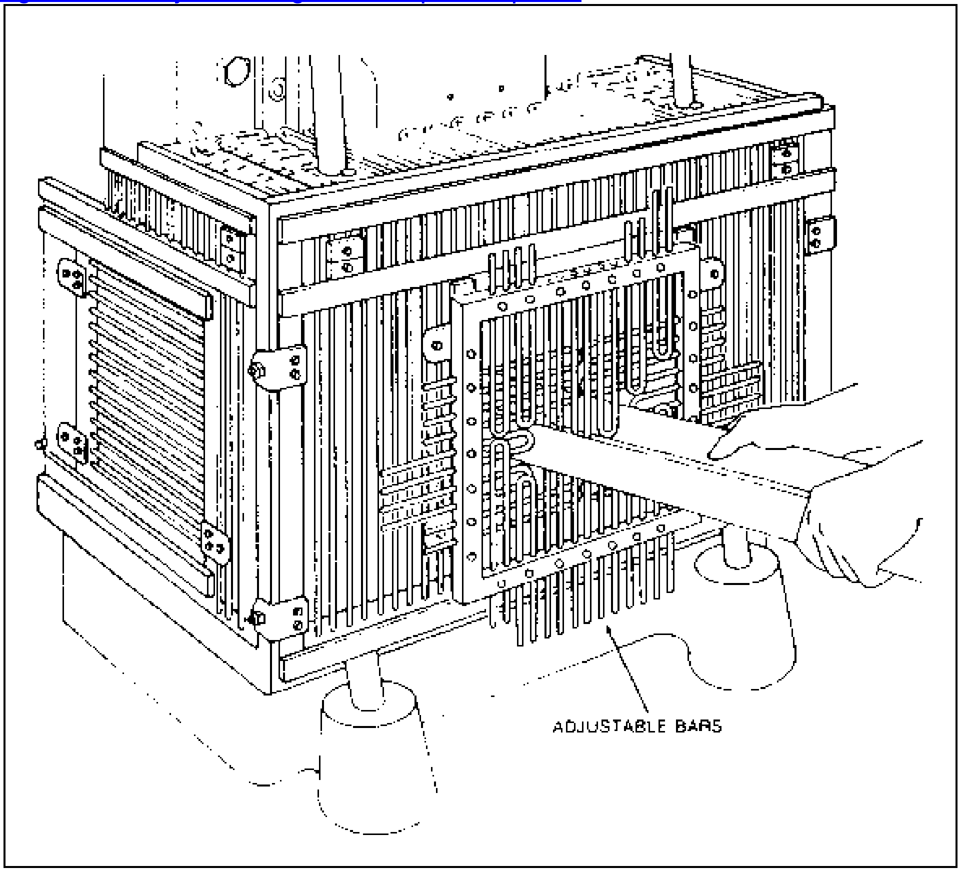


Figure 23. Adjustable guard on router.

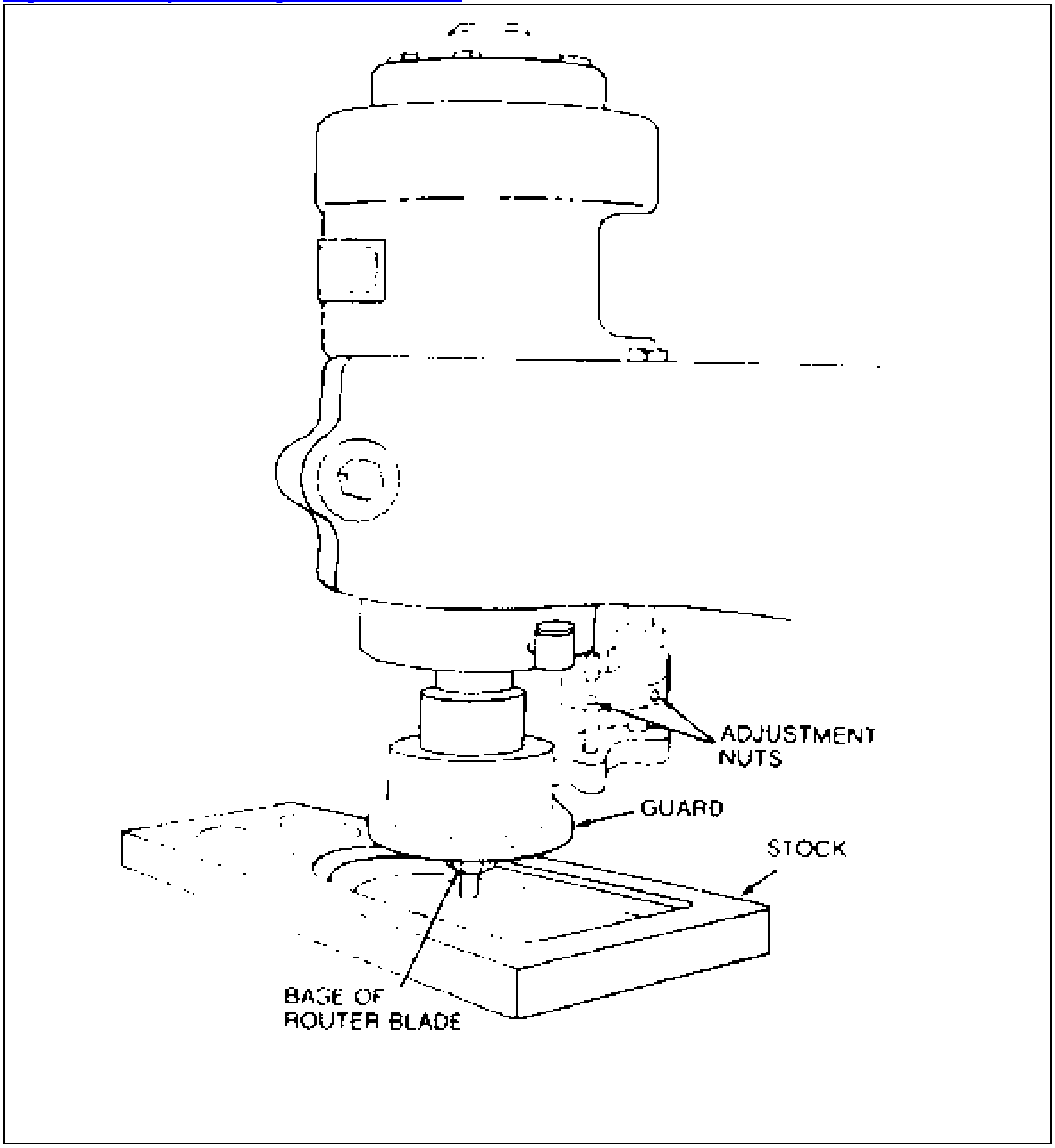
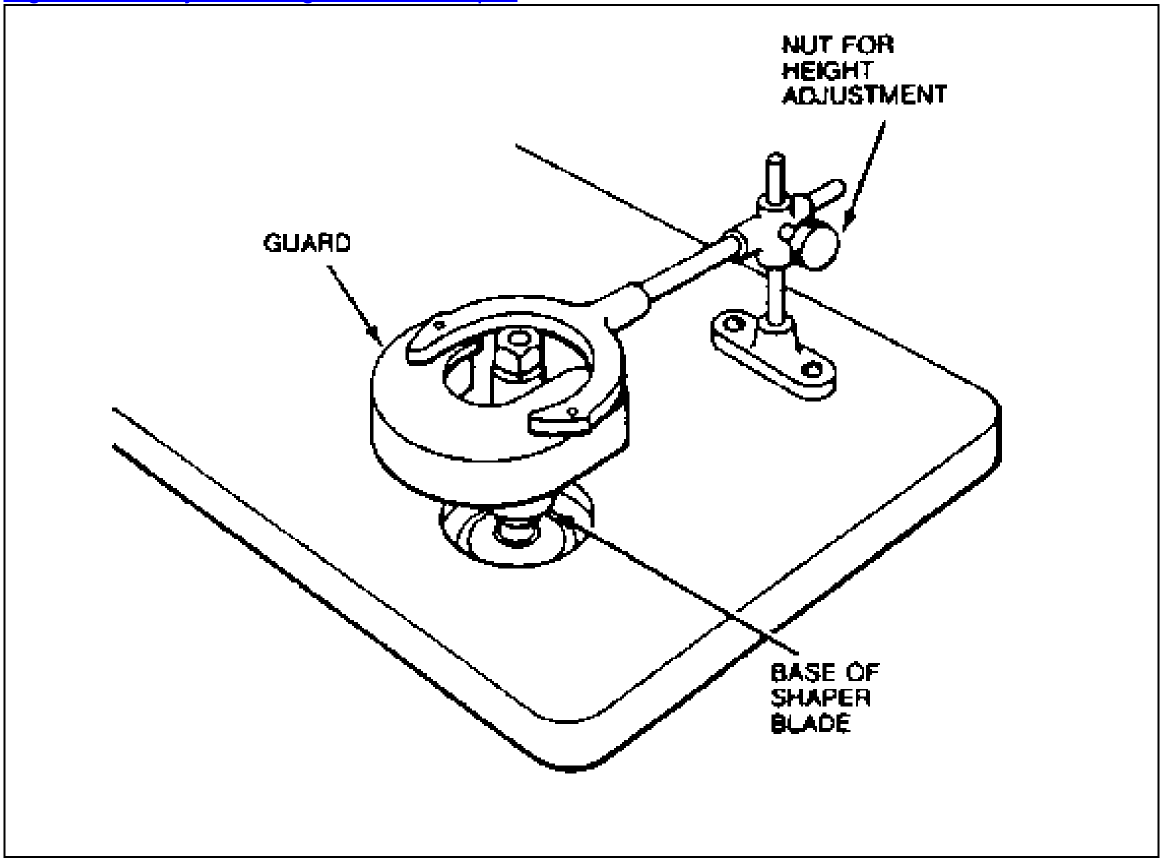


Figure 24. Adjustable guard on shaper.



In Figure 25, the guard adjusts to provide a barrier between the operator and the blade.

Figure 25. Adjustable guard on table saw.

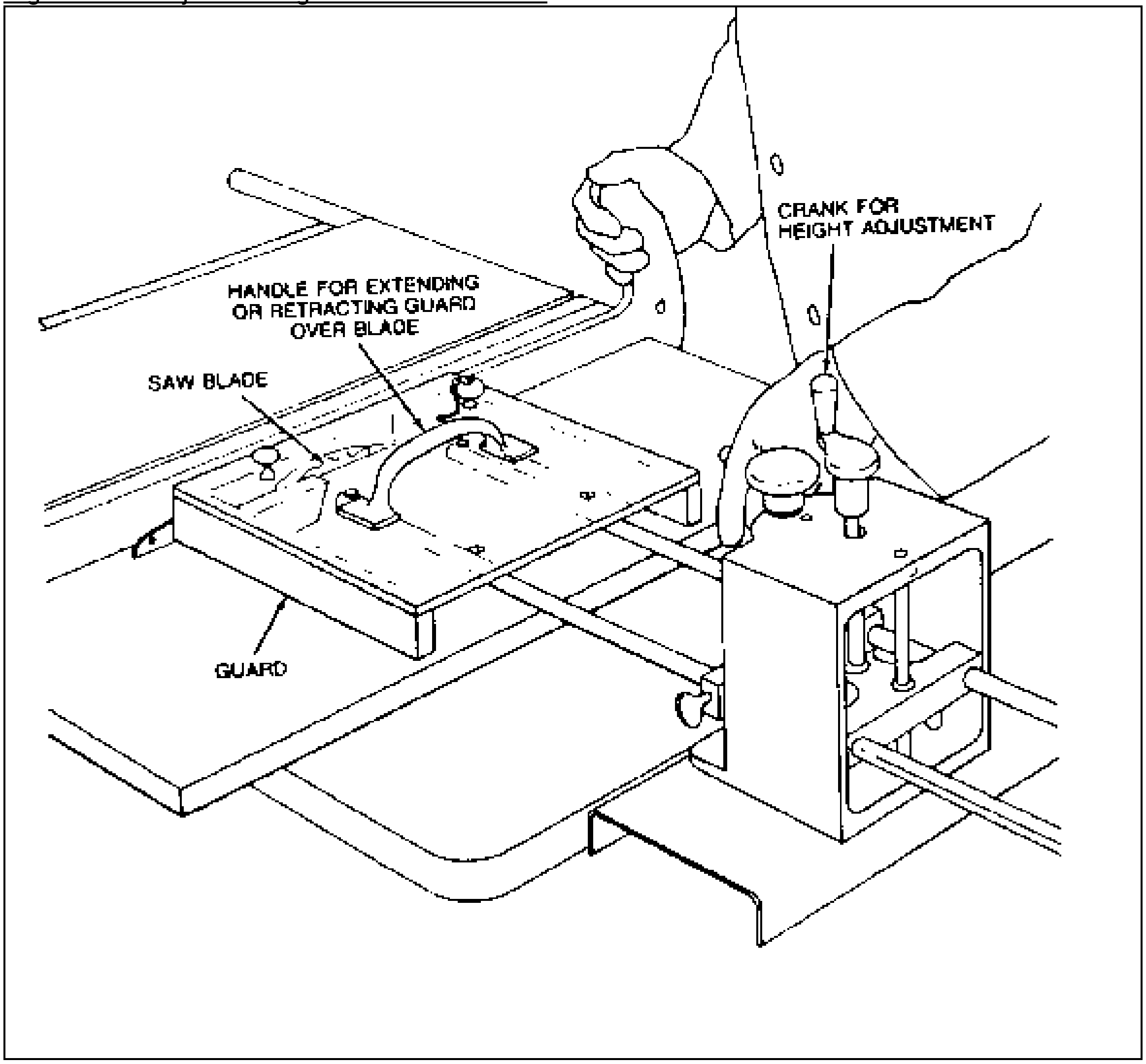
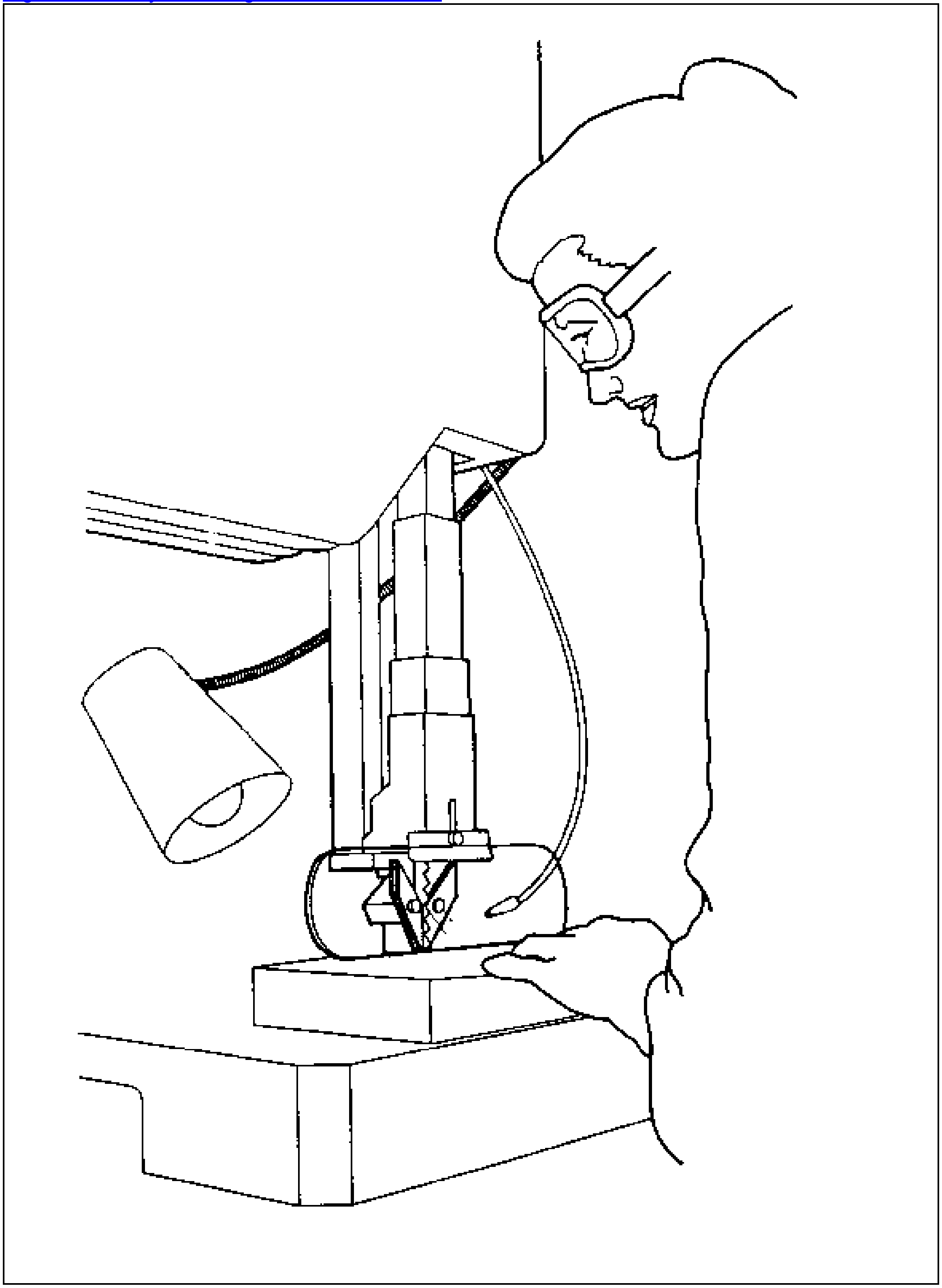


Figure 26 shows an adjustable enclosure guard on a bandsaw.

Figure 26. Adjustable guard on bandsaw.



Self-Adjusting: The openings of these barriers are determined by the movement of the stock. As the operator moves the stock into the danger area, the guard is pushed away, providing an opening which is only large enough to admit the stock. After the stock is removed, the guard returns to the rest position. This guard protects the operator by placing a barrier between the danger area and the operator. The guards may be constructed of plastic, metal, or other substantial material. Self-adjusting guards offer different degrees of protection.

Examples of self-adjusting guards...

Figure 27 shows a radial arm saw with a self-adjusting guard. As the blade is pulled across the stock, the guard moves up, staying in contact with the stock.

Figure 27. Self-adjusting guard on radial arm saw.

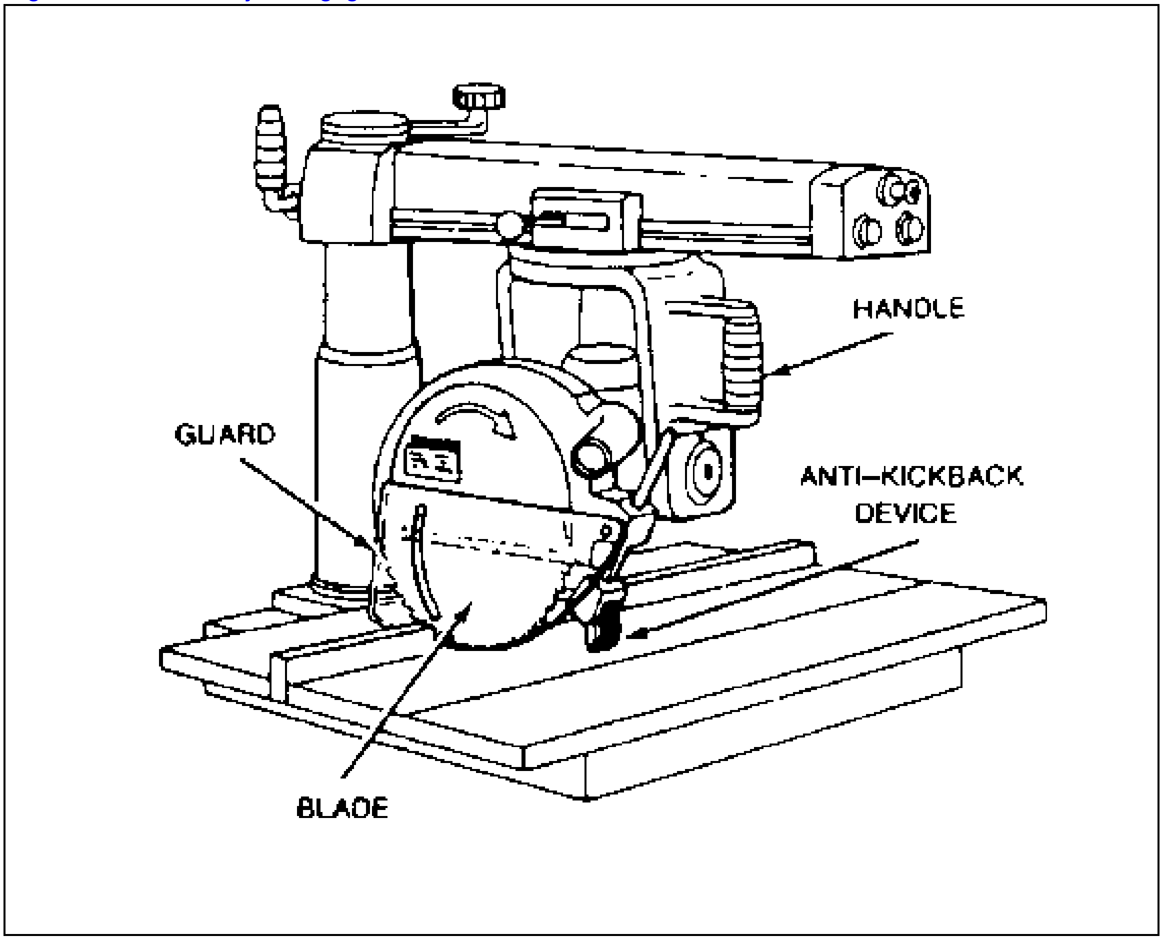
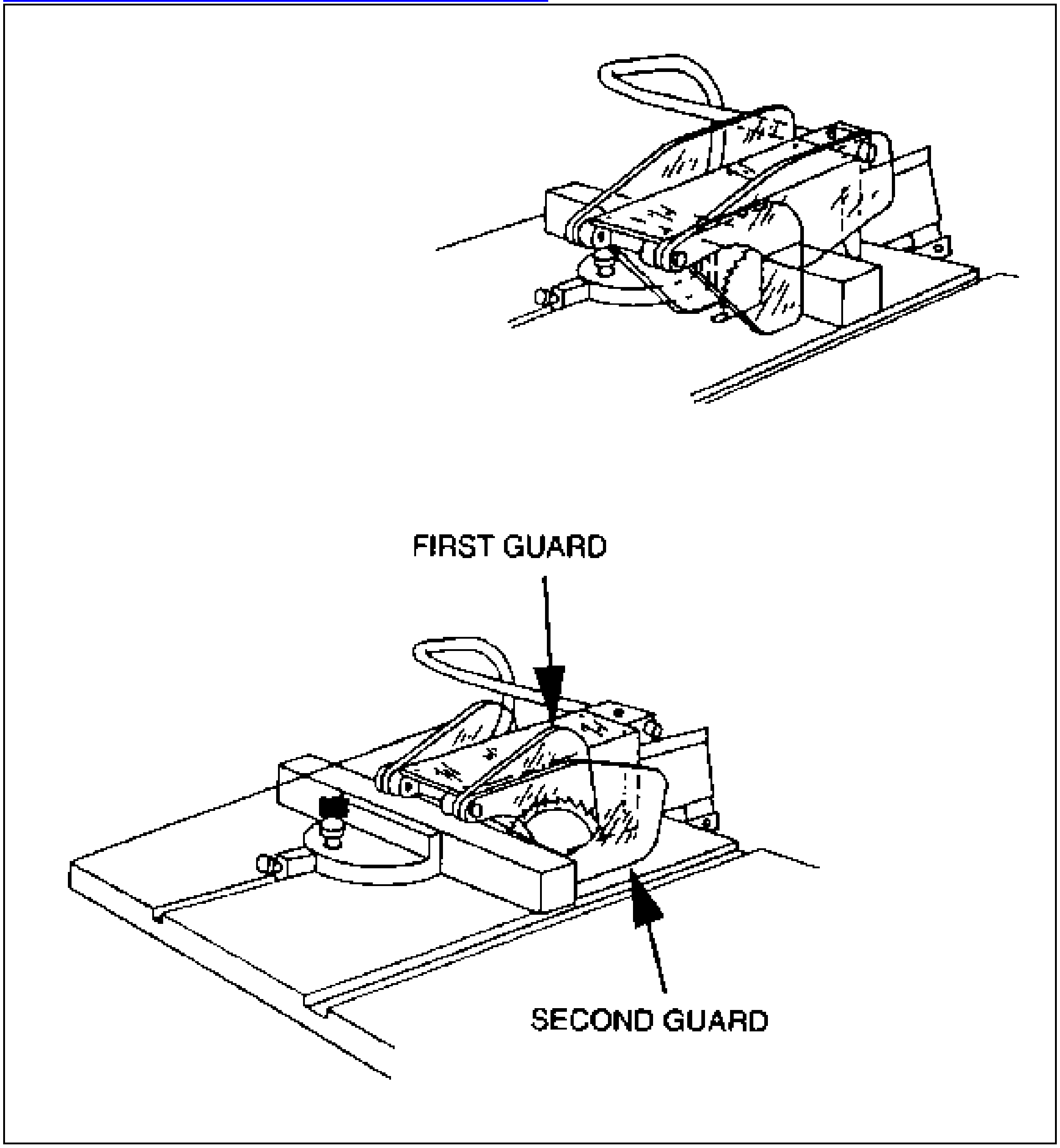


Figure 28 shows a twin-action, transparent, self-adjusting guard. The first guard rises as the stock enters, then returns to its rest position as the stock moves ahead to raise the second guard.



A self-adjusting guard is shown in Figure 29. As the blade moves through the stock, the guard rises up to the stock surface.

Figure 29. Self-adjusting guard on circular saw.

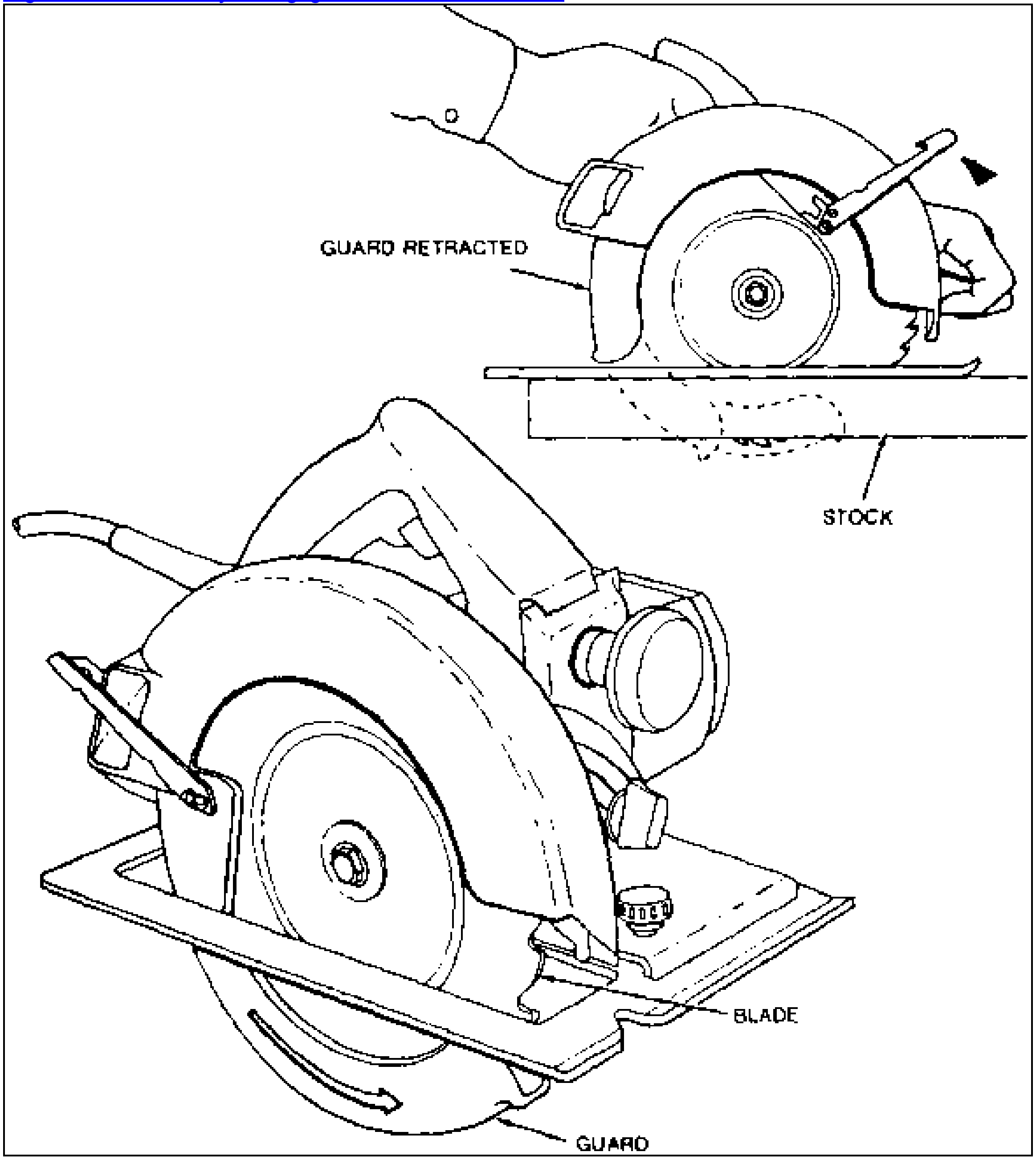
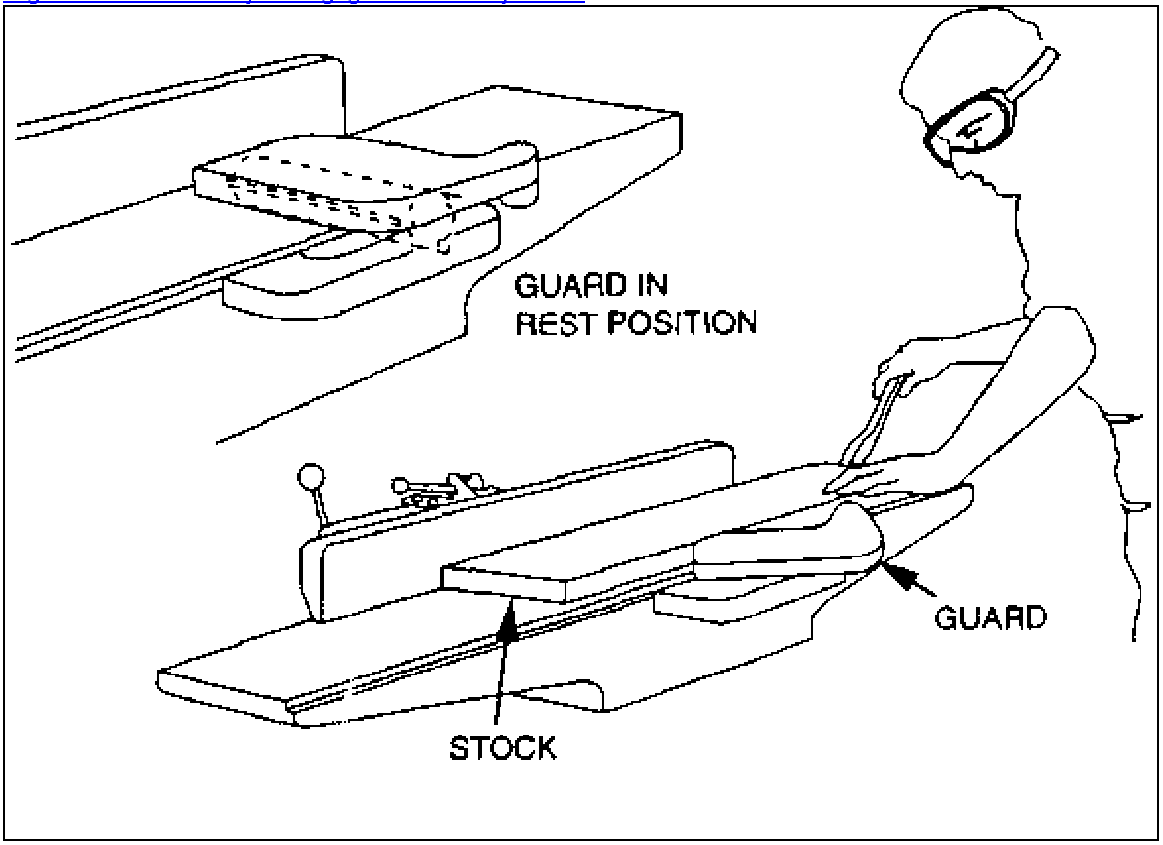


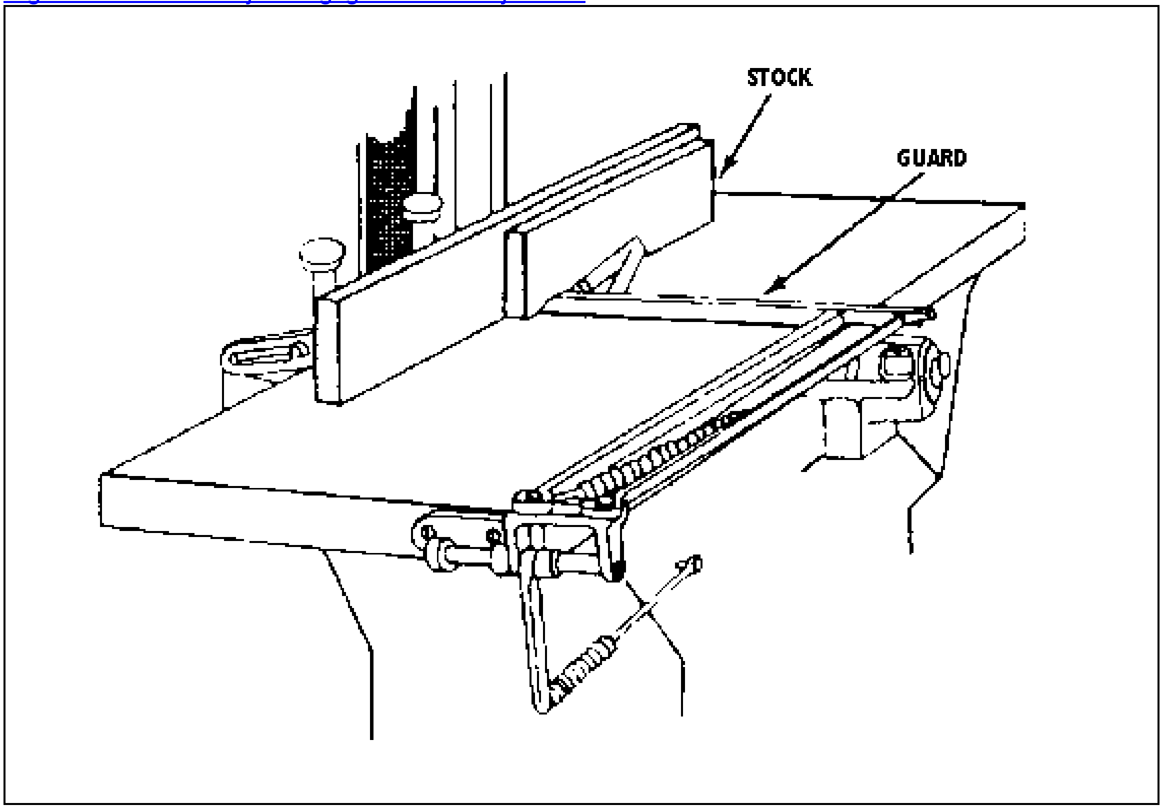
Figure 30 shows a self-adjusting enclosure guard mounted on a jointer. This guard is moved from the cutting head by the stock. After the stock is removed, the guard will return, under spring tension, to the rest position.

Figure 30. Self-adjusting guard on a jointer



Another type of self-adjusting guard mounted on a jointer is illustrated in Figure 31. The guard moves two ways. An edging operation causes the guard to move horizontally. If the stock is wide enough during a surfacing operation, the stock may be fed under the guard, causing it to move vertically.

Figure 31. Self-adjusting guard on a jointer



Guards			
Method	**Safeguarding Action**	**Advantages**	**Limitations**
Fixed	Provides a barrier	Can be constructed to suit many specific applications In-plant construction is often possible Can provide maximum protection Usually requires minimum maintenance Can be suitable to high production, repetitive operations.	May interfere with visibility Can be limited to specific operations Machine adjustment and repair often require its removal, thereby necessitating other means of protection for maintenance personnel.
Interlocked	Shuts off or disengages power and prevents starting of machine when guard is open; should require the machine to be stopped before the worker can reach into the danger area	Can provide maximum protection Allows access to machine for removing jams without time-consuming removal of fixed guards	Requires careful adjustment and maintenance May be easy to disengage
Adjustable	Provides a barrier which may be adjusted to facilitate a variety of production operations	Can be constructed to suit many specific applications Can be adjusted to admit varying sizes of stock	Hands may enter danger area— Protection may not be complete at all times May require frequent maintenance and/or adjustment The guard may be made ineffective by the operator May interfere with visibility
Self-Adjusting	Provides a barrier which moves according to the size of the stock entering the danger area	Off-the-shelf guards are often commercially available	Does not always provide maximum protection May interfere with visibility May require frequent maintenance and adjustment

Devices

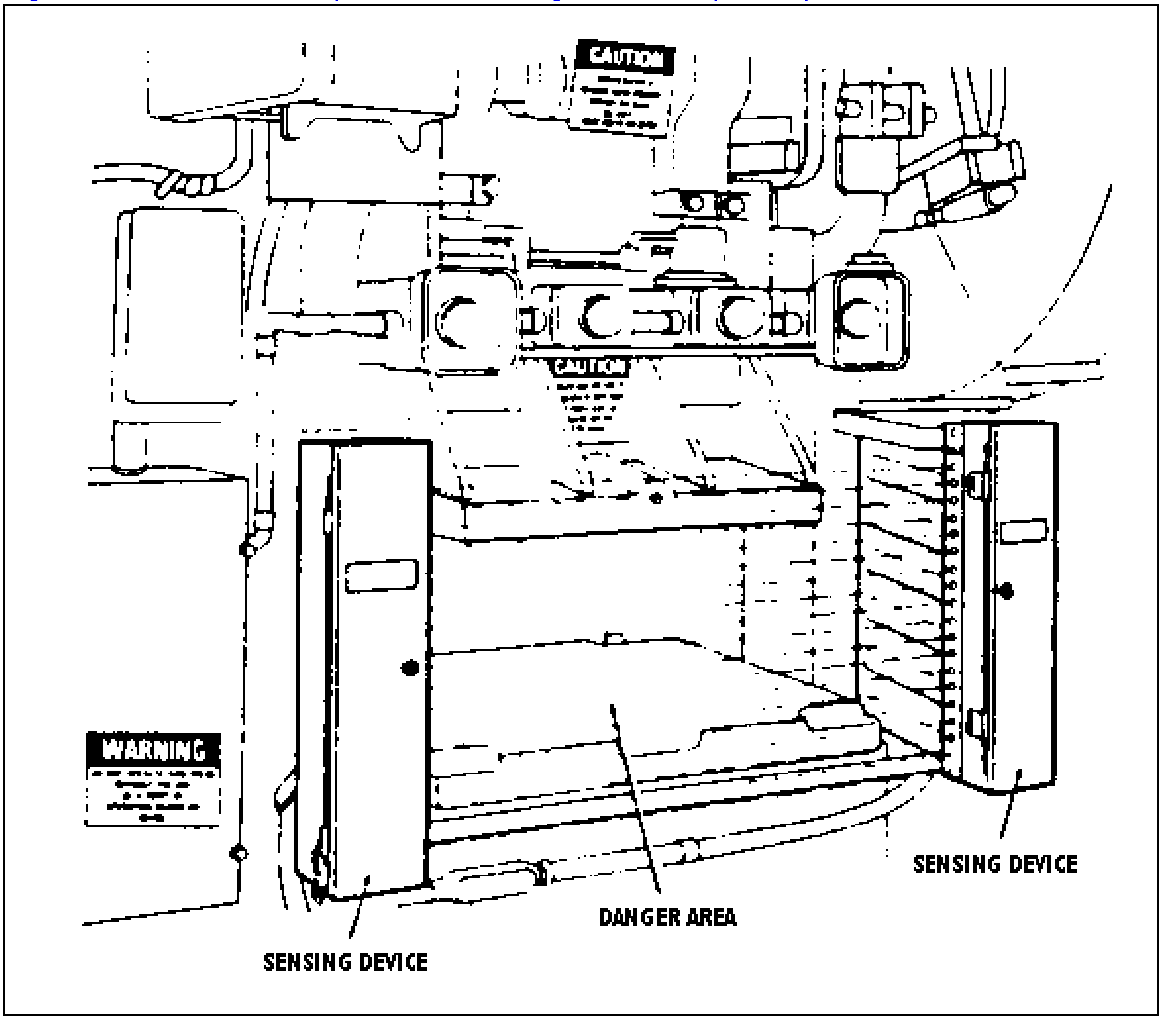
A safety device may perform one of several functions. It may stop the machine if a hand or any part of the body is inadvertently placed in the danger area; restrain or withdraw the operator's hands from the danger area during operation; require the operator to use both hands on machine controls, thus keeping both hands and body out of danger; or provide a barrier which is synchronized with the operating cycle of the machine in order to prevent entry to the danger area during the hazardous part of the cycle.

Presence-Sensing

The photoelectric (optical) presence-sensing device uses a system of light sources and controls which can interrupt the machine's operating cycle. If the light field is broken, the machine stops and will not cycle. This device must be used only on machines which can be stopped before the worker can reach the danger area. The design and placement of the guard depends upon the time it takes to stop the mechanism and the speed at which the employee's hand can reach across the distance from the guard to the danger zone.

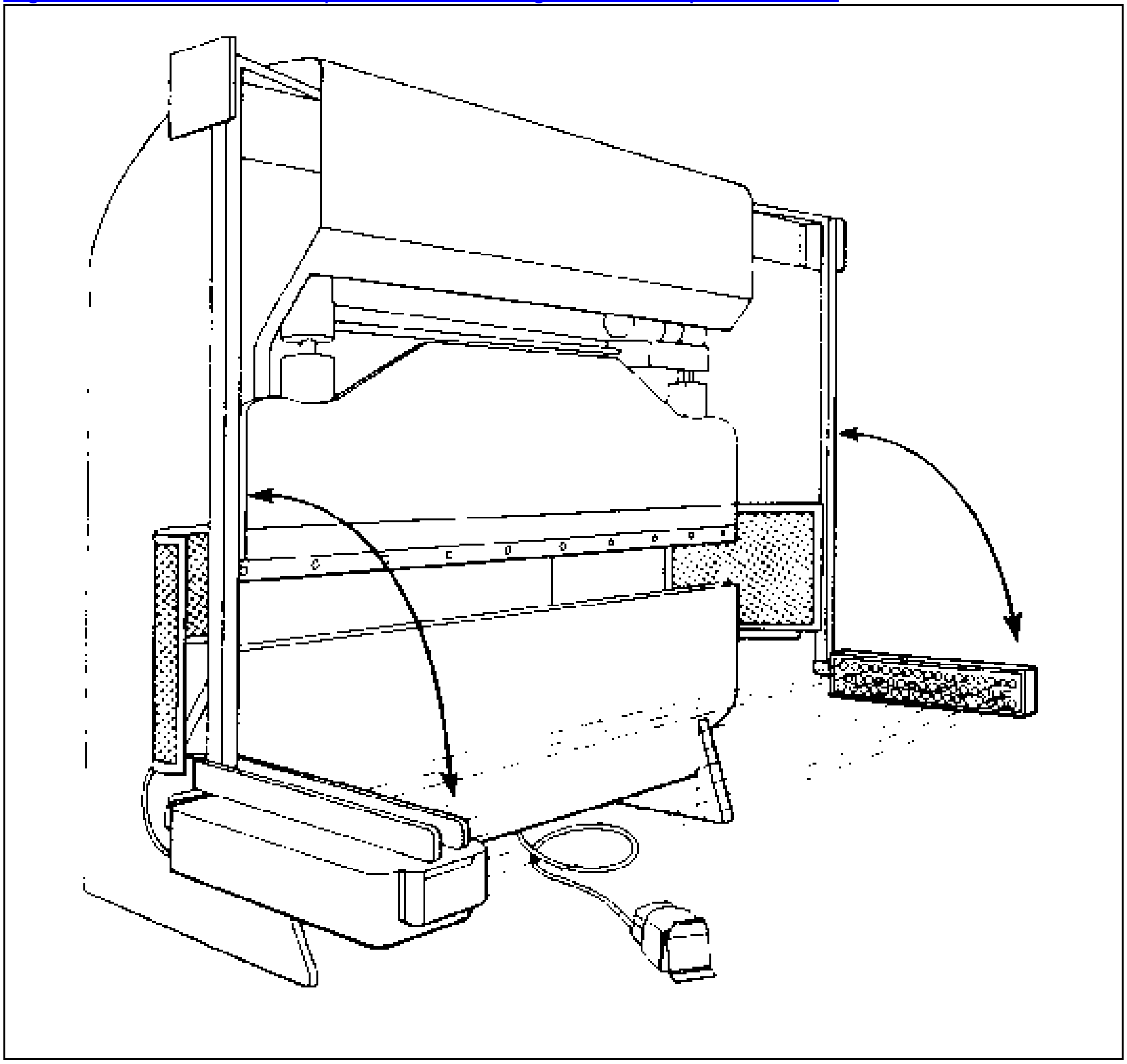
Figure 32 shows a photoelectric presence-sending device on a part-revolution power press. When the light beam is broken, either the ram will not start to cycle, or, if the cycle has begun, the stopping mechanism will be activated so that the press stops before the operator's hand can enter the danger zone.

Figure 32. Photoelectric presence-sensing device on power press.



A photoelectric presence-sending device used with a press brake is illustrated in Figure 33. The device may be swung up or down to accommodate different production requirements.

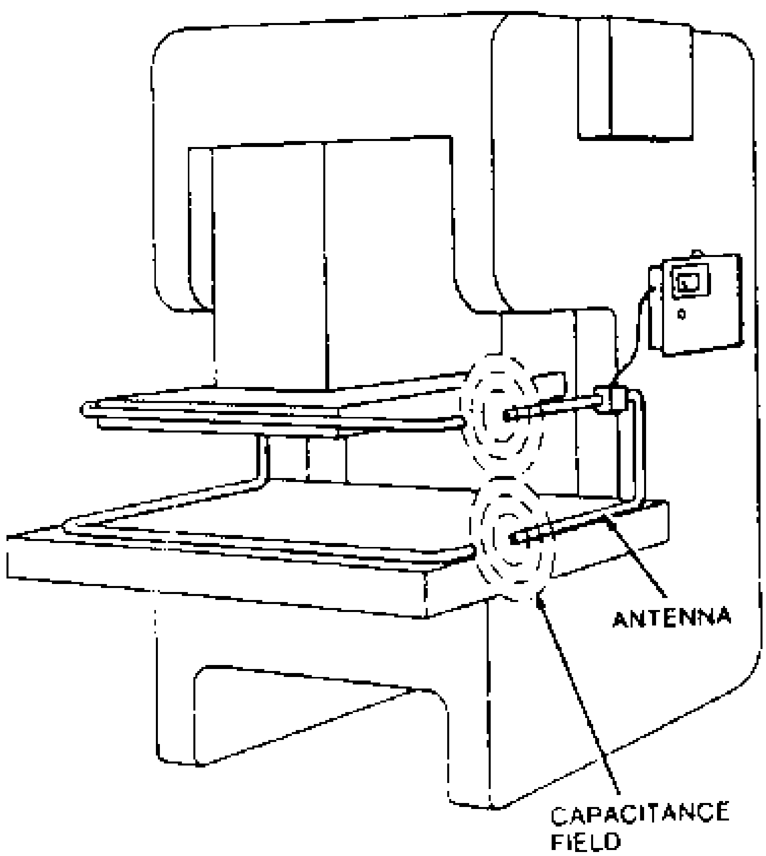
Figure 33. Photoelectric presence-sensing device on press brake



The radiofrequency (capacitance) presence-sending device uses a radio beam that is part of the machine control circuit. When the capacitance field is broken, the machine will stop or will not activate. Like the photoelectric device, this device shall only be used on machines which can be stopped before the worker can reach the danger area. This requires the machine to have a friction clutch or other reliable means for stopping.

Figure 34 shows a radiofrequency presence-sensing device mounted on a part-revolution power press.

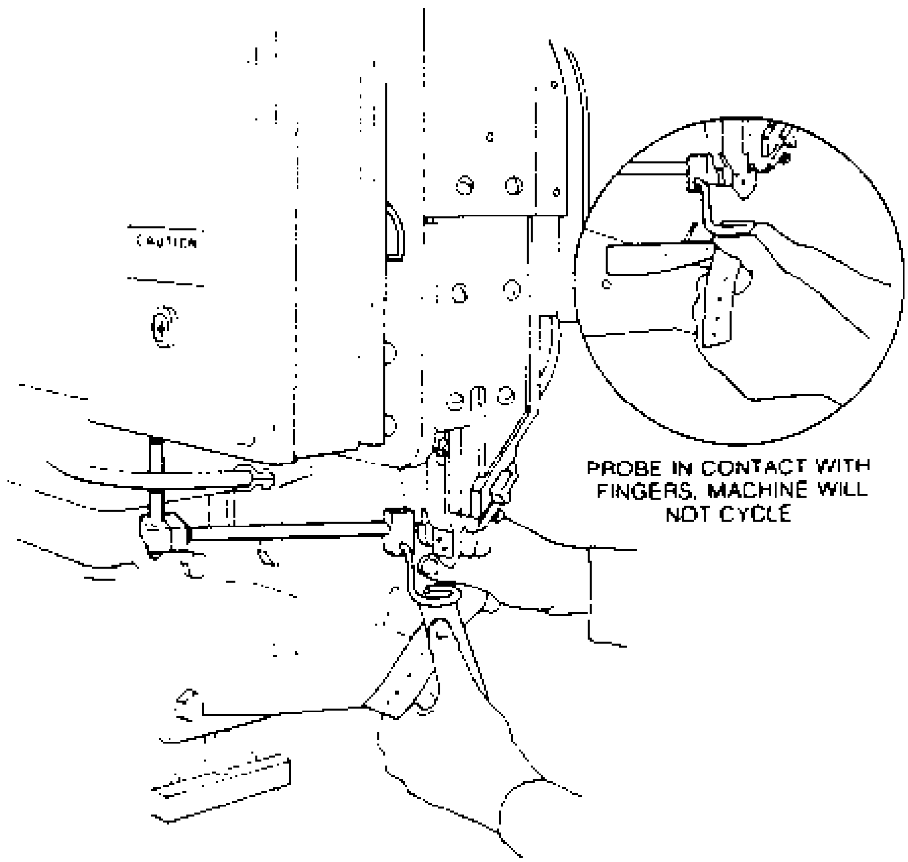
Figure 34. Radiofrequency presence-sensing device on a power press



The electromechanical sensing device has a probe or contact bar which descends to a predetermined distance when the operator initiates the machine cycle. If there is an obstruction preventing it from descending its full predetermined distance, the control circuit does not actuate the machine cycle.

Figure 35 shows an electromechanical sensing device on an eyeletter. The sensing probe in contact with the operator's finger is also shown.

Figure 35. Electromechanical sensing device on an eyeletter.



Pullback

Pullback devices utilize a series of cables attached to the operator's hands, wrists, and/or arms. This type of device is primarily used on machines with stroking action. When the slide/ram is up between cycles, the operator is allowed access to the point of operation. When the slide/ram begins to cycle by starting its descent, a mechanical linkage automatically assures withdrawal of the hands from the point of operation.

Figure 36 shows a pullback device on a straight-side power press. When the slide/ram is in the "up" position, the operator can feed material by hand into the point of operation. When the press cycle is actuated, the operator's hands and arms are automatically withdrawn. Figure 37 shows a pullback device on a smaller press.

Figure 36. Pullback device on a power press.

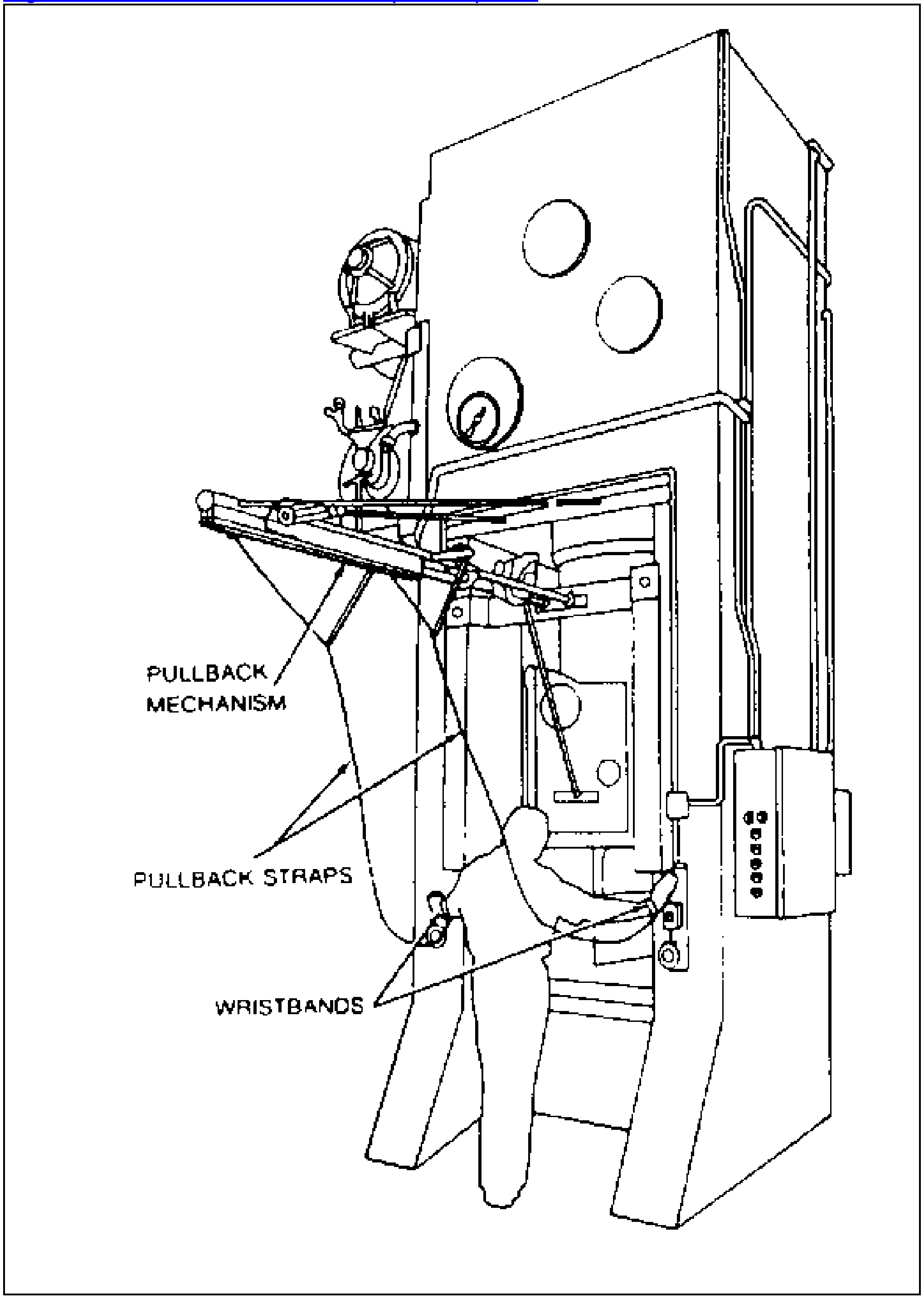
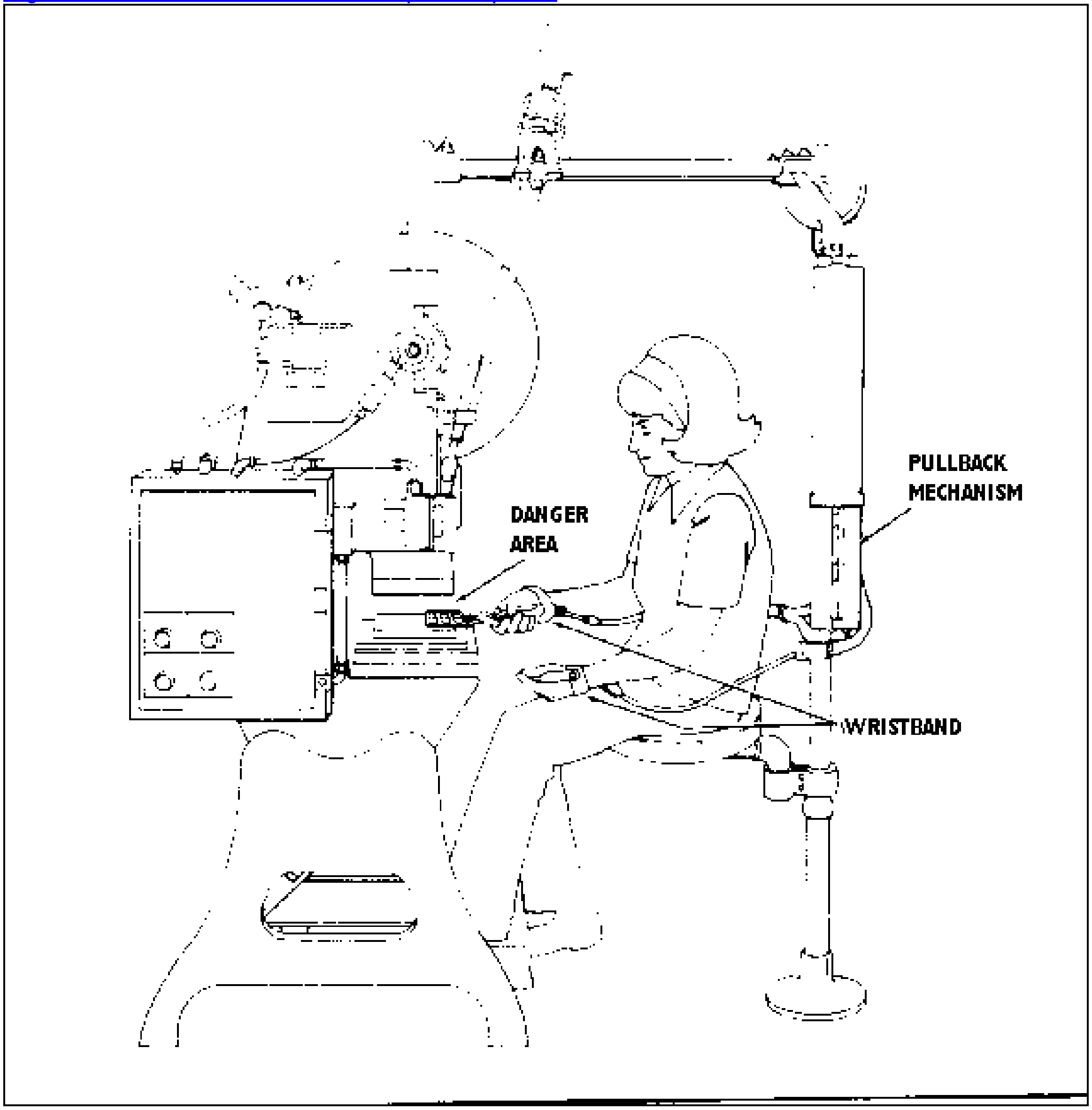
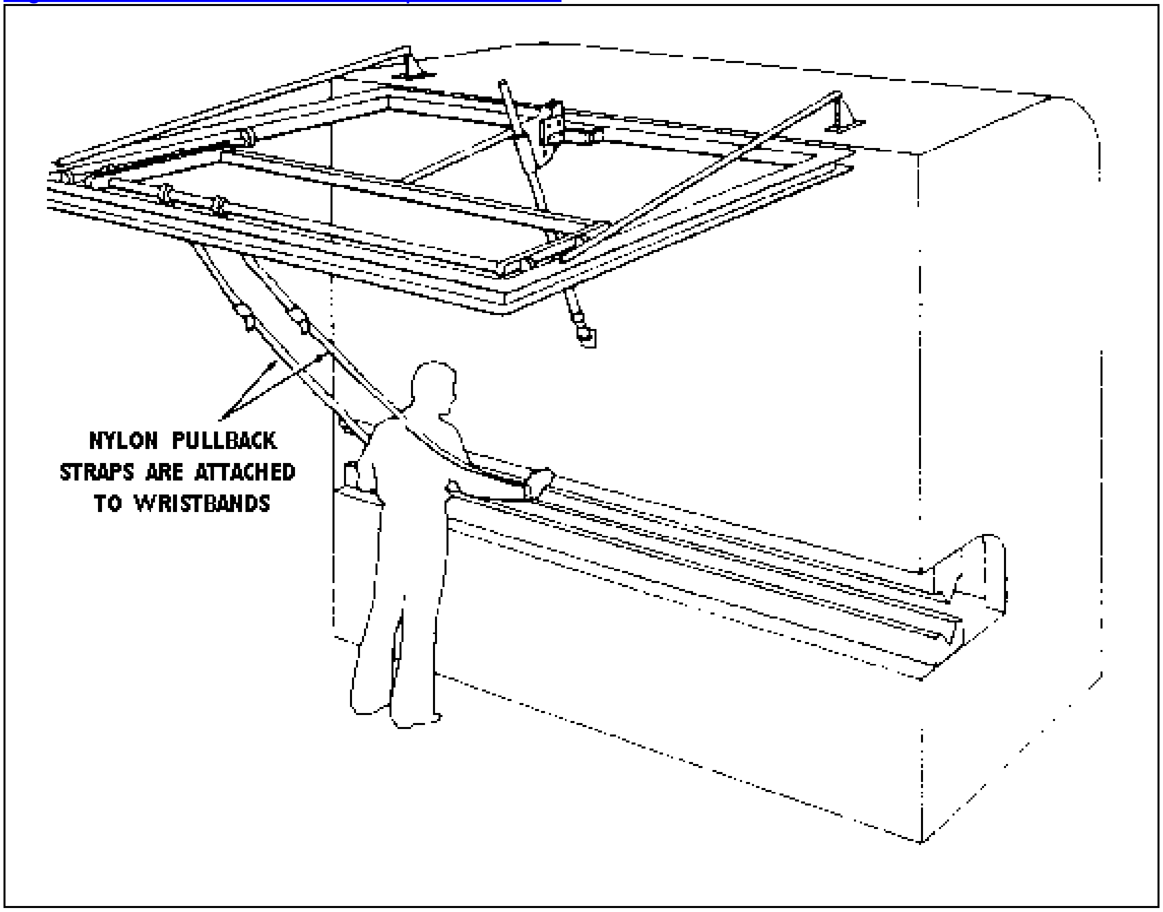


Figure 37. Pullback device on a power press.



A pullback device on a press brake is illustrated in Figure 38.

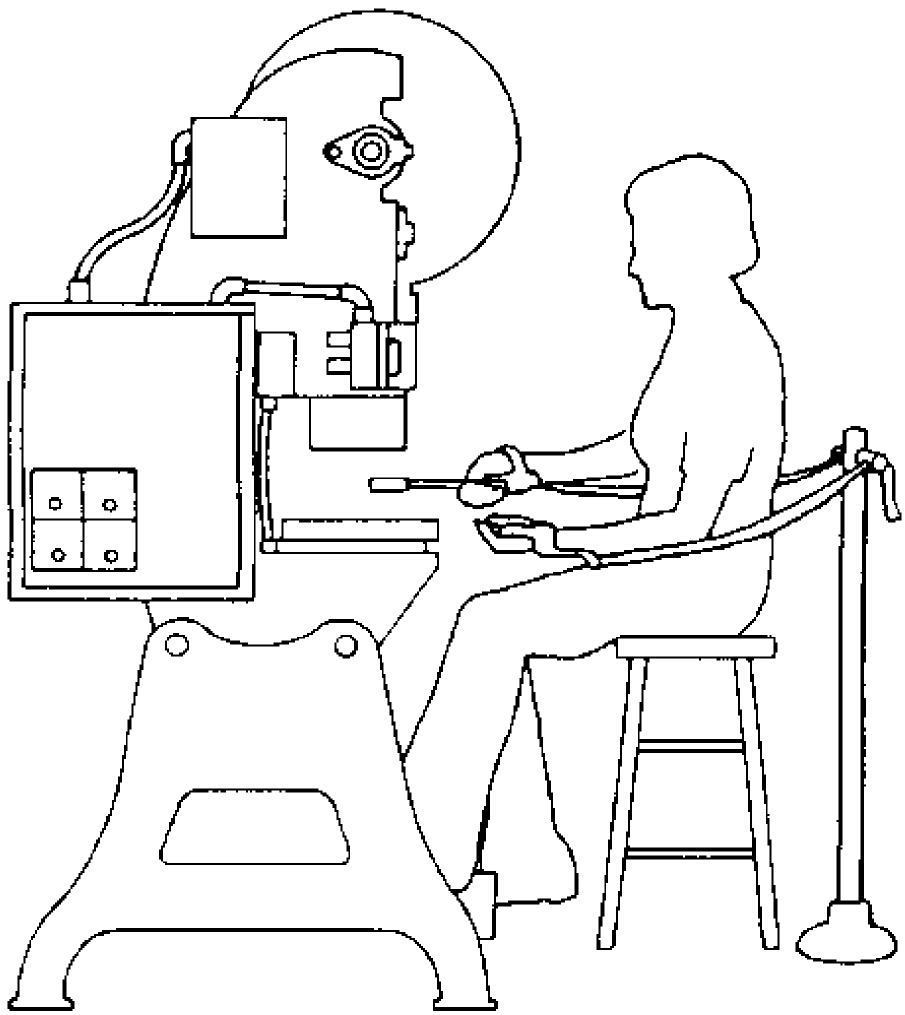
Figure 38. Pullback device on press brake



Restraint

The restraint (holdout) device in Figure 39 utilizes cables or straps that are attached to the operator's hands at a fixed point. The cables or straps must be adjusted to let the operator's hands travel within a predetermined safe area. There is no extending or retracting action involved. Consequently, hand-feeding tools are often necessary if the operation involves placing material into the danger area.

Figure 39. Restraint device on power press



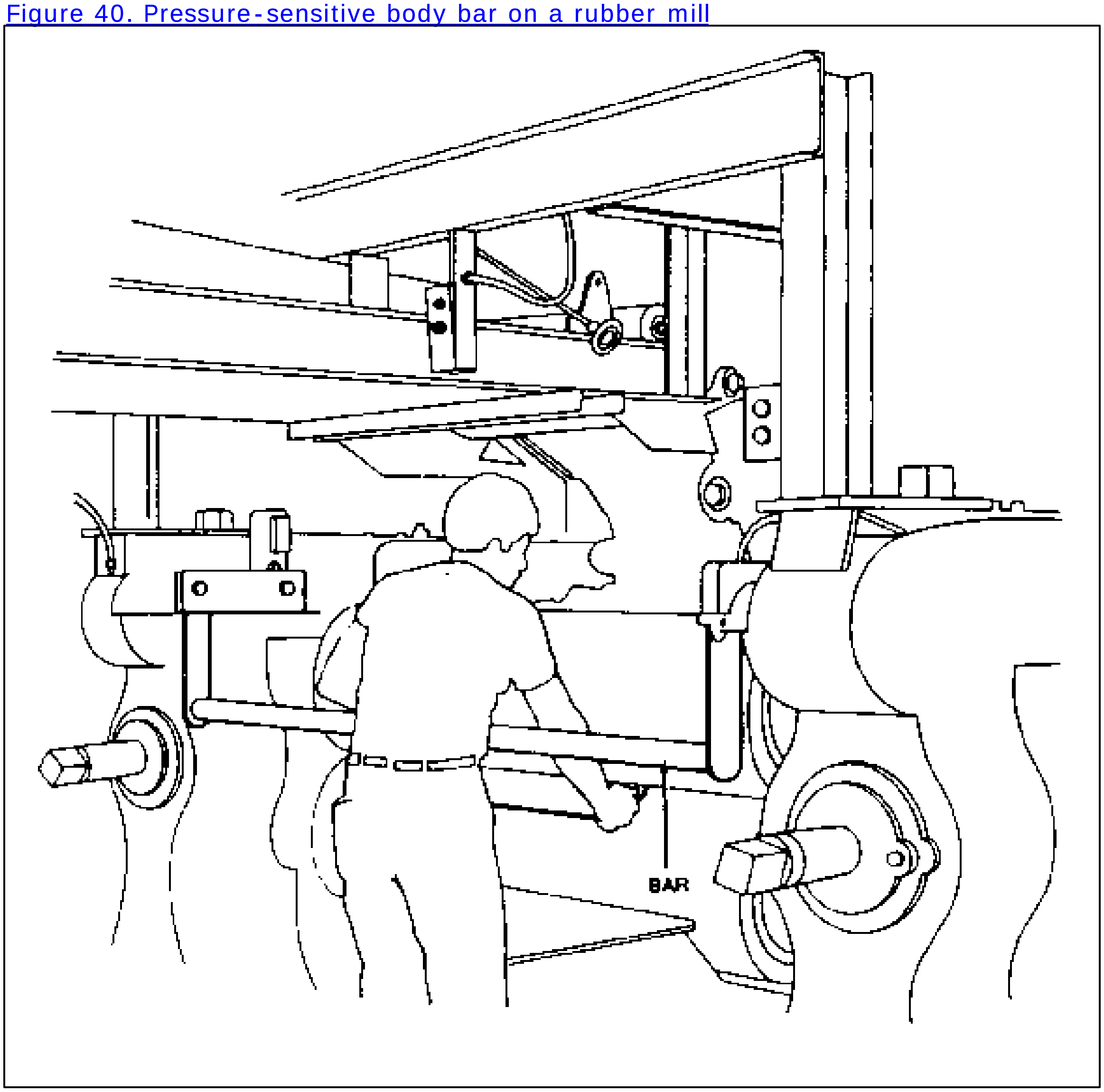
Chapter 2 -
Methods of Machine Safeguarding (Page 2)

Safety Trip Controls

Safety trip controls provide a quick means for deactivating the machine in an emergency situation.

A pressure-sensitive body bar, when depressed, will deactivate the machine. If the operator or anyone trips, loses balance, or is drawn toward the machine, applying pressure to the bar will stop the operation. The positioning of the bar, therefore, is critical. It must stop the machine before a part of the employee's body reaches the danger area. Figure 40 shows a pressure-sensitive body bar located on the front of a rubber mill.

Figure 40. Pressure-sensitive body bar on a rubber mill



When pressed by hand, the safety deactivates the machine. Because the triprod has to be actuated by the operator during an emergency situation, its proper position is also critical. Figure 41 shows a triprod located above the rubber mill. Figure 42 shows another application of a triprod.

Figure 41. Safety triprod on a rubber mill.

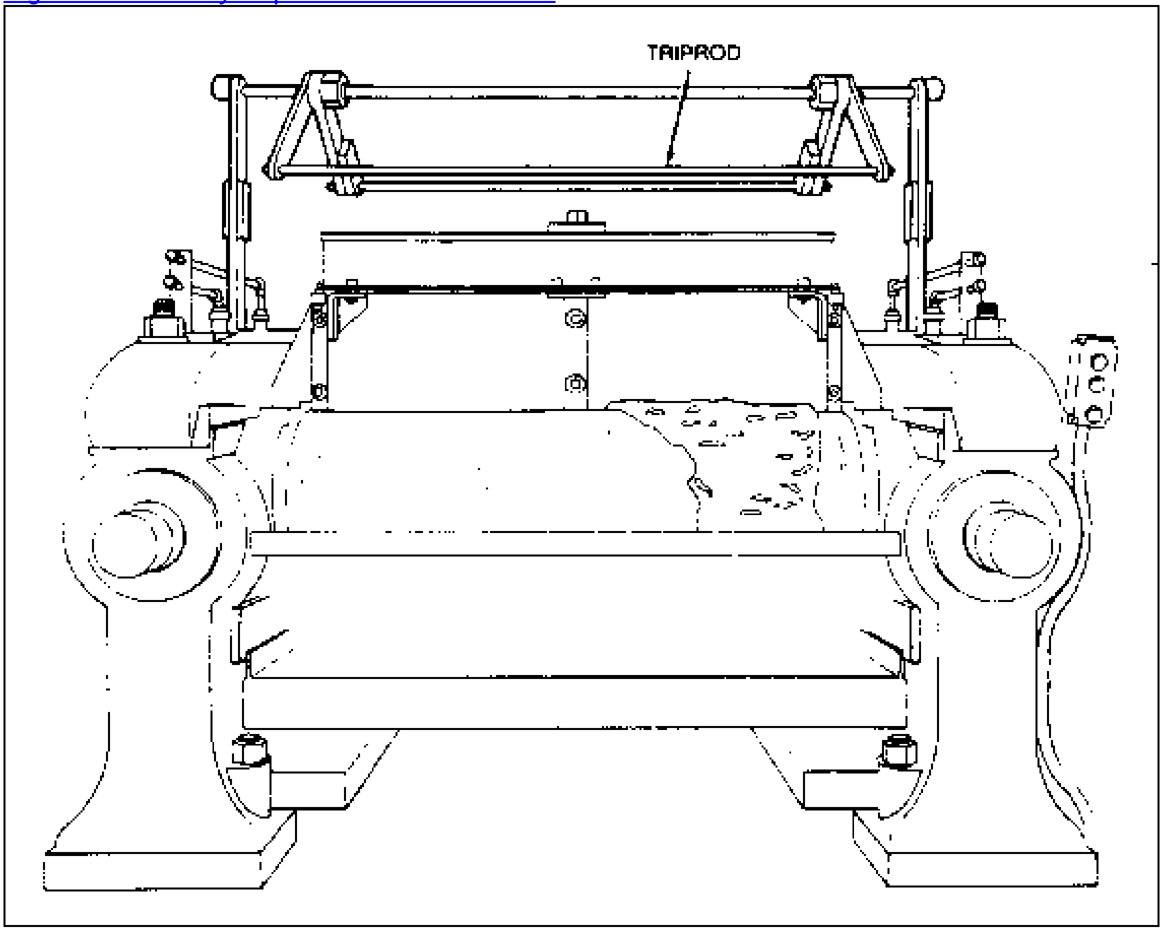
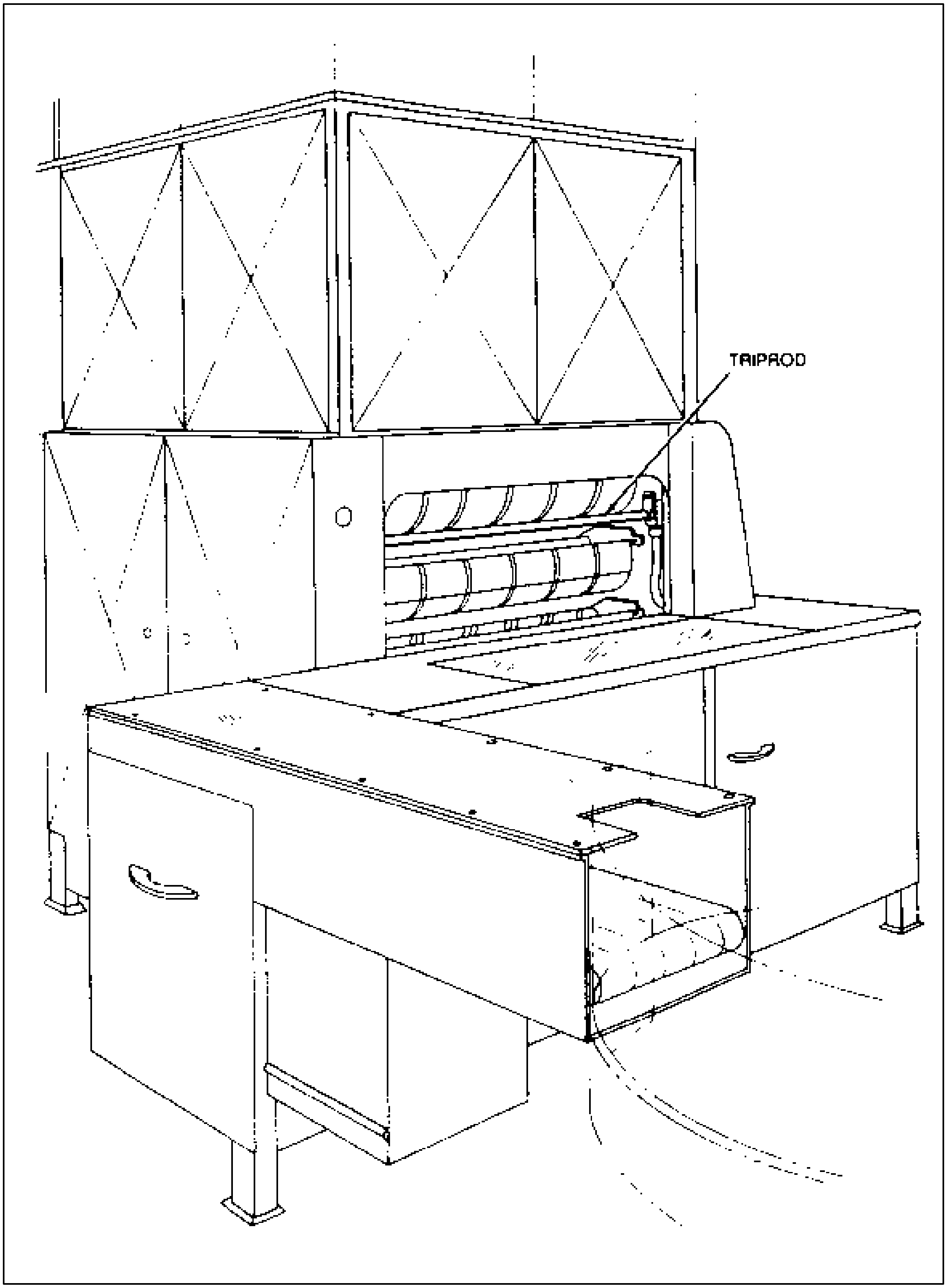


Figure 42. Safety triprod on a bread proofer machine.



Safety tripwire cables are located around the perimeter of or near the danger area. The operator must be able to reach the cable with either hand to stop the machine. Figure 43 shows a calender equipped with this type of control, while Figure 44 shows a tomato sorter with a safety tripwire cable.

Figure 43. Safety tripwire cable on a calender

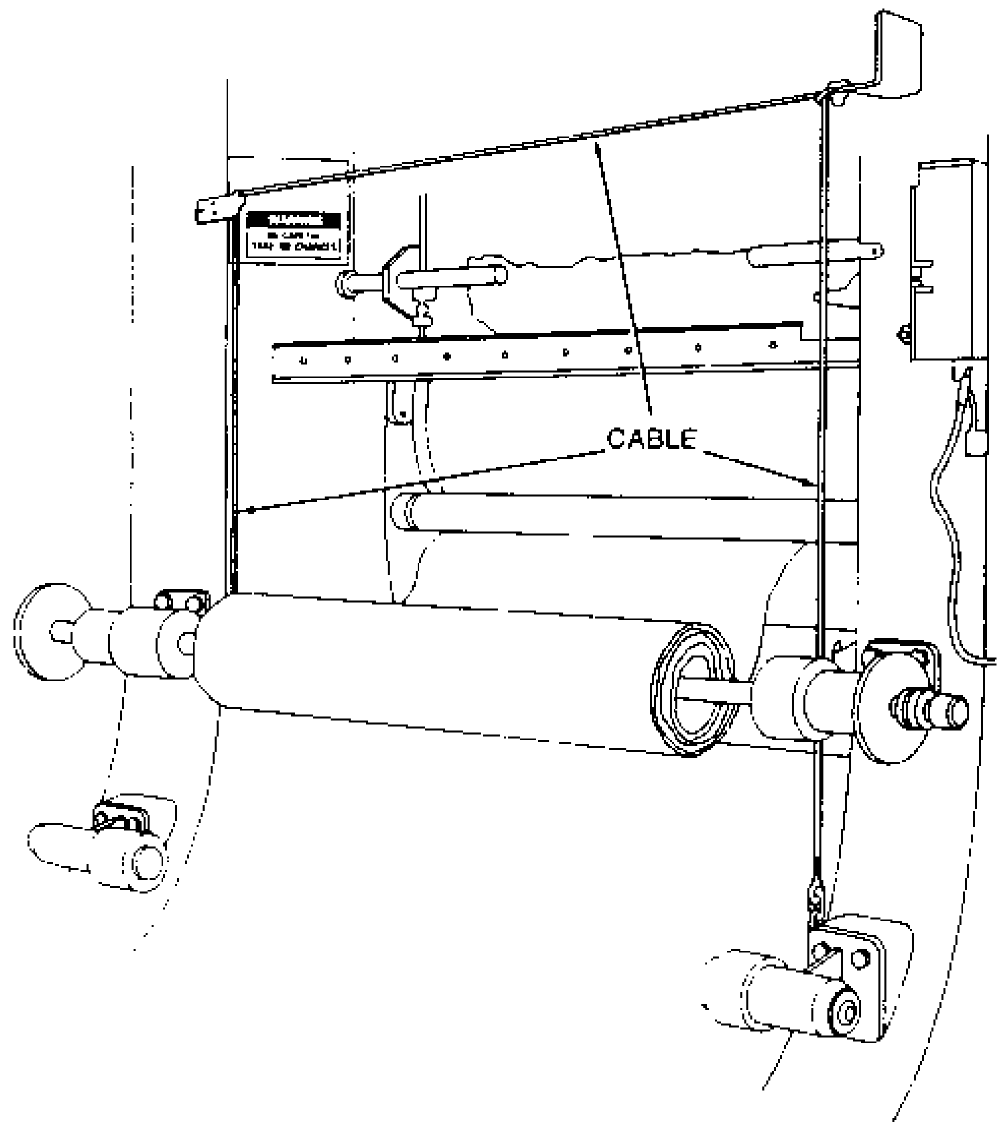
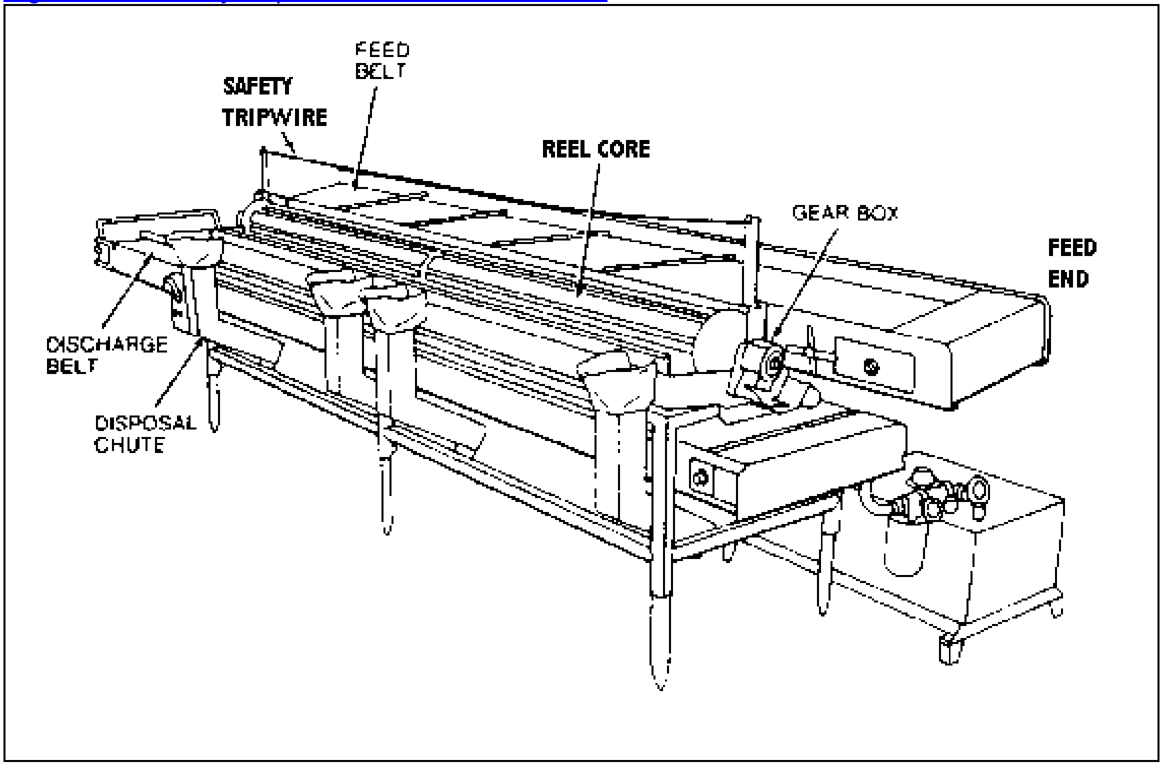


Figure 44. Safety tripwire on a tomato sorter

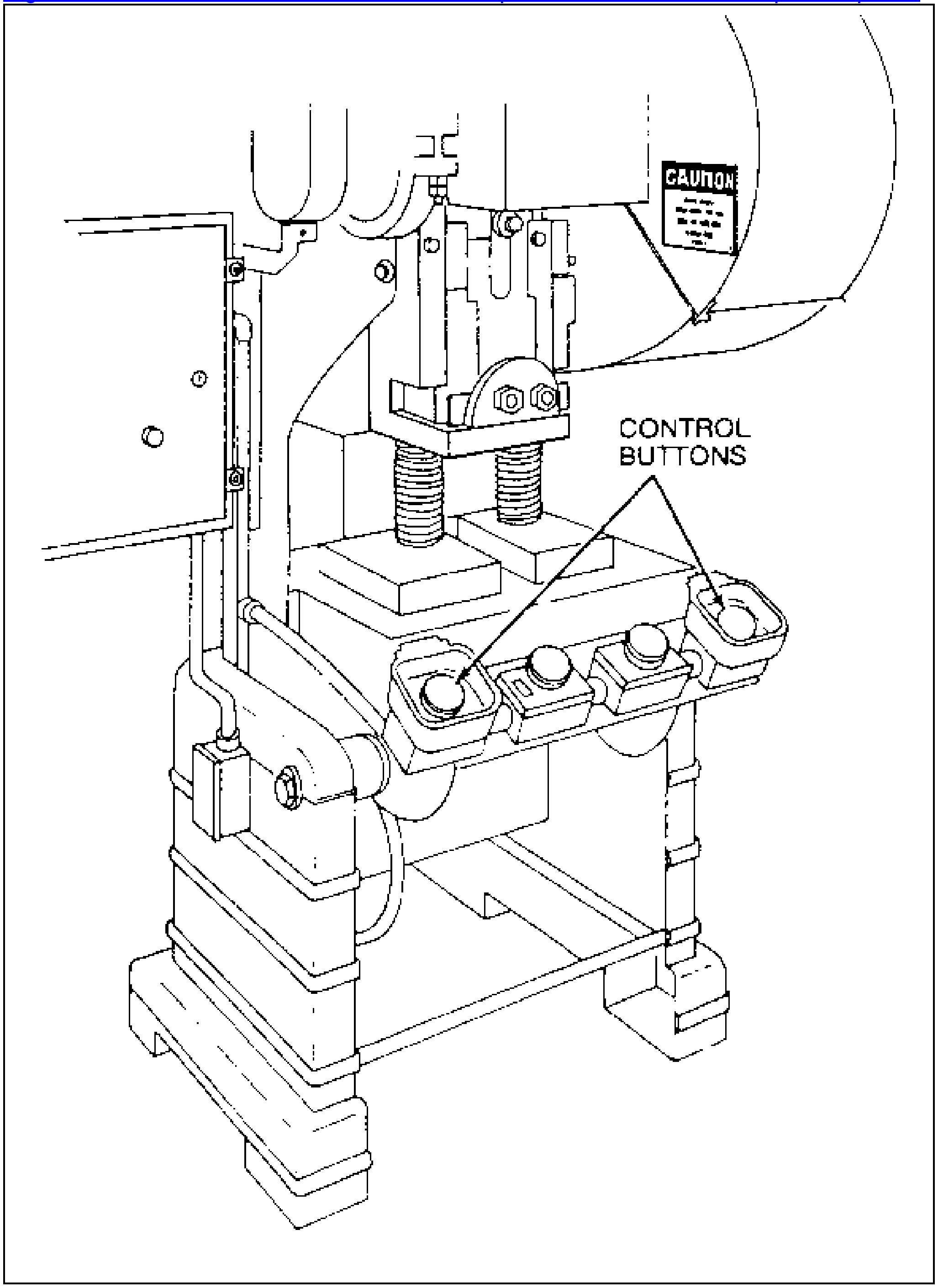


All of these tripwire rods or other safety devices must be manually reset to restart the machine. Simply releasing the tripwire to restart the machine will not ensure that the employee is out of danger when the machine restarts.

Two-Hand Control

The two-hand control requires constant, concurrent pressure by the operator to activate the machine. This kind of control requires a part-revolution clutch, brake, and a brake monitor if used on a power press as shown in Figure 45. With this type of device, the operator's hands are required to be at a safe location (on control buttons) and at a safe distance from the danger area while the machine completes its closing cycle.

Figure 45. Two-hand control buttons on part-revolution clutch power press

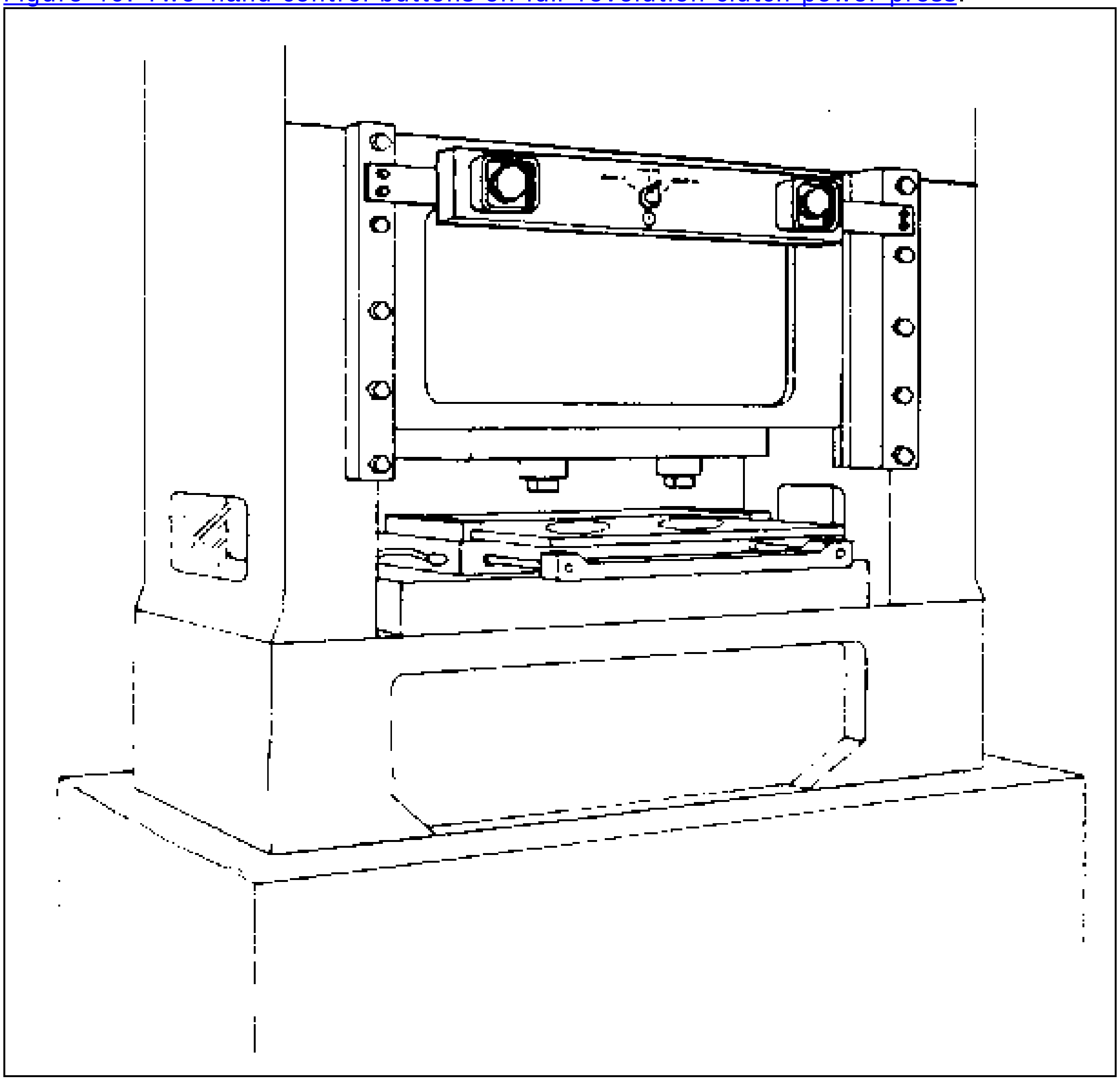


Two-Hand Trip

The two-hand trip in Figure 46 requires concurrent application of both the operator's control buttons to activate the machine cycle, after which the hands are free. This device is usually used with machines equipped with full-revolution clutches. The trips must be placed far enough from the point of operation to make it impossible for the operator to move his or her hands from the trip buttons or handles into the point of operation before the first half of the cycle is completed. The distance from the trip button depends upon the speed of the cycle and the band speed constant. Thus the operator's hands are kept far enough away to prevent them from being placed in the danger area prior to the slide/ram or blade reaching the full "down" position.

To be effective, both two-hand controls and trips must be located so that the operator cannot use two hands or one hand and another part of his/her body to trip the machine.

Figure 46. Two-hand control buttons on full-revolution clutch power press.



Gate
A gate is a movable barrier that protects the operator at the point of operation before the machine cycle can be started. Gates are, in many instances, designed to be operated with each machine cycle.
Figure 47 shows a horizontal injection molding machine with a gate. To be effective, the gate must be interlocked so that the machine will not begin a cycle unless the gate guard is in place. It must be in the closed position before the machine can function.

Figure 47. Horizontal injection molding machine with gate.

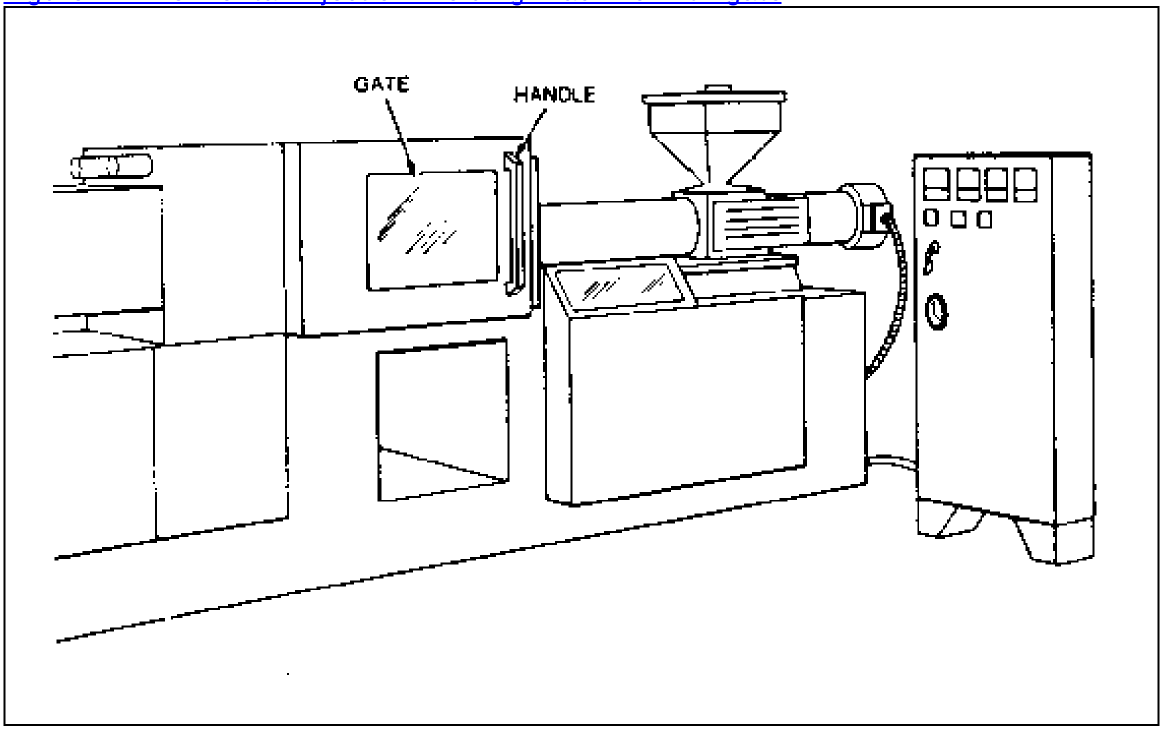
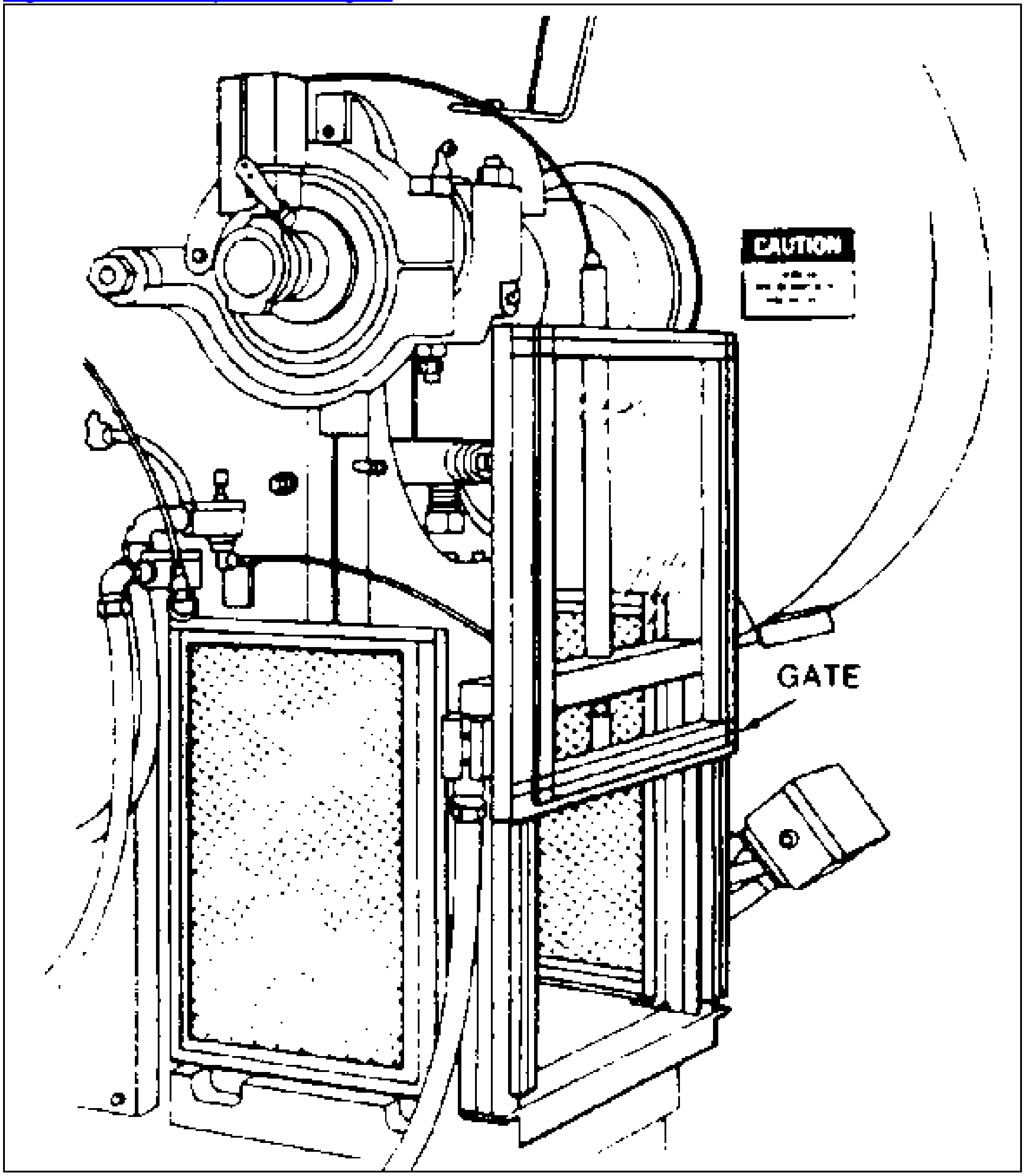


Figure 48 shows a gate on a power press. If the gate is not permitted to descend to the fully closed position, the press will not function.

Figure 48. Power press with gate.



Another potential application of this type of guard is where the gate is a component of a perimeter safeguarding system. Here the gate may provide protection not only to the operator but to pedestrian traffic as well.

Devices			
Method	**Safeguarding Action**	**Advantages**	**Limitations**
Photoelectric	Machine will not start cycling when the light field is interrupted. When the light field is broken by any part of the operator's body during the cycling process, immediate machine braking is activated	Can allow freer movement for operator.	Does not protect against mechanical failure. May require frequent alignment and calibration. Excessive vibration may cause lamp filament damage and premature burnout. Limited to machines that can be stopped.
Radiofrequency (capacitance)	Machine cycling will not start when the capacitance field is interrupted. When the capacitance field is disturbed by any part of the operator's body during the cycling process, immediate machine braking is activated.	Can allow freer movement for operator.	Does not protect against mechanical failure. Antennae sensitivity must be properly adjusted. Limited to machines that can be stopped.
Electromechanical	Contact bar or probe travels a predetermined distance between the operator and the danger area. Interruption of this movement prevents the starting of machine cycle.	Can allow access at the point of operation.	Contact bar or probe must be properly adjusted for each application; this adjustment must be maintained properly
Pullback	As the machine begins to cycle, the operator's hands are pulled out of the danger area.	Eliminates the need for auxiliary barriers or other interference at the danger area.	Limits movement of operator. May obstruct work-space around operator. Adjustments must be made for specific operations and for each individual. Requires frequent inspections and regular maintenance. Requires close supervision of the operator's use of the equipment.
Restraint (holdback0	Prevents the operator from reaching into the danger area.	Little risk of mechanical failure.	Limits movements of the operator. May obstruct work-space. Adjustments must be made for specific operations and each individual. Requires close supervision of the operator's use of the equipment.
Safety trip controls: Pressure sensitive body bar Safety tripod Safety tripwire	Stops machine when tripped.	Simplicity of use.	All controls must be manually activated. May be difficult to activate controls because of their location. Only protects the operator. May require special fixtures to hold work. May require a machine brake.
Two-hand control	Concurrent use of both hands is required, preventing the operator from entering the danger area.	Operator's hands are at a predetermined location. Operator's hands are free to pick up a new part after the first half of cycle is completed.	Requires a partial cycle machine with a brake. Some two-hand controls can be rendered unsafe by holding with arm or blocking, thereby permitting one-hand operation. Protects only the operator.
Two-hand trip	Concurrent use of two hands on separate controls prevents hands from being in danger area when machine cycle starts.	Operator's hands are away form danger area. Can be adapted to multiple operations. No obstruction to hand feeding. Does not require adjustment for each operation.	Operator may try to reach into danger area after tripping machine. Some trips can be rendered unsafe by holding with arm or blocking, thereby permitting one-hand operation. Protects only the operator. May require special fixtures.
Gate	Provides a barrier between danger area and operator or other personnel	Can prevent reaching into or walking into the danger area.	May require frequent inspection and regular maintenance. May interfere with operator's ability to see the work.

Safeguarding by Location/Distance

The examples mentioned below are a few of the numerous applications of the principle of safeguarding by location/distance. A thorough hazard analysis of each machine and particular situation is absolutely essential before attempting this safeguarding technique.

To consider a part of a machine to be safeguarded by location, the dangerous moving part of a machine must be so positioned that those areas are not accessible or do not present a hazard to a worker during the normal operation of the machine. This may be accomplished by locating a machine so that the hazardous parts of the machine are located away from operator work stations or other areas where employees walk or work. This can be accomplished by positioning a machine with its power transmission apparatus against a wall and leaving all routine operations conducted on the other side of the machine. Additionally, enclosure walls or fences can restrict access to machines. Another possible solution is to have dangerous parts located high enough to be out of the normal reach of any worker.

The feeding process can be safeguarded by location if a safe distance can be maintained to protect the worker's hands. The dimensions of the stock being worked on may provide adequate safety.

For instance, if the stock is several feet long and only one end of the stock is being worked on, the operator may be able to hold the opposite end while the work is being performed. An example would be a single-end punching machine. However, depending upon the machine, protection might still be required for another personnel.

The positioning of the operator's control station provides another potential approach to safeguarding by location. Operator controls may be located at a safe distance from the machine if there is no reason for the operator to tend it.

Feeding the Ejection Methods to Improve Operator Safety

Many feeding and ejection methods do not require the operator to place his or her hands in the danger area. In some cases, no operator involvement is necessary after the machine is set up. In other situations, operators can manually feed the stock with the assistance of a feeding mechanism. Properly designed ejection methods do not require any operator involvement after the machine starts to function.

Some feeding and ejection methods may even create hazards themselves. For instance, a robot may eliminate the need for an operator to be near the machine but may create a new hazard itself by the movement of its arm.

Using these feeding and ejection methods does not eliminate the need for guards and devices. Guards and devices must be used wherever they are necessary and possible in order to provide protection from exposure to hazards.

Types of feeding and ejection methods...

Automatic feeds reduce the exposure of the operator during the work process, and sometimes do not require any effort by the operator after the machine is set up and running.

In Figure 49, the power press has an automatic feeding mechanism. Notice the transparent fixed enclosure guard at the danger area.

Figure 49. Power press with automatic feed

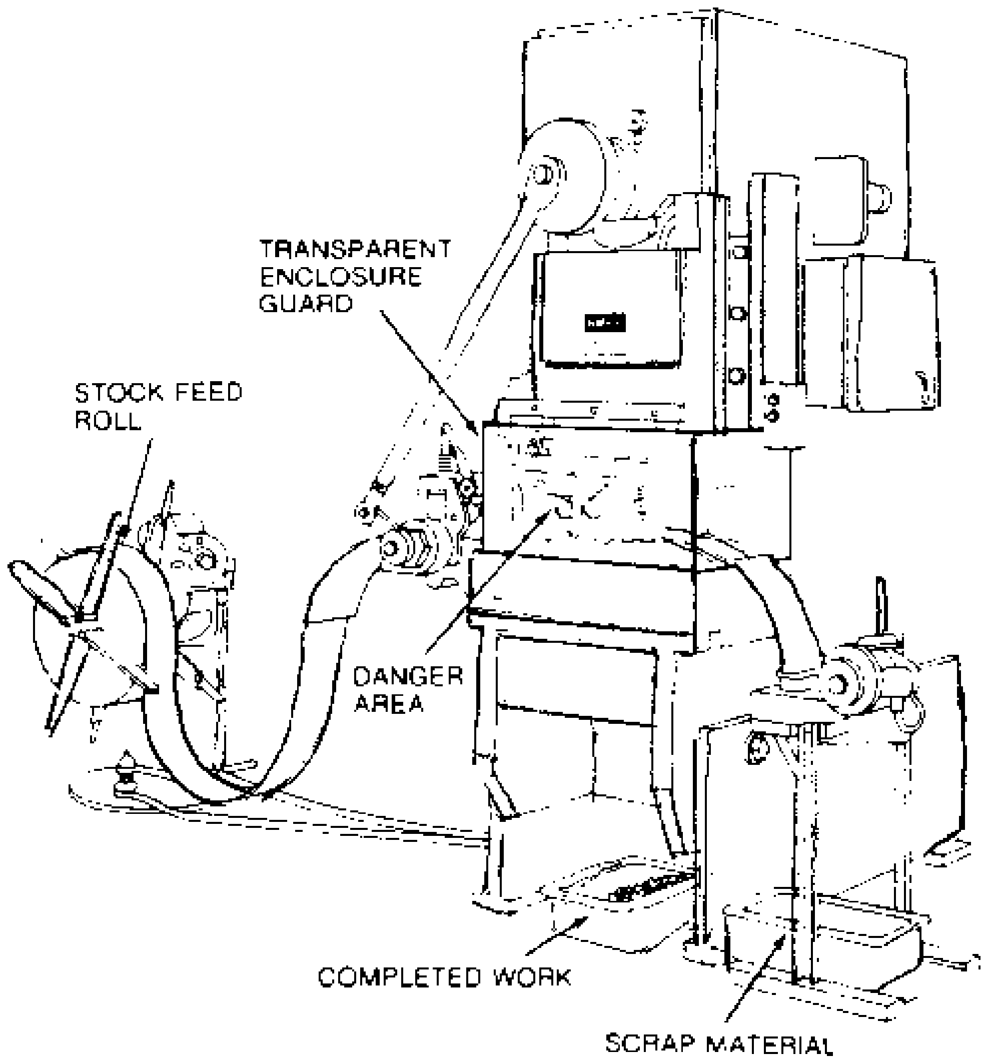
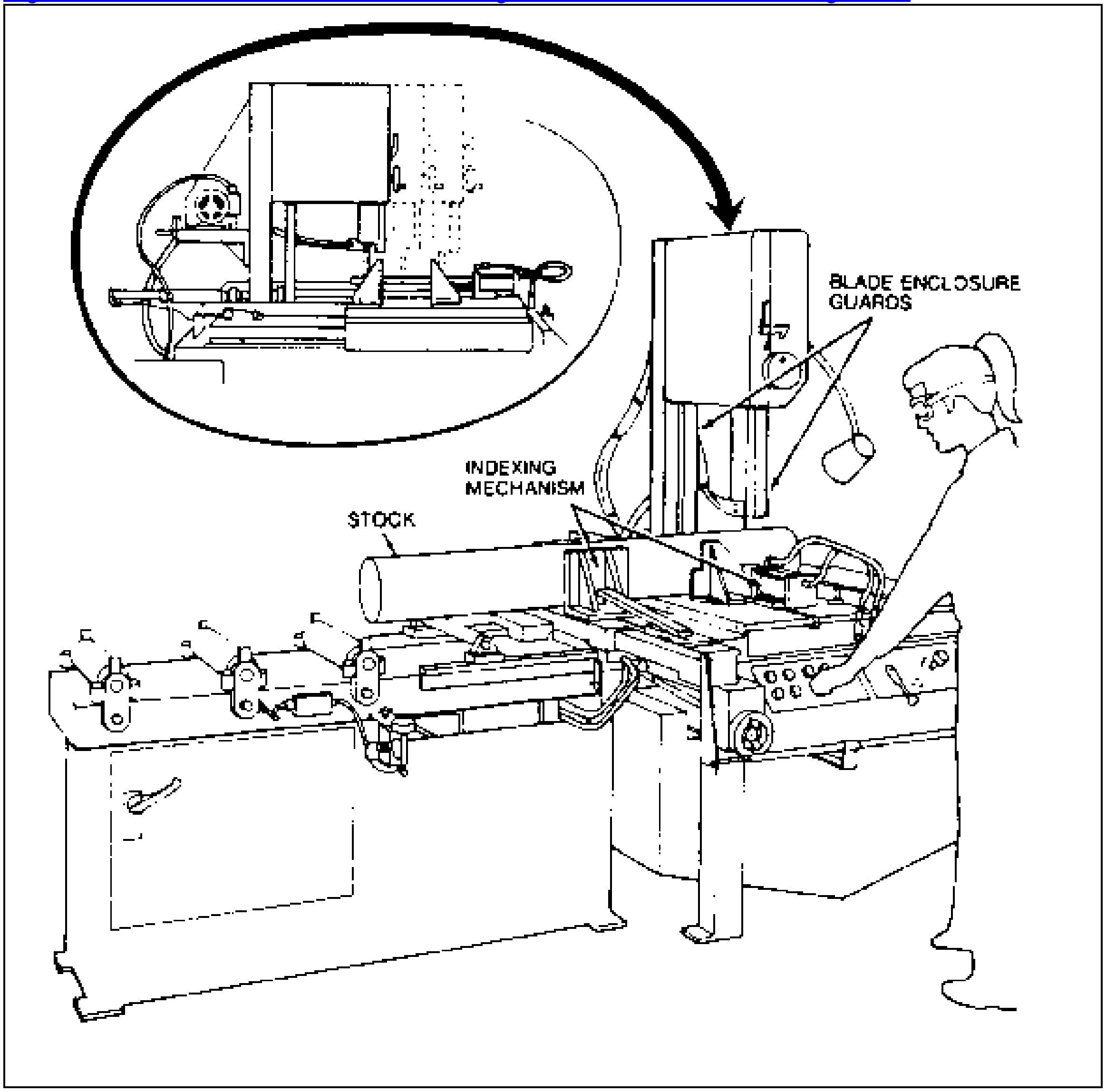


Figure 50 shows a saw with an automatic indexing mechanism that moves the stock a predetermined distance for each cut. The traveling head automatically recycles for each cut.

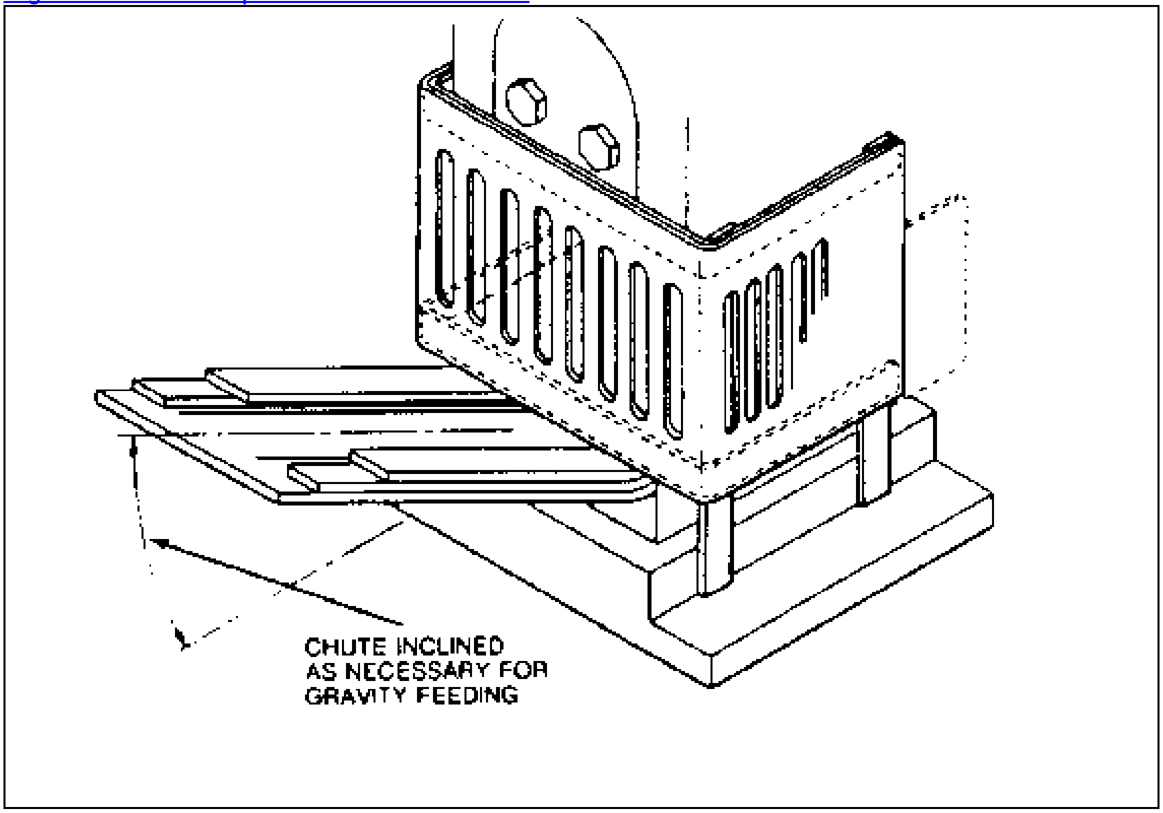
Figure 50. Saw with automatic indexing mechanism and traveling head.



With semiautomatic feeding, as in the case of a power press, the operator uses a mechanism to place the piece being processed under the ram at each stroke. The operator does not need to reach into the danger area, and the danger area is completely enclosed.

Figure 51 shows a chute feed. It may be either a horizontal or an inclined chute into which each piece is placed by hand. Using a chute feed on an inclined press not only helps center the piece as it slides into the die, but may also simplify the problem of ejection.

Figure 51. Power press with chute feed.



A plunger feed is shown in Figure 52. The blanks or pieces are placed in the nest one at a time by the plunger with pushes them under the slide. Plunger feeds are useful for operations on irregularly shaped workpieces which will not stack in a magazine or will not slide easily down a gravity chute. The mechanism shown is mechanically connected to the press tripping mechanism. When the plunger is pushed in, pin "B" is allowed to rise up into hole "A," allowing yoke "C" to release so the press can be tripped.

Figure 52. Power press with plunger feed.

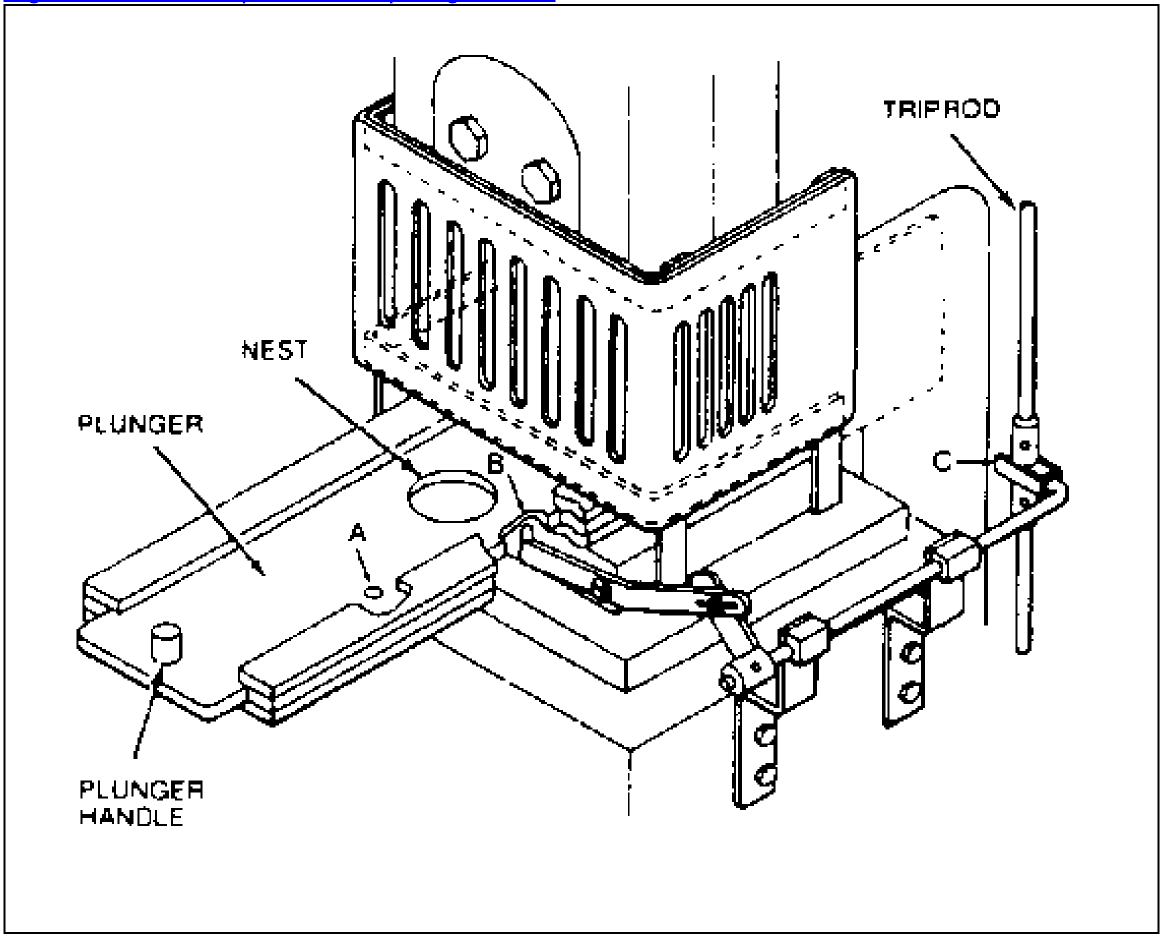
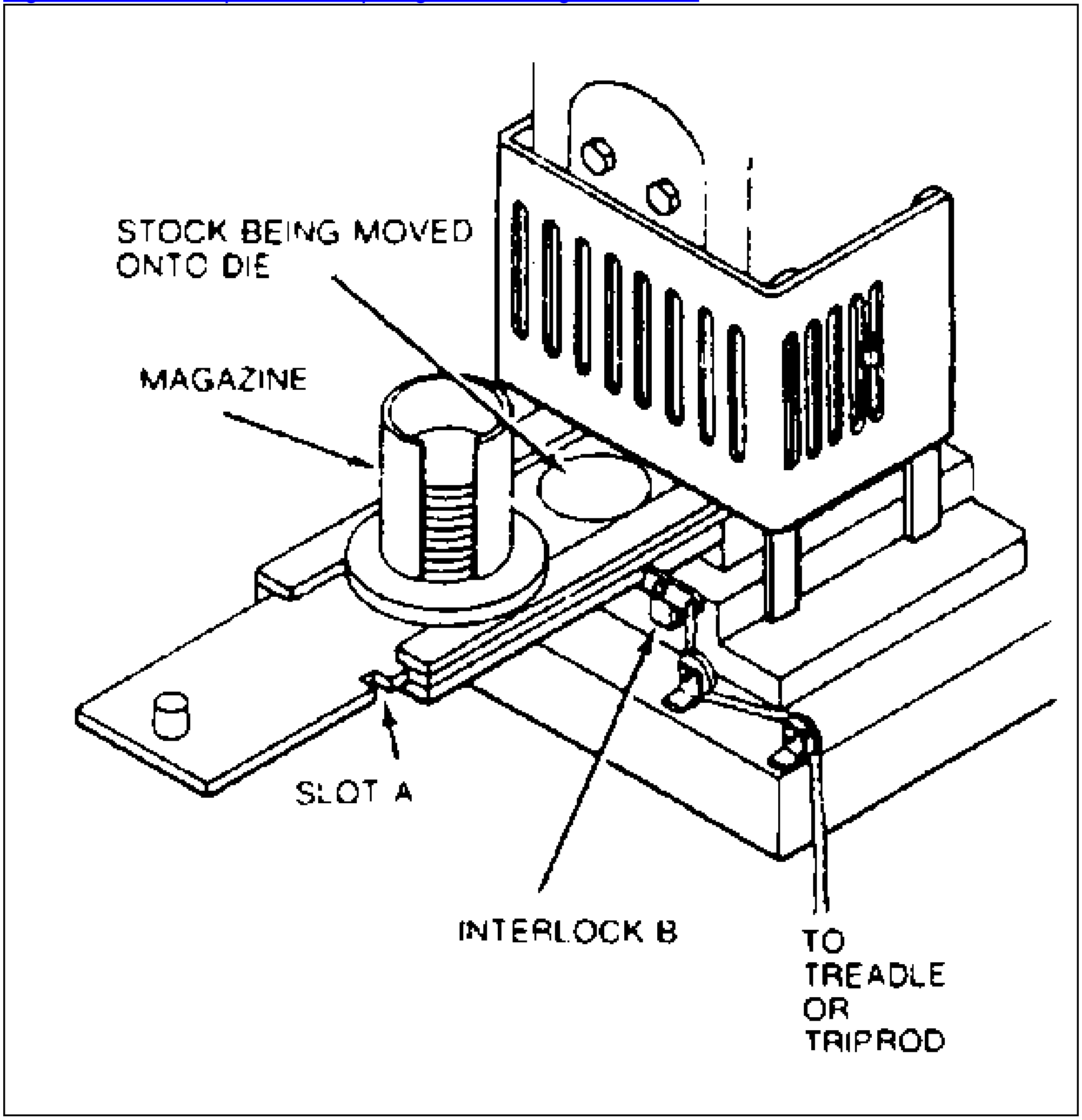


Figure 53 shows a plunger and magazine feed. Slot "A" must be in alignment with interlock "B" before the press can be tripped.

Figure 53. Power press with plunger and magazine feed



The sliding die in Figure 54 is pulled toward the operator for safe feeding and then pushed into position under the slide prior to the downward stroke. The die moves in and out by hand or by a foot lever. The die should be interlocked with the press to prevent tripping when the die is out of alignment with the slide. Providing "stops" will prevent the die from being inadvertently pulled out of the slides.

Figure 54. Power press with sliding die.

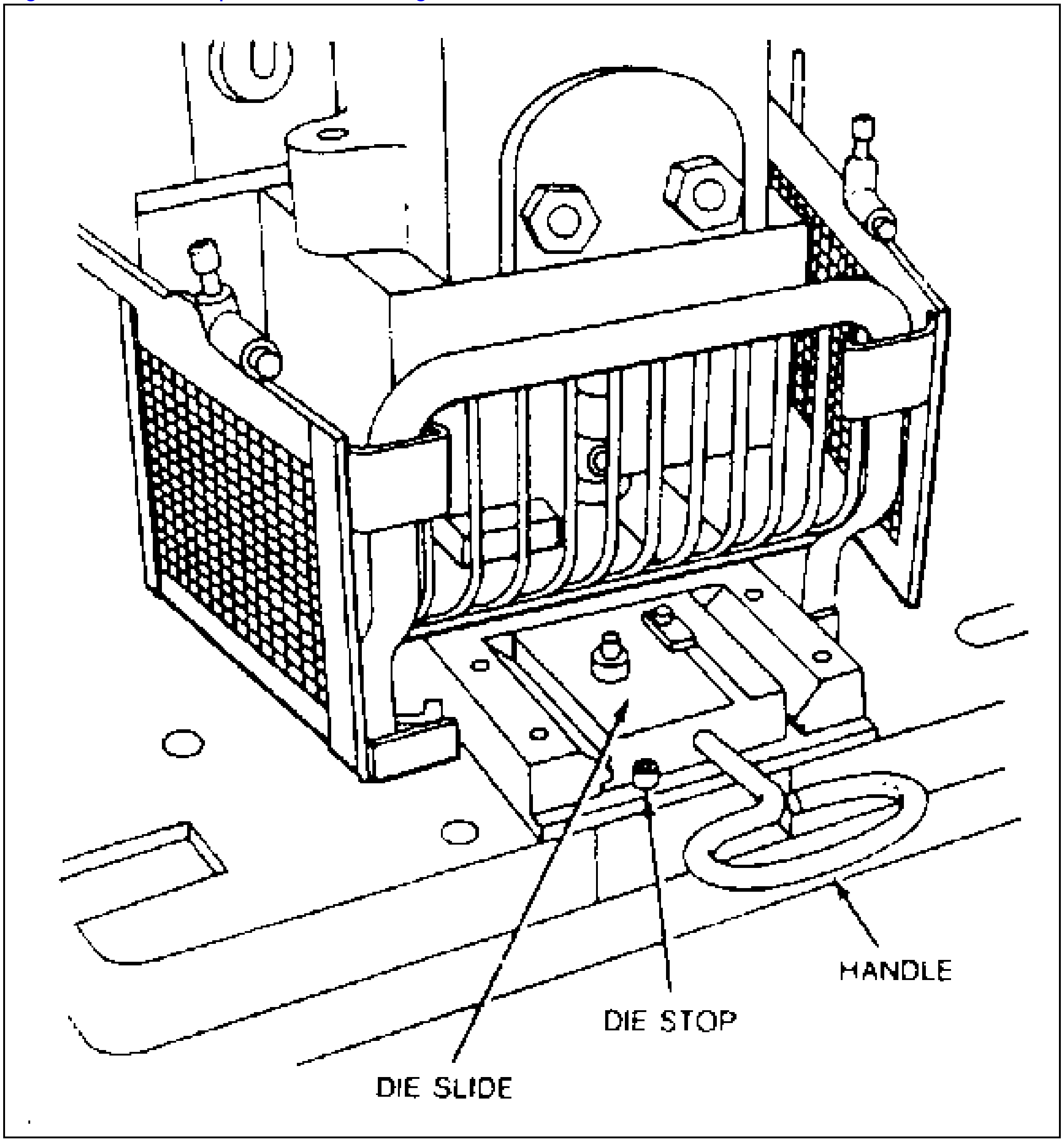


Figure 55 shows a sliding bolster. The press bed is modified with a hydraulically or pneumatically controlled bolster that slides in when "start" buttons are depressed, and out when the stroke is completed.

Figure 55. Power press with sliding bolster

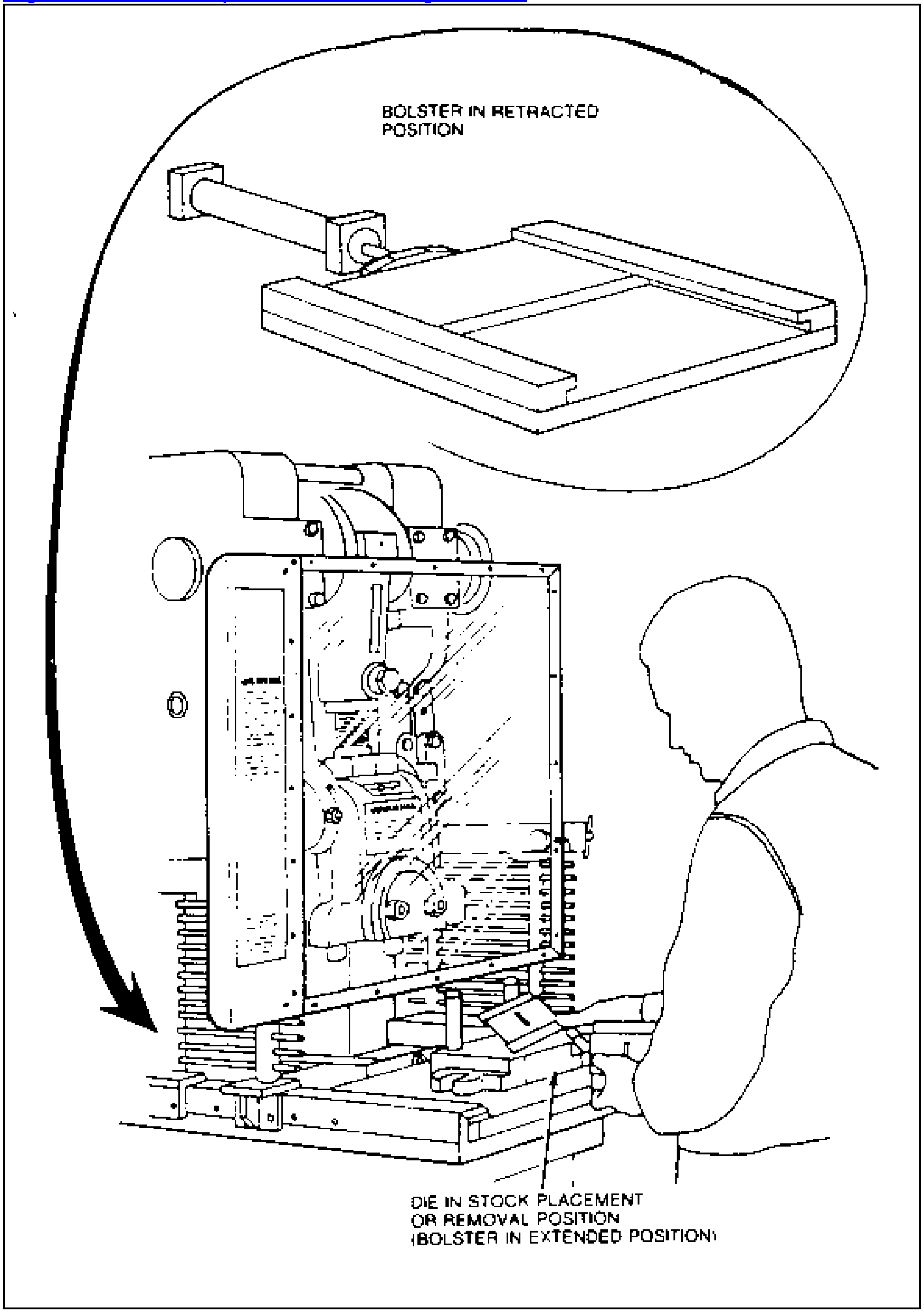
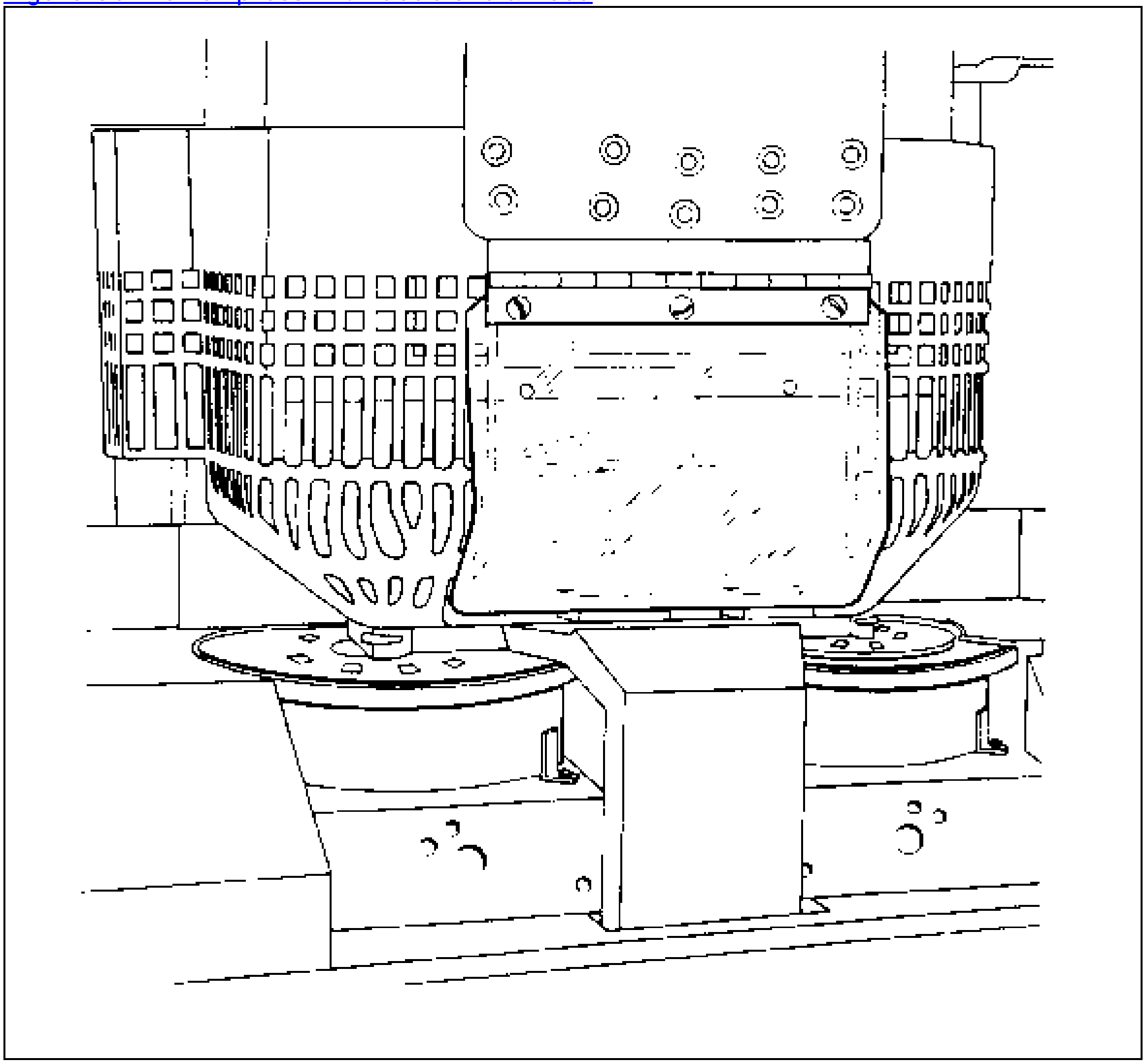


Figure 56 shows a double-dial feed. The dials revolve with each stroke of the press. The operator places the part to be processed in a nest on the dial which is positioned in front of the die. The dial is indexed with each upstroke of the press to deliver the nested part into the die.

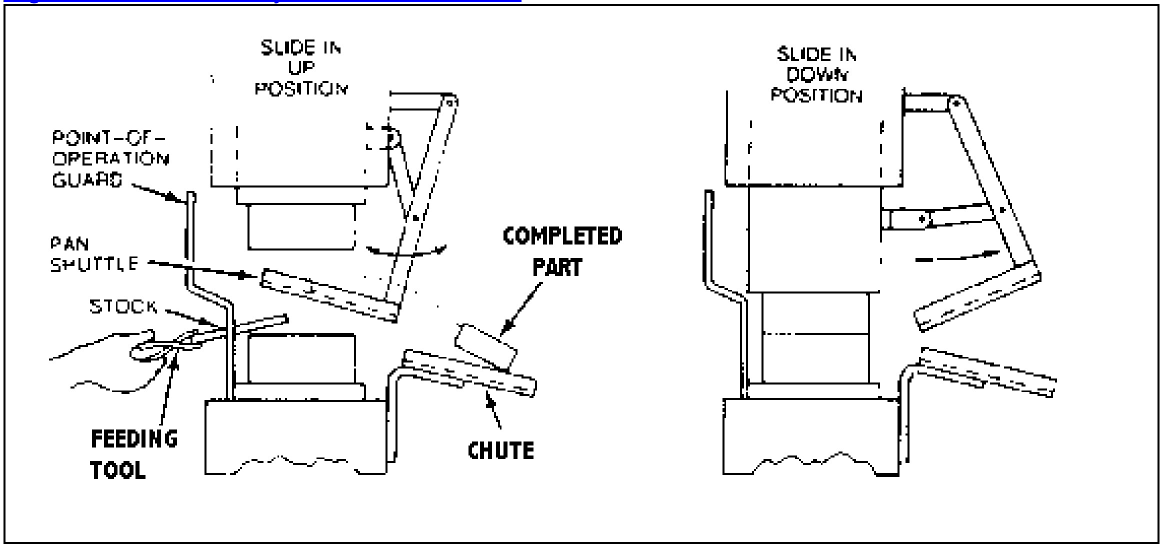
Automatic ejection may employ either an air-pressure or a mechanical apparatus to remove the completed part from a press. It may be interlocked with the operating controls to prevent operation until part ejection is completed. This method requires additional safeguards for full protection of the operator

Figure 56. Power press with double-dial feed



As shown in Figure 57, the pan shuttle mechanism moves under the finished part as the slide moves toward the "up" position. The shuttle then catches the part stripped from the slide by the knockout pins and deflects it into a chute. When the ram moves down toward the next blank, the pan shuttle moves away from the die area.

Figure 57. Shuttle ejection mechanism.



Figures 58 and 59 show air ejection and mechanical ejection mechanisms, respectively. Note: Air ejection methods often present a noise hazard to operators.

Figure 58. Air ejection.

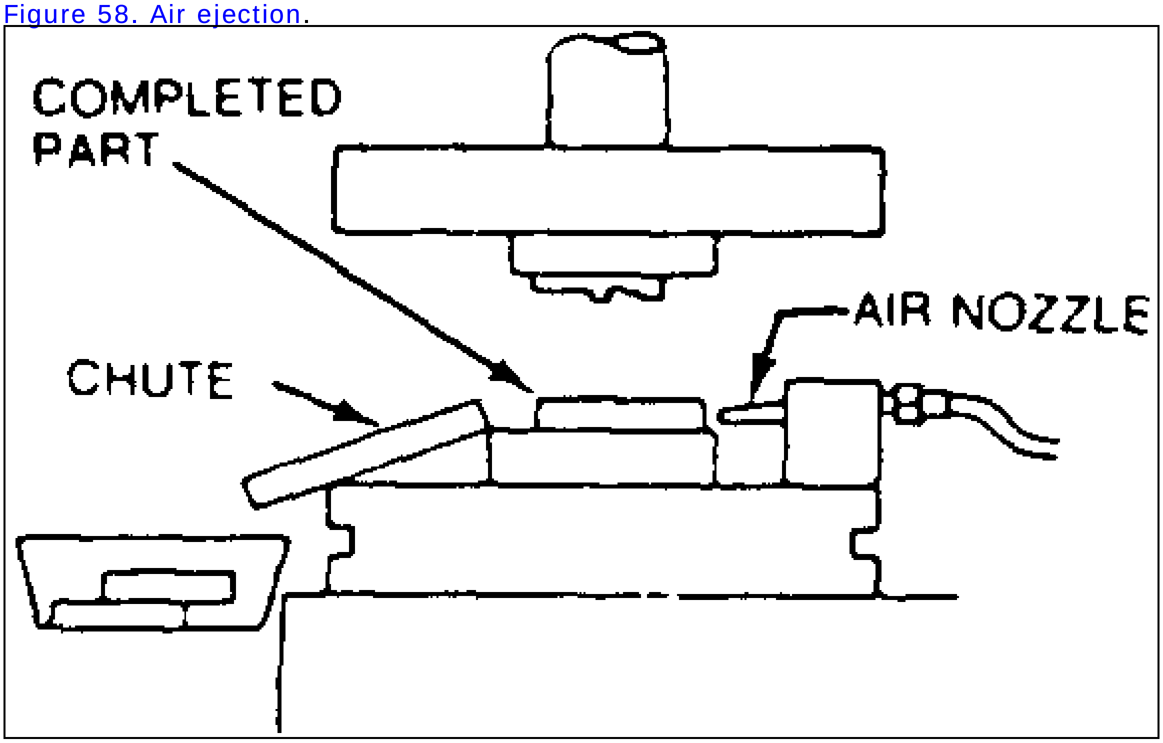


Figure 59 Mechanical ejection.

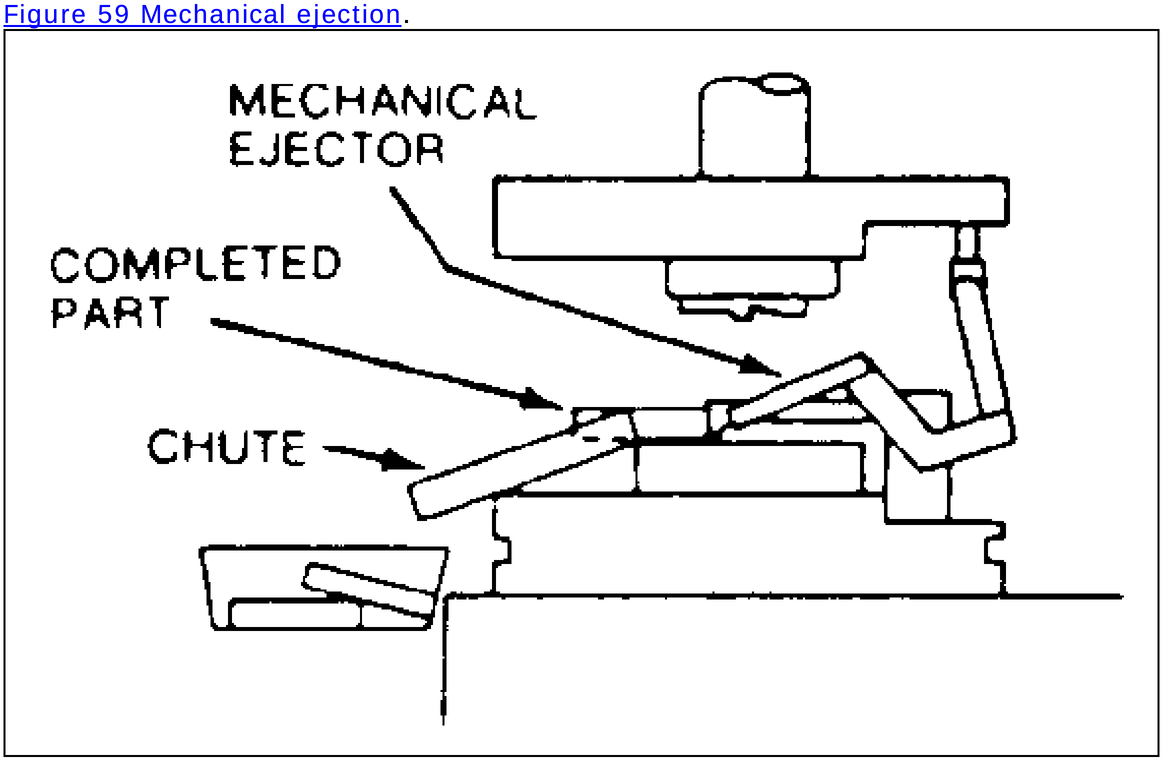
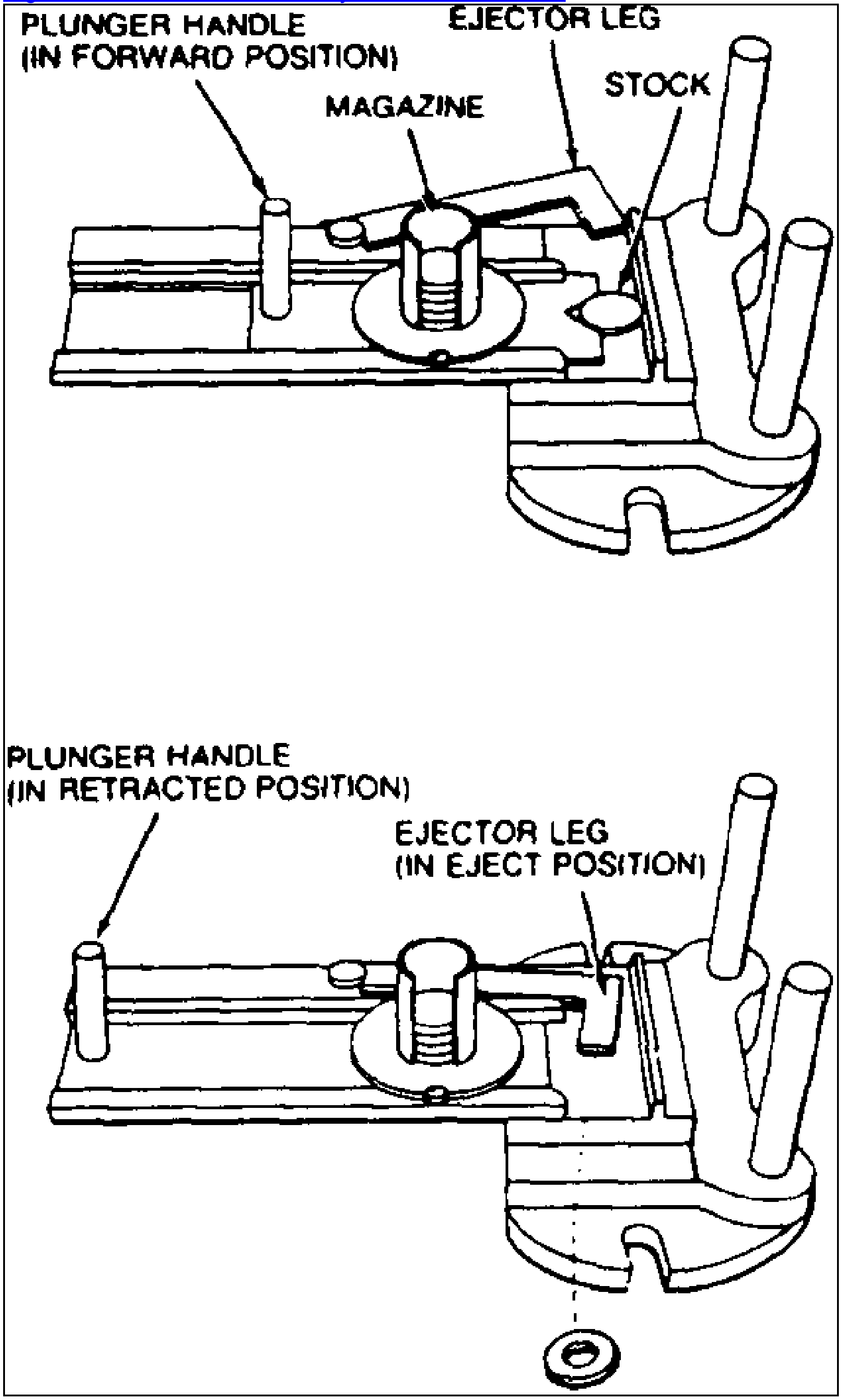


Figure 60 shows a semiautomatic ejection mechanism used on a power press. When the plunger is withdrawn from the die area, the ejector leg, which is mechanically coupled to the plunger, kicks the completed work out.

Figure 60. Semiautomatic ejection mechanism.



Essentially, robots perform work that would otherwise have to be done by an operator. They are best used in high-production processes requiring repeated routines where they prevent other hazards to employees. However, they may create hazards themselves, and if they do, appropriate guards must be used.
Figures 61, 62, and 63, respectively, show a type of robot in operation, the danger areas it can create, and an example of the kind of task (feeding a press) it can perform.

Figure 61. Robot movement capability.

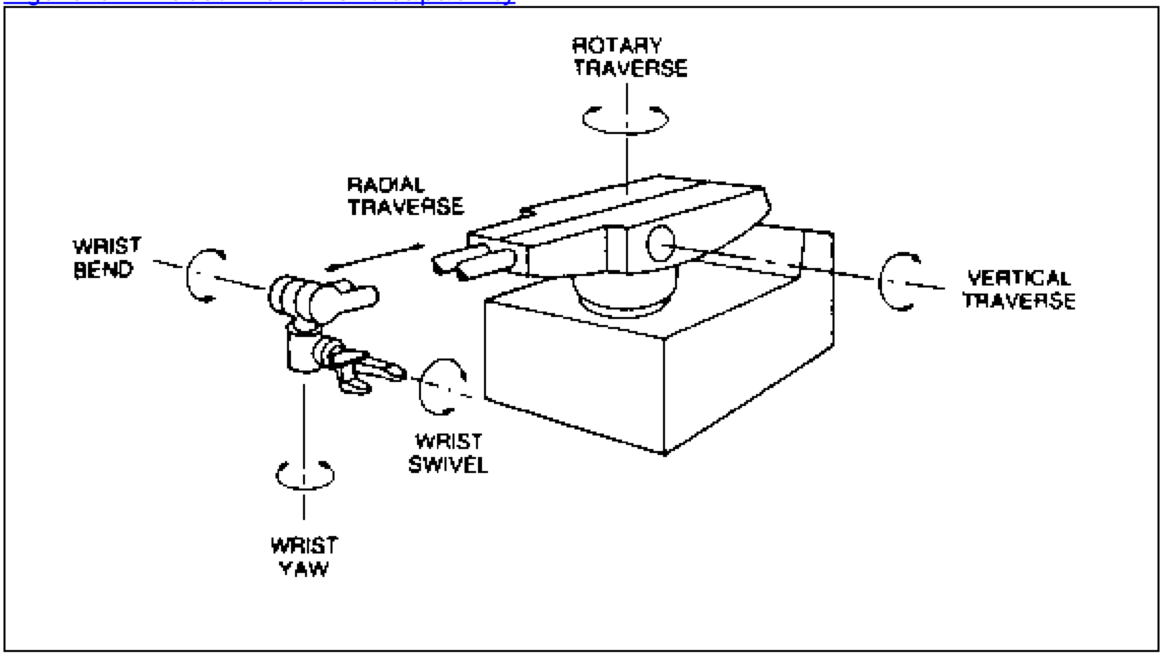


Figure 62. Potential danger areas in robot envelope.

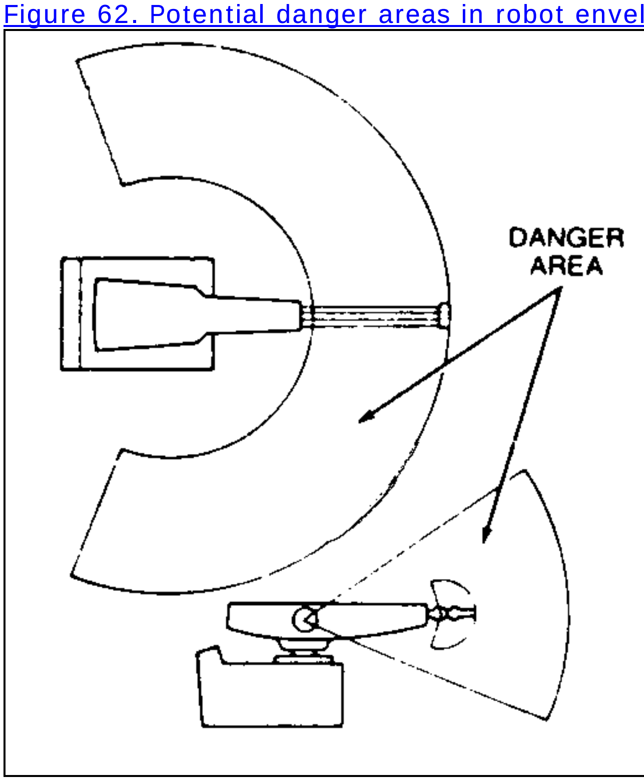
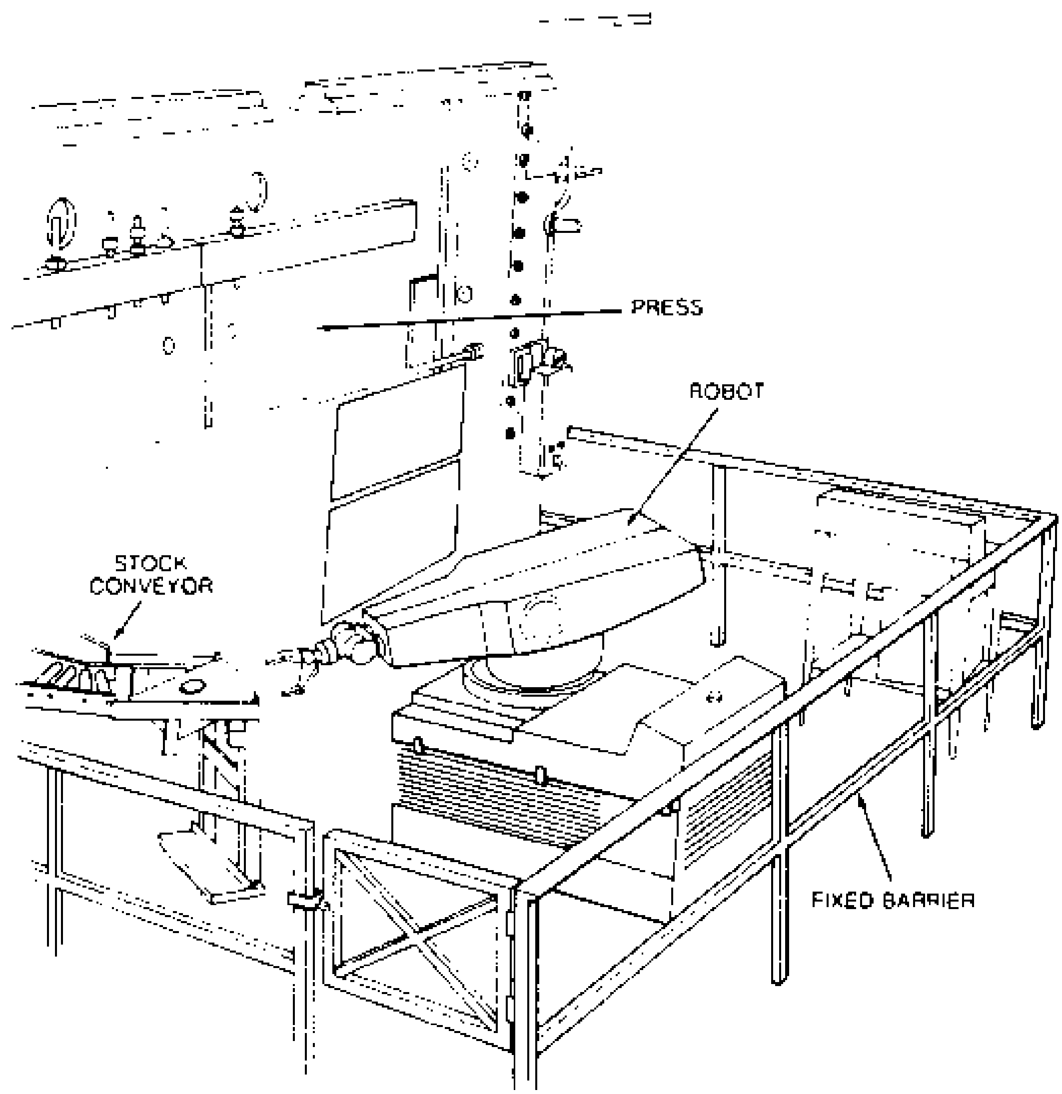


Figure 63. Using barrier guards to protect robot envelope



FEEDING AND EJECTION METHODS			
Method	**Safeguarding Action**	**Advantages**	**Limitations**
Automatic Feed	Stock is fed from rolls, indexed by machine mechanism, etc.	Eliminates the need for operator involvement in the danger area.	Other guards are also required for operator protection--usually fixed barrier guards. Requires frequent maintenance. May not be adaptable to stock variation.
Semiautomatic Feed	Stock is fed by chutes, movable dies, dial feed, plungers or sliding bolster.	Eliminates the need for operator involvement in the danger area.	
Automatic Ejection	Work pieces are ejected by air or mechanical means	Eliminates the need for operator involvement in the danger area.	May created a hazard of blowing chips or debris. Size of stock limits the use of this method. Air ejection may present a noise hazard.
Semiautomatic Ejection	Workpieces are ejected by mechanical means which are initiated by the operator	Operator does not have to enter danger area to remove finished work.	Other guards are required for operator protection. May not be adaptable to stock variation.
Robots	They perform work usually done by operator.	Operator does not have to enter danger area. Are suitable for operations where high stress factors are present, such as heat and noise.	Can create hazards themselves. Require maximum maintenance. Are suitable only to specific operations.

Miscellaneous Aids

While these aids do not give complete protection from machine hazards, they may provide the operator with an extra margin of safety. Sound judgment is needed in their application and usage. Below are several examples of possible applications.

An awareness barrier does not provide physical protection, but serves only to remind a person that he or she is approaching the danger area. Generally, awareness barriers are not considered adequate when continual exposure to the hazard exists. Figure 64 shows a rope used as an awareness barrier on the rear of a power squaring shear. Although the barrier does not physically prevent a person from entering the danger area, it calls attention to it. For an employee to enter the danger area, it calls attention to it. For an employee to enter the danger area, an overt act must take place, that is, the employee must either reach or step over, under or through the barrier.

Figure 64. Rear view of power shearing square.

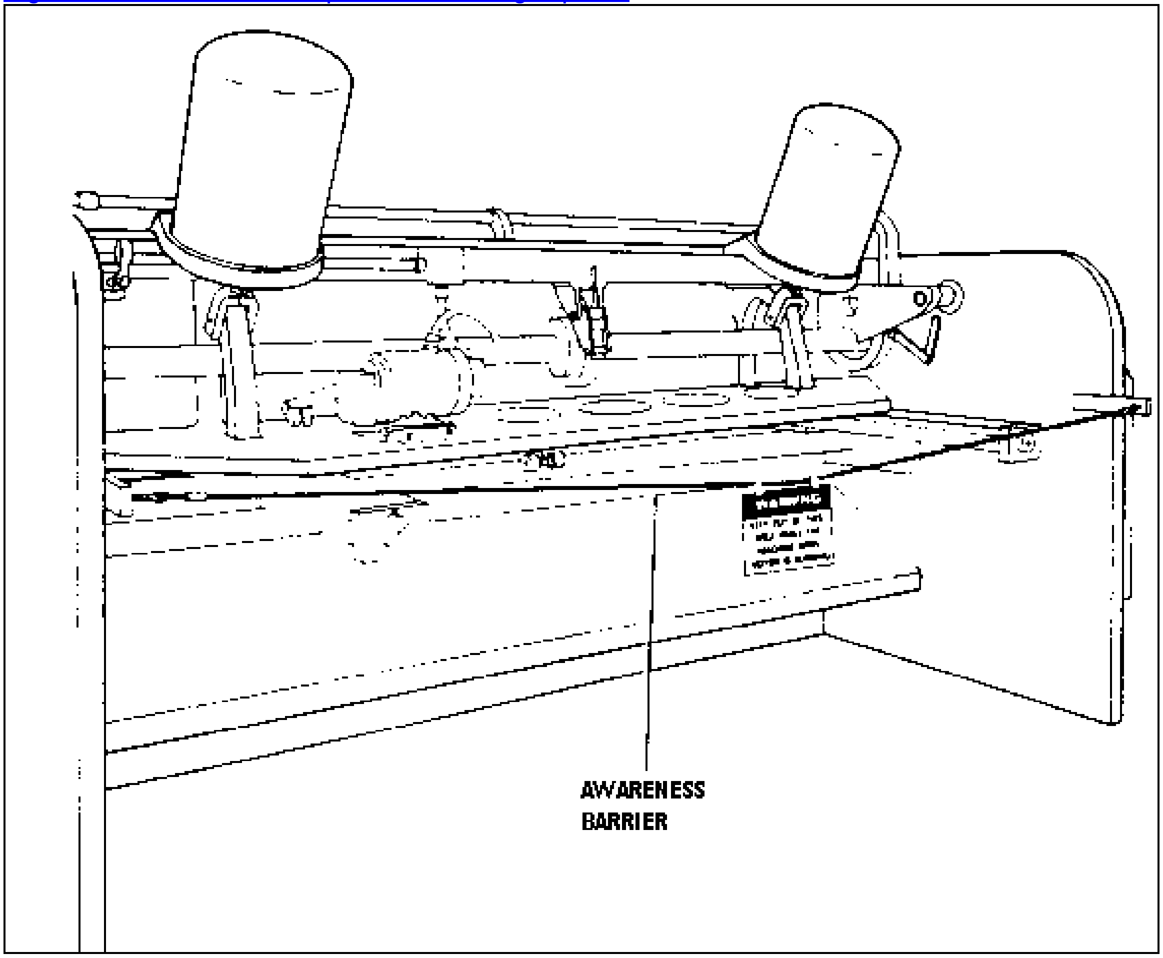
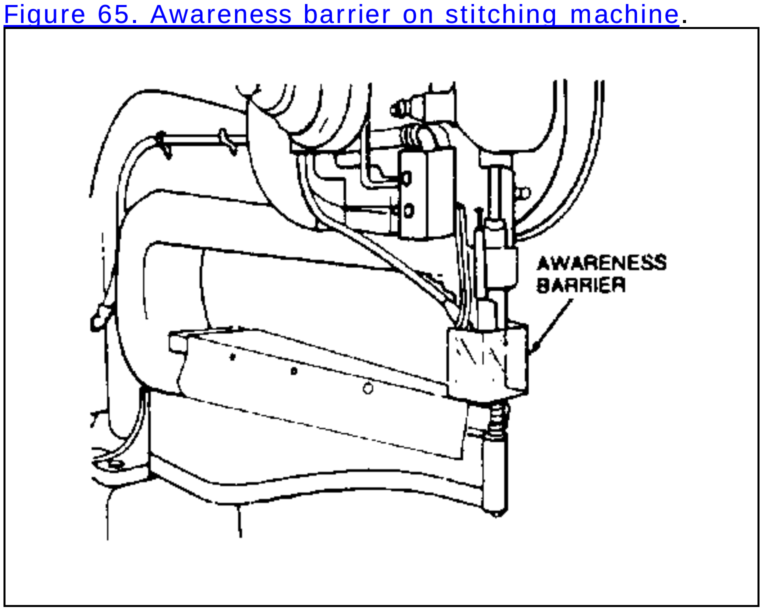


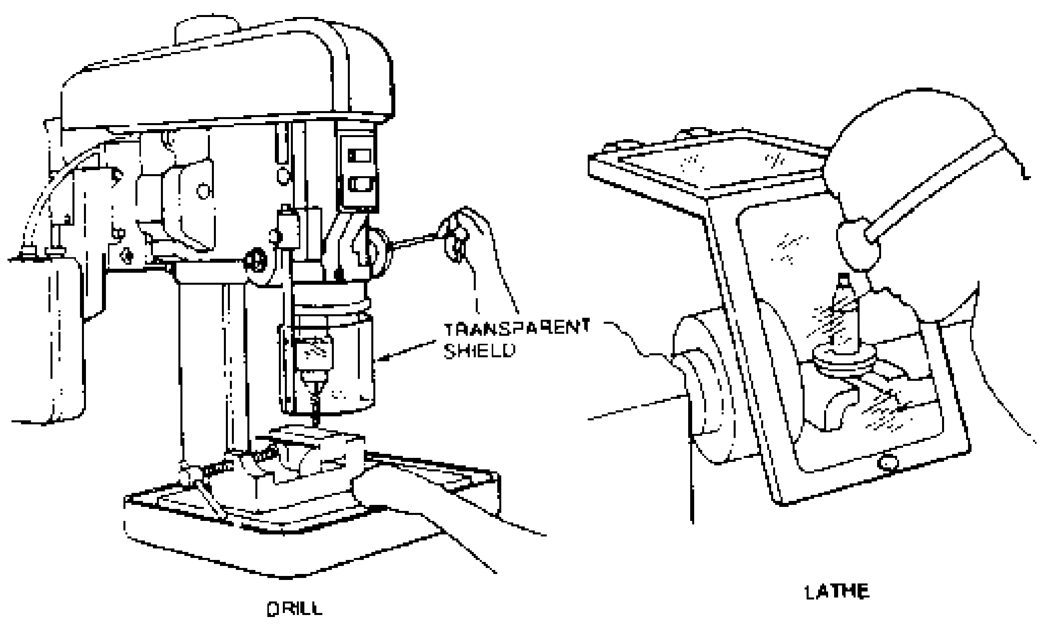
Figure 65 shows an awareness barrier on a stitching machine.

Figure 65. Awareness barrier on stitching machine.



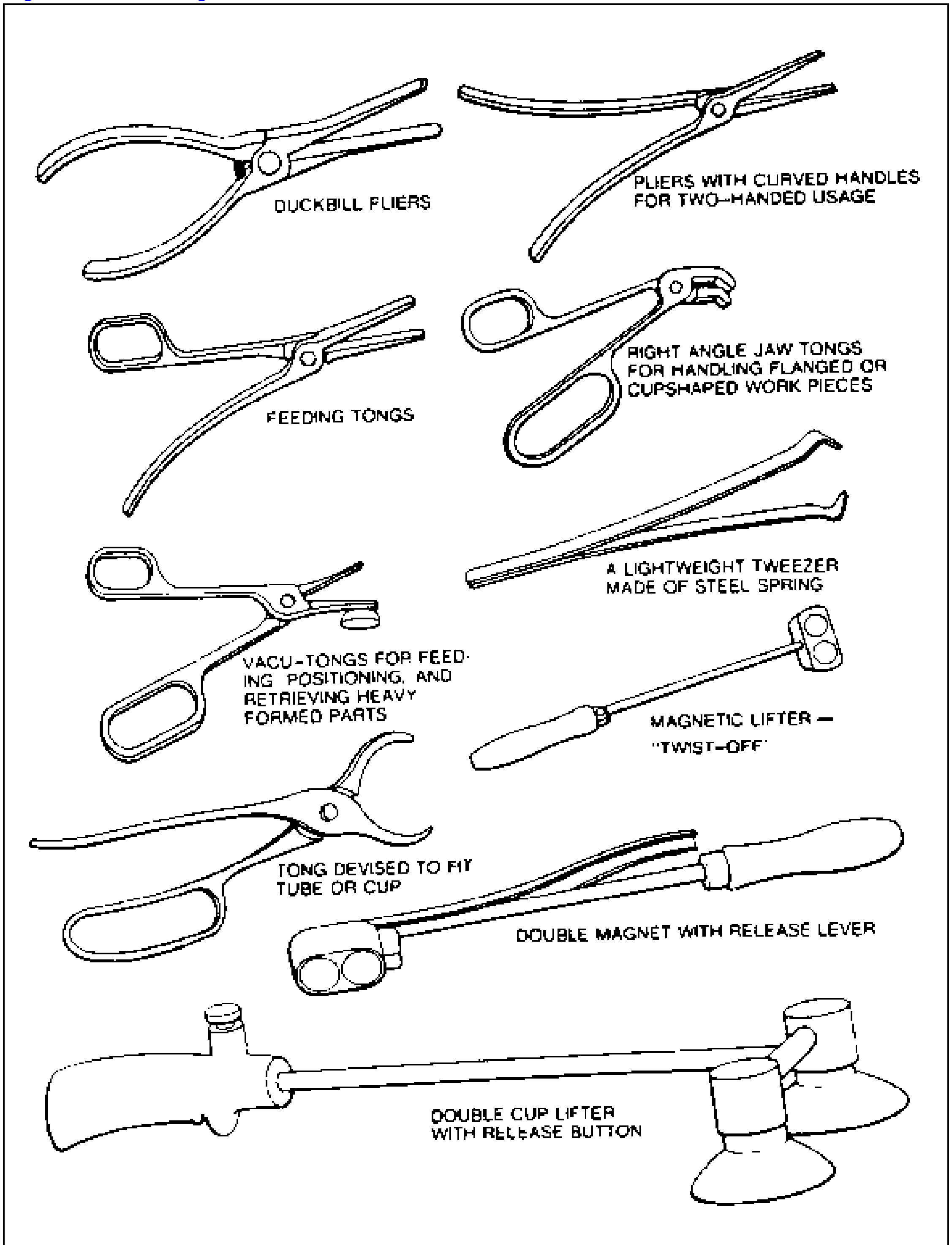
Shields, another aid, may be used to provide protection from flying particles, splashing cutting oils, or coolants. Figure 66 shows several potential applications.

Figure 66. Other applications of shields.



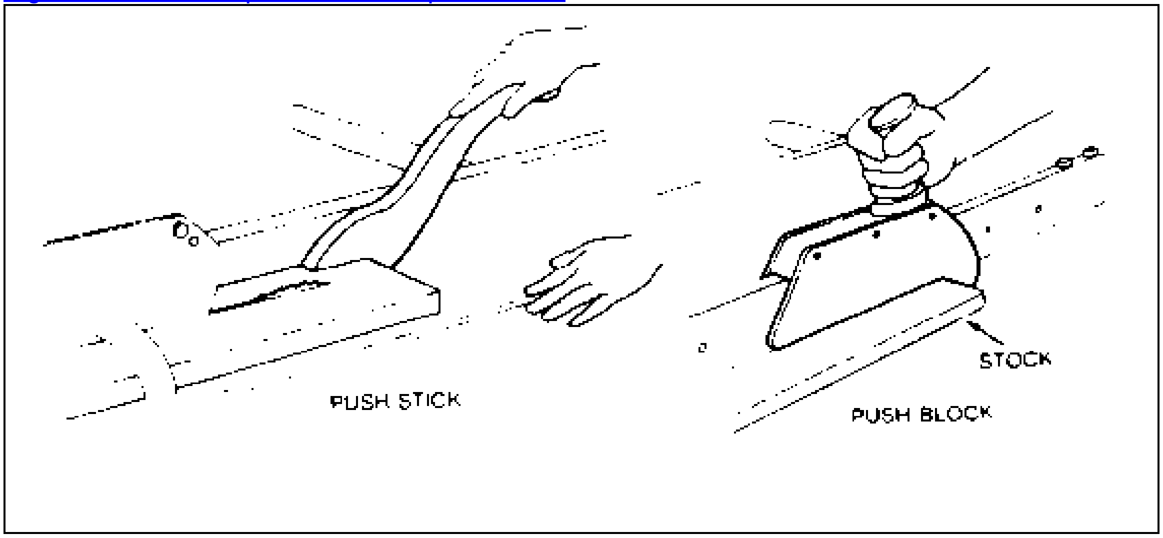
Special hand tools may be used to place or remove stock, particularly from or into the point of operation of a machine. A typical use would be for reaching into the danger area of a press or press brake. Figure 67 shows an assortment of tools for this purpose. Holding tools should not be used instead of other machine safeguards; they are merely a supplement to the protection that other guards provide.

Figure 67. Holding tools.



A push stick or block, such as those in Figure 68, may be used when feeding stock into a saw blade. When it becomes necessary for hands to be in close proximity to the blade, the push stick or block may provide a few inches of safety and prevent a severe injury. In the illustration the push block fits over the fence.

Figure 68. Use of push stick or push block.



Chapter 3

Guard Construction

Today many builders of single-purpose machines provide point-of-operation and power transmission safeguards as standard equipment. However, not all machines in use have built-in safeguards provided by the manufacturer.

Guards designed and installed by the builder offer two main advantages:

- They usually conform to the design and function of the machine.
- They can be designed to strengthen the machine in some way or to serve some additional functional purposes.

User-built guards are sometimes necessary for a variety of reasons. They have these advantages:

- Often, with older machinery, they are the only practical safeguarding solution.
- They may be the only choice for mechanical power transmission apparatus in older plants, where machinery is not powered by individual motor drives.
- They permit options for point-of-operation safeguards when skilled personnel design and make them.
- They can be designed and built to fit unique and even changing situations.
- They can be installed on individual dies and feeding mechanisms.
- Design and installation of machine safeguards by plant personnel can help to promote safety consciousness in the workplace.

However, they also have disadvantages:

- User-built guards may not conform well to the configuration and function of the machine.
- There is a risk that user-built guards may be poorly designed or built.

Point-of-Operation Guards

Point-of-operation safeguarding is complicated by the number and complexity of machines and also by the different uses for individual machines. For these reasons, not all machine builders provide point-of-operation guards on their products. In many cases a point-of-operation guard can only be made and installed by the user after a thorough hazard analysis of the work requirements. Poorly designed, built or installed guards may create a hazard rather than eliminate one. To be effective they must safeguard the employee while allowing the work to continue with minimum disruption to the production process.

Mechanical Power Transmission Apparatus Guarding

A significant difference between power transmission guards and point-of-operation guards is that the former type needs no opening for feeding stock. The only openings necessary for power transmission guards are those for lubrication, adjustment, repair, and inspection. These openings should be provided with interlocked covers that cannot be removed except by using tools for service or adjustment.

To be effective, power transmission guards should cover all moving parts in such a manner that no part of the operator's body can come in contact with them.

Guard Material

Under many circumstances, metal is the best material for guards. Guard framework is usually made from structural shapes, pipe, bar, or rod stock. Filler material generally is expanded or perforated or solid sheet metal or wire mesh. It may be feasible to use plastic or safety glass where visibility is required.

Guards made of wood generally are not recommended because of their flammability and lack of durability and strength. However, in areas where corrosive materials are present, wooden guards may be the better choice.

Chapter 4 - Machinery Maintenance and Repair

Machinery Maintenance and Repair

Good maintenance and repair procedures contribute significantly to the safety of the maintenance crew as well as that of machine operators. The variety and complexity of machines to be serviced, the hazards associated with their power sources, the special dangers that may be present during machine breakdown, and the severe time constraints often placed on maintenance personnel all make safe maintenance and repair work difficult.

Training and aptitude of people assigned to these jobs should make them alert for the intermittent electrical failure, the worn part, the inappropriate noise, the cracks or other signs that warn of impending breakage or that a safeguard has been damaged, altered, or removed. By observing machine operators at their tasks and listening to their comments, maintenance personnel may learn where potential trouble spots are and give them early attention before they develop into sources of accidents and injury. Sometimes all that is needed to keep things running smoothly and safely is machine lubrication or adjustment. Any damage observed or suspected should be reported to the supervisor; if the condition impairs safe operation, the machine should be out of service for repair. Safeguards that are missing, altered, or damaged also should be reported so appropriate action can be taken to insure against worker injury.

If possible, machine design should permit routine lubrication and adjustment without removal of safeguards. But when safeguards must be removed, and the machine serviced, the lockout procedure of 29 CFR 1910.147 must be adhered to. The maintenance and repair crew must never fail to replace the guards before the job is considered finished and the machine released from lockout..

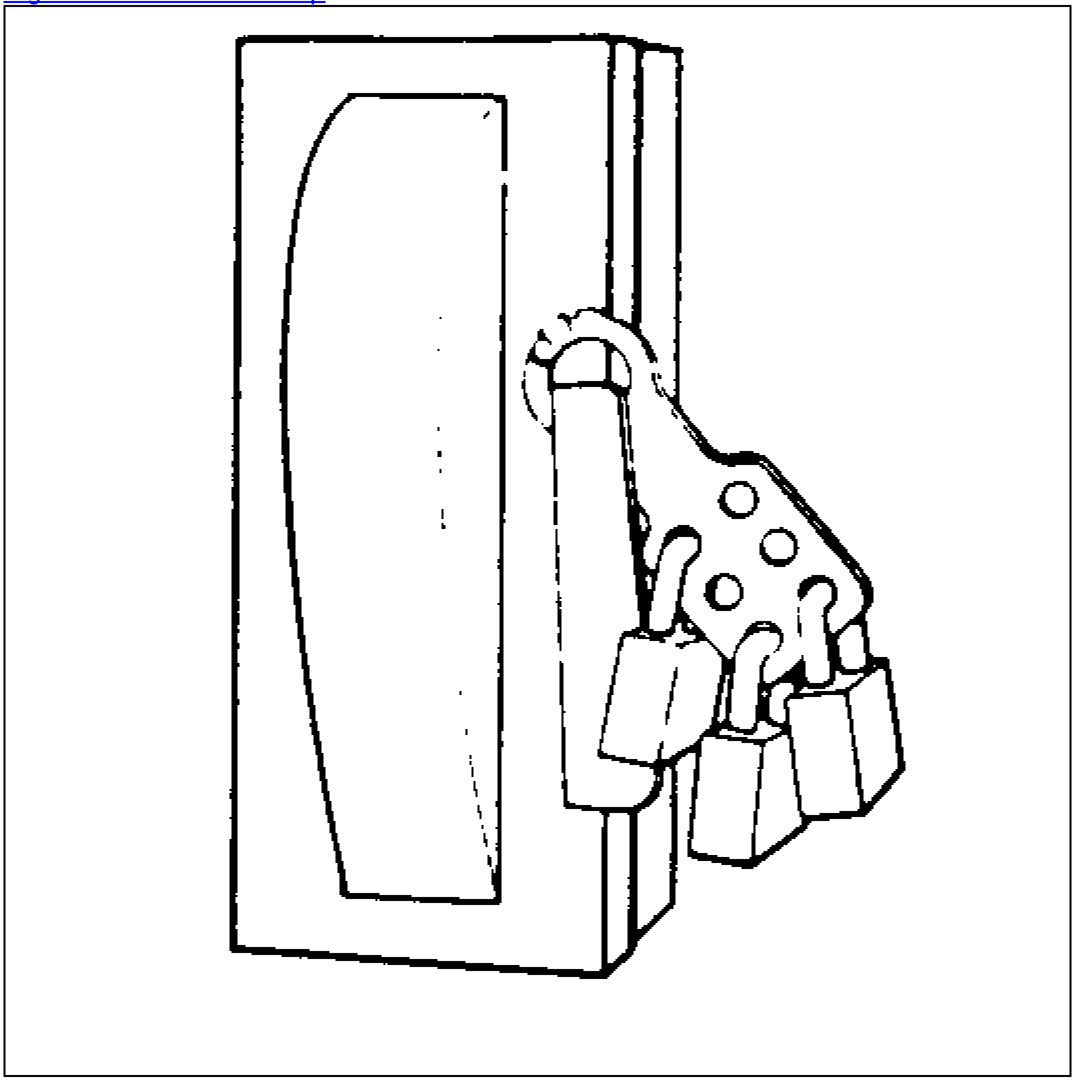
Is it necessary to oil machine parts while a machine is running? If so, special safeguarding equipment may be needed solely to protect the oiler from exposure to hazardous moving parts. Maintenance personnel must know which machines can be serviced while running and which cannot. "If in doubt, lock it out." Obviously, the danger of accident or injury is reduced by shutting off and locking out all sources of energy.

In situations where the maintenance or repair worker would necessarily be exposed to electrical elements or hazardous moving machine parts in the performance of the job, there is no question that all power sources must be shut off and locked out before work begins. Warning signs or tags are inadequate insurance against the untimely energizing of mechanical equipment.

Thus, one of the first procedures for the maintenance person is to disconnect and lock out the machine from all of its power sources, whether the source is electrical, mechanical, pneumatic, hydraulic, or a combination of these. Energy accumulation devices must be "bled down."

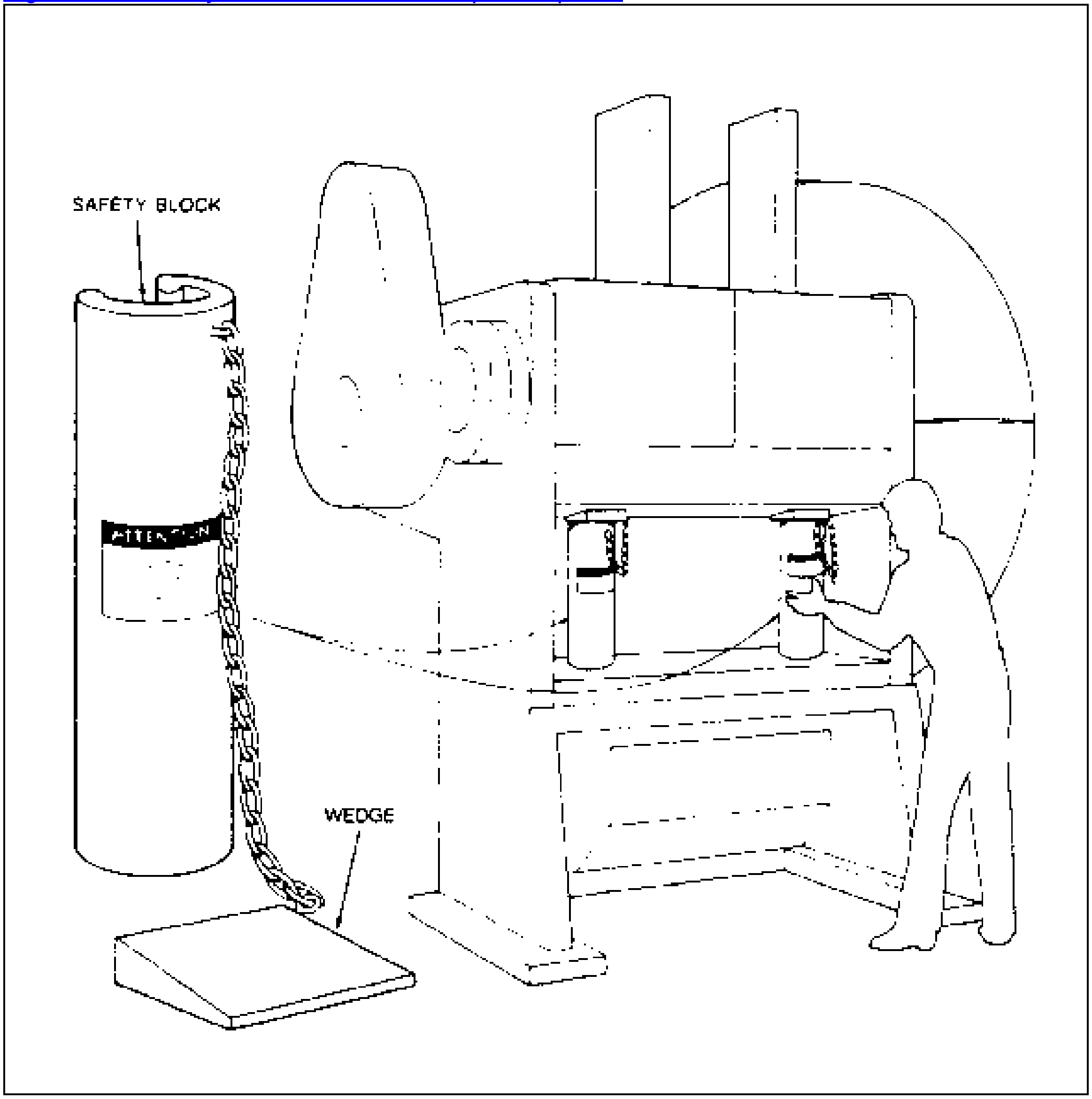
Electrical: Unexpected energizing of any electrical equipment that can be started by automatic or manual remote control may cause electric shock or other serious injuries to the machine operator, the maintenance worker, or others operating adjacent machines controlled by the same circuit. For this reason, when maintenance personnel must repair electrically powered equipment, they should open the circuit at the switch box and padlock the switch (lock it out) in the "off" position. This switch should be tagged with a description of the work being done, the name of the maintenance person, and the department involved. When more than one worker is to be engaged in the servicing/maintenance function a typical lockout hasp to which each may affix a personal lock is shown in Figure 69.

Figure 69. Lockout hasp



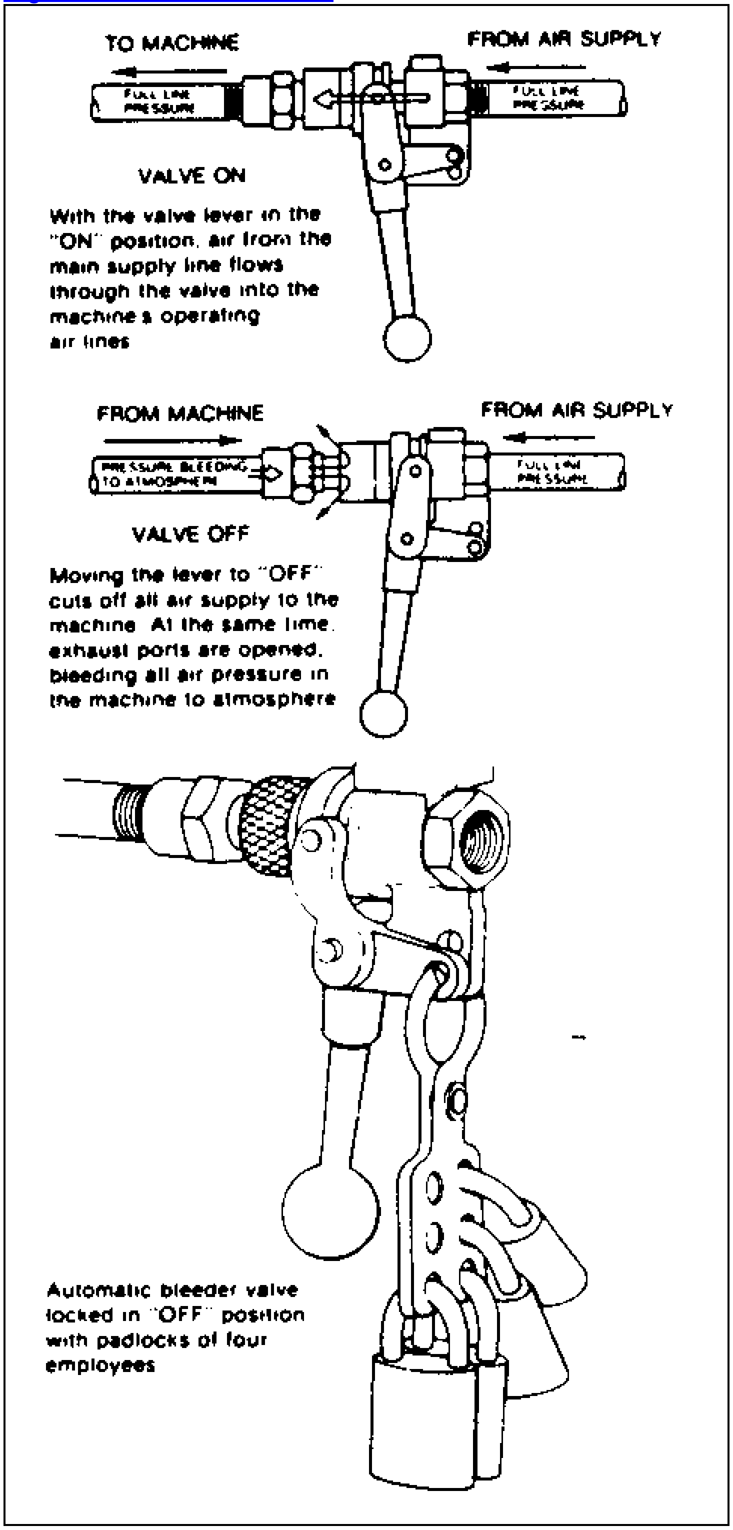
Mechanical: Figure 70 shows safety blocks being used as an additional safeguard on a mechanical power press, even though the machine has been locked out. The safety blocks prevent the ram from coming down under its own weight.

Figure 70. Safety blocks installed on power press



Pneumatic and hydraulic: Figure 71 shows a lockout valve. The lever-operated air valve used during repair or shutdown to keep a pneumatic-powered machine or its components from operating can be locked open or shut. Before the valve can be opened, everyone working on the machine must use his or her own key to release the lockout. A sliding-sleeve valve exhausts line pressure at the same time it cuts off the air supply. Valves used to lock out pneumatic or hydraulic-powered machines should be designed to accept locks or lockout adapters and should be capable of "bleeding off" pressure residues that could cause any part of the machine to move.

Figure 71. Lockout valve



In shops where several maintenance persons might be working on the same machine, multiple lockout devices accommodating several padlocks are used. The machine cannot be reactivated until each person removes his or her lock. As a matter of general policy, lockout control is gained by the procedure of issuing personal padlocks to each maintenance or repair person; no one but that person can remove the padlock, thereby each worker controls the power systems.

Whenever machines or equipment are serviced, there are hazards encountered by the employees performing the servicing or maintenance which are unique to the repair or maintenance procedures being conducted. These hazards may exist due to the failure of the employees doing the servicing or maintenance to stop the machine being worked on. Even if the machine has been stopped, the machine can still be hazardous due to the possibility of the machine becoming reenergized or restarting.

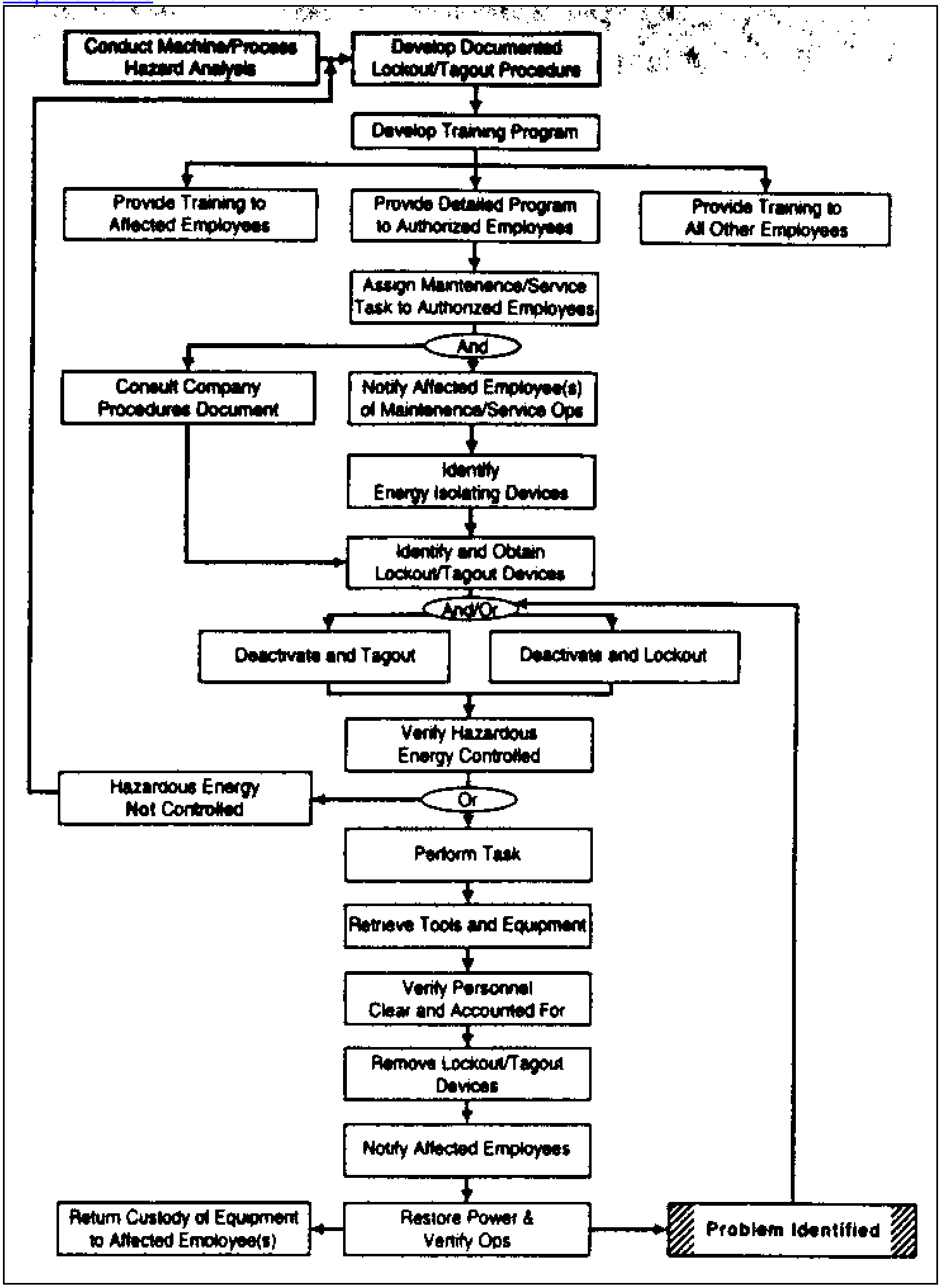
In order to prevent these hazards, each machine or piece of equipment should be safeguarded during the conduct of servicing or maintenance by: (1) notifying all affected employees (usually machine or equipment operators or users) that the machine or equipment must be shut down to perform some maintenance or servicing; (2) stopping the machine; (3) isolating the machine or piece of equipment from its energy source; (4) locking out or tagging out the energy source; (5) relieving any stored or residual energy; and (6) verifying that the machine or equipment is isolated from the energy source. Although this is the general rule, there are exceptions when the servicing or maintenance is not hazardous for an employee, when the servicing which is conducted is minor in nature, done as an integral part of production, and the employer utilizes alternative safeguards which provide effective protection as is required by 29 CFR 1910.212 or other specific OSHA standards.

When the servicing or maintenance is completed, there are specific steps which must be taken to return the machine or piece of equipment to service. These steps include (1) inspection of the machine or equipment to ensure that all guards and other safety devices are in place and functional, (2) checking the area to ensure that energization and start up of the machine or equipment will not endanger employees, (3) removal of the lockout devices, (4) reenergization of the machine or equipment, and (5) notification of affected employees that the machine or equipment may be returned to service.

The steps to lockout described above are only a part of the total energy control program which must exist in the workplace. In addition, the employee should have written procedures for all machines and equipment, employees must be trained in their duties and responsibilities under the energy control program and periodic inspections must be conducted to maintain the effectiveness of the program.

Figure 72 provides a functional flow diagram of the functions necessary during the conduct of a viable servicing/maintenance operation during which the equipment must be isolated and locked out.

Figure 72. Functional flow diagram for implementation of lockout/tagout requirements



The maintenance and repair facility in the plant deserves consideration here. Are all the right tools on hand and in good repair? Are lubricating oils and other common supplies readily available and safely stored? Are commonly used machine parts and hardware kept in stock so that the crews are not encouraged (even obliged) to improvise, at the risk of doing an unsafe repair, or to postpone a repair job? And don't overlook the possibility that maintenance equipment itself may need guarding of some sort. The same precaution applies to tools and machines used in the repair shop. Certainly, the maintenance and repair crew are entitled to the same protection that their service provides to the machine operators in the plant.

Chapter 5 - The Utilization of Industry Consensus Standards

The Utilization of Industry Consensus Standards

OSHA uses industry consensus standards, related to the safe operation of equipment, as guidance of the industry accepted practice for safe operations. Industry consensus standards which describe equipment configuration or design but which do not describe safe and/or healthful use and operation of the equipment are of limited assistance to OSHA. In any event, even when an industry consensus standard addresses safety/health considerations, OSHA may determine that the safety/health practices described by that industry consensus standard are deficient when related to the requirement(s) set forth by the pertinent OSHA regulation(s). However, many of the various ANSI safety standards devoted to the safe use of equipment and machines are pertinent and provide valuable guidance as they relate to the multitude of safe operating procedures regularly discussed in ANSI safety standards.

All of the requirements of 29 CFR 1910.212, are applicable to machines found in industry. Paragraph (a)(1), requires that employees be protected from the hazards created by the point of operation, ingoing nip points, and rotating parts. Paragraph (a)(2), describes the manner in which guards shall be affixed. The proper application of devices are not described; therefore, other similar OSHA or pertinent industry standards must be referred to for guidance. Paragraph (a)(3) describes, with particularity, the requirements for safeguarding the point of operation.

The OSHA standard specifically requires that at the point of operation, "the guarding device shall be in conformity with any appropriate standards therefore, or in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle. "Applicable standards include any similar OSHA standard or any OSHA adopted industry consensus standard(s) which provide for the safety of the operator during the operating cycle. However, any specific industry consensus standard, such as an ANSI standard for the particular machine or equipment, should be used for guidance relative to the accepted procedures for safeguarding workers and operators from the recognized hazards of the equipment.

Employers who comply with the requirements of an industry consensus standard rather than a specific OSHA standard, where such compliance deviates from the OSHA requirements but provides for a more conservative safeguarding concept, are categorized as having created a de minimis violation of the specific OSHA standard. (A de minimis violation is a violation of an OSHA standard that has no direct or immediate relationship to safety or health. Such de minimis violations require no correction and result in no penalty.)

OSHA encourages employers to abide by the more current industry consensus standards since those standards are more likely to be abreast of the state of the art than an applicable OSHA standard may be. Furthermore, the industry consensus standards will usually discuss a variety of techniques for averting exposure to the identified hazards of the machine or process.

Listing of Specific ANSI Safety Standards

ANSI B11.1-1982	Mechanical Power Presses
ANSI B11.2-1982	Hydraulic Power Presses
ANSI B11.3-1982	Power Press Brakes
ANSI B11.4-1983	Shears
ANSI B11.5-1988	Iron Workers
ANSI B11.6-1984	Lathes
ANSI B11.7-1985	Cold Headers and Cold Formers
ANSI B11.8-1983	Drilling, Milling, and Boring Machines
ANSI B11.9-1975	Grinding Machines
ANSI B11.10-1983	Metal Sawing Machines
ANSI B11.11-1985	Gear Cutting Machines
ANSI B11.12-1983	Roll Forming and Roll Bending Machines
ANSI B11.13-1983	Single- and Multiple-Spindle Automatic Screw/Bar and Chucking Machines
ANSI B11.14-1983	Coil Slitting Machines/Equipment
ANSI B11.15-1984	Pipe, Tube, and Shape Bending Machines
ANSI B11.17-1982	Horizontal Hydraulic Extrusion Presses
ANSI B11.18-1985	Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate
ANSI B11.19-1990	Machine Tools, Safeguarding
ANSI B11.20-1991	Manufacturing Systems/Cells
(ANSI B15.1-1994/6)	Power Transmission Apparatus
ANSI B19.1-1990	Air Compressor Systems
ANSI B19.3-1986/90	Compressors for Process Industries
ANSI B20.1-1990	Conveyors and Related Equipment
ANSI B24.1-1985	Forging Machinery
ANSI B28.6-1983	Rubber Machinery, Hose
ANSI B28.7-1983	Rubber Machinery, Hose
ANSI B28.8-1983	Rubber Machinery, Hose
ANSI B28.9-1983	Rubber Machinery, Hose
ANSI B28.10-1986	Rubber Machinery, Endless Belt
ANSI B30.16-1987	Overhead Hoists
ANSI B151.1-1990	Plastics Injection Molding Machinery, Horizontal
ANSI B151.2-1982/88	Plastics Machinery, Film Casting
ANSI B151.3-1982/88	Plastics Machinery, Screen Changers
ANSI B151.4-1982/88	Plastics Machinery, Blown Film Takeoff & Auxiliary Equipment
ANSI B151.5-1982/88	Plastics Machinery, Film & Sheet Winding
ANSI B151.6-1982/88	Plastics Machinery, Slit Tape & Monofilament Postextrusion Equipment
ANSI B151.7-1982/88	Plastics & Rubber Extrusion Machinery
ANSI B151.11-1982	Plastics Machinery, Granulators, Pelletizers, & Dicers
ANSI B151.15-1985	Plastics Machinery, Extrusion Blow Molding
ANSI B151.21-1986	Plastics Machinery, Injection Blow Molding
ANSI B151.25-1988	Plastics Machinery, Injection Molding
ANSI B152.2-1982	Permanent-Mold Casting Machines (Other than Gray Iron)
ANSI B153.1-1990	Automotive Lifts
ANSI B155.1-1986	Packaging Machinery
ANSI B169.1-1990	Envelope Manufacturing Machinery

ANSI B176-1985	Copper-Alloy Diecasting
ANSI B177.2-1977/82	Printing Ink Vertical Post Mixers
ANSI/NEMA ICS2:225.95-1983	Interlocking Control Circuits for Personnel Protection
ANSI/NFPA 79-1991	Electrical Standard for Industrial Machinery
ANSI/RIA R15.06-1986	Industrial Robots and Robot Systems
ANSI Z8.1-1972	Commercial Laundry & Dry-Cleaning Equipment
ANSI Z241.1-1989	Foundry, Sand Prep., Molding, & Core-Making
ANSI Z241.2-1989	Foundry, Melting & Pouring of Metals
ANSI Z241.3-1989	Foundry, Cleaning & Finishing of Castings
ANSI Z245.1-1984	Refuse Collecting & Compacting Equipment
ANSI Z245.3-1977/83	Stability of Refuse Bins
ANSI Z245.5-1982	Bailing Equipment
ANSI Z268.1-1082	Metal Scrap Processing Equipment

Chapter 6 - Robotics in the Workplace

Robotics in the Workplace
Robot Applications

Robots are machines that load and unload stock, assemble parts, transfer objects, or perform other tasks.

Robots are used for replacing humans who were performing unsafe, hazardous, highly repetitive, and unpleasant tasks. They are utilized to accomplish many different types of application functions such as material handling, assembly, arc welding, resistance welding, machine tool load/unload functions, painting/spraying, etc.

Studies in Sweden and Japan indicate that many robot accidents have not occurred under normal operating conditions but rather during programming, program touch-up, maintenance, repair, testing, setup, or adjustment. During many of these operations, the operator, programmer or corrective maintenance worker may temporarily be within the robot's working envelope where unintended operations could result in injuries.

All industrial robots are either servo or non-servo controlled. Servo robots are controlled through the use of sensors which are employed to continually monitor the robot's axes for positional and velocity feedback information. This feedback information is compared on an on-going basis to pre-taught information which which has been programmed and stored in the robot's memory.

Non-servo robots do not have the feedback capability of monitoring the robot's axes and velocity and comparing with a pre-taught program. Their axes are controlled through a system of mechanical stops and limit switches to control the robot's movement.

Type of Potential Hazards
The use of robotics in the workplace also can pose potential mechanical and human hazards.

Mechanical hazards might include workers colliding with equipment, being crushed, or trapped by equipment, or being injured by falling equipment components. For example, a worker could collide with the robot's arm or peripheral equipment as a result of unpredicted movements, component malfunctions, or unpredicted program changes.

A worker could be injured by being trapped between the robot's arm and other peripheral equipment or being crushed by peripheral equipment as a result of being impacted by the robot into this equipment.

Mechanical hazards also can result from the mechanical failure of components associated with the robot or its power source, drive components, tooling or end-effector, and/or peripheral equipment. The failure of gripper mechanisms with resultant release of parts, or the failure of end-effector power tools such as grinding

wheels, buffing wheels, deburring tools, power screwdrivers, and nut runners to name a few.
Human errors can result in hazards both to personnel and equipment. Errors in programming, interfacing peripheral equipment, connecting input/output sensors, can all result in unpredicted movement or action by the robot which can result in personnel injury or equipment breakage.

Human errors in judgment result frequently from incorrectly activating the teach pendant or control panel. The greatest human judgment error results from becoming so familiar with the robot's redundant motions that personnel are too trusting in assuming the nature of these motions and place themselves in hazardous positions while programming or performing maintenance within the robot's work envelope.

Robots in the workplace are generally associated with the machine tools or process equipment. **Robots are machines,** and as such must be safeguarded in ways similar to those presented for any hazardous remotely controlled machine.

Various techniques are available to prevent employee exposure to the hazards which can be imposed by robots. The most common technique is through the installation of perimeter guarding with interlocked gates. A critical parameter relates to the manner in which the interlocks function. Of major concern is whether the computer program, control circuit, or the primary power circuit, is interrupted when an interlock is activated. The various industry standards should be investigated for guidance; however, it is generally accepted that the primary motive power to the robot should be interrupted by the interlock.

The ANSI safety standard for industrial robots, ANSI/RIA R15.06-1986, is very informative and presents certain basic requirements for protecting the worker. However, when a robot is to be used in a workplace, the employer should accomplish a comprehensive operational safety/health hazard analysis and then devise and implement an effective safeguarding system which is fully responsive to the situation. (Various effective safeguarding techniques are described in ANSI B11.19-1990.)

Chapter 7 -
Cellular Manufacturing Systems

A recent development in manufacturing technology has given rise to a manufacturing concept known as Manufacturing Systems/Cells, or Cellular Manufacturing Systems. These systems of integrated industrial machines, linked by a material handling system and operated by (controlled by) a programmable electronic system (computer) are capable of manufacturing discrete parts or assemblies. The safety of employees exposed to these systems is of first order importance.

Because a system is to be safeguarded it is logical that a system hazard analysis will yield the parameters of the safeguarding system required. Figures 73 through 75 depict typical cellular system concepts and safeguarding considerations.
ANSI B11.20-1991, should be referred to for assistance when a cellular manufacturing system is envisioned.

Figure 73. Typical manufacturing system/cell using a robot as the material handling system showing perimeter marking/barrier, fixed barriers with interlocked gates, presence sensing devices, warning devices, and additional system emergency stop devices

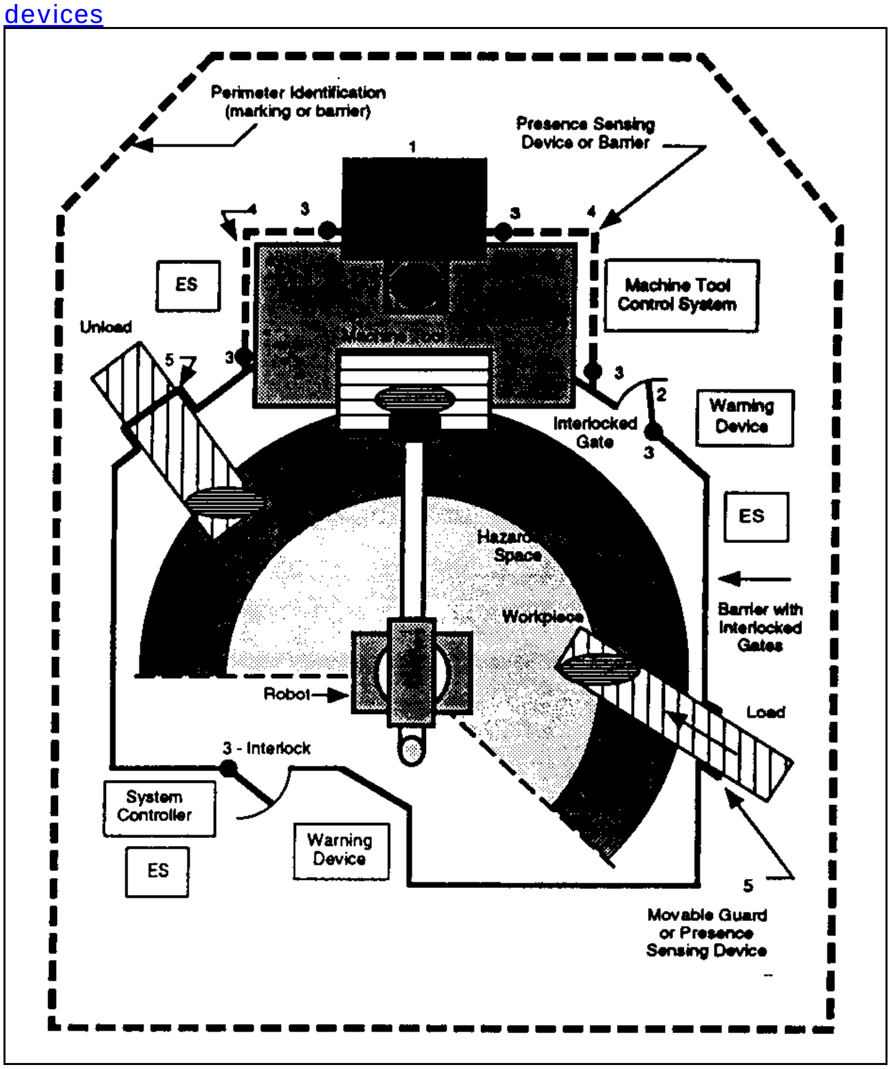


Figure 74. Manufacturing system composed of several cells.

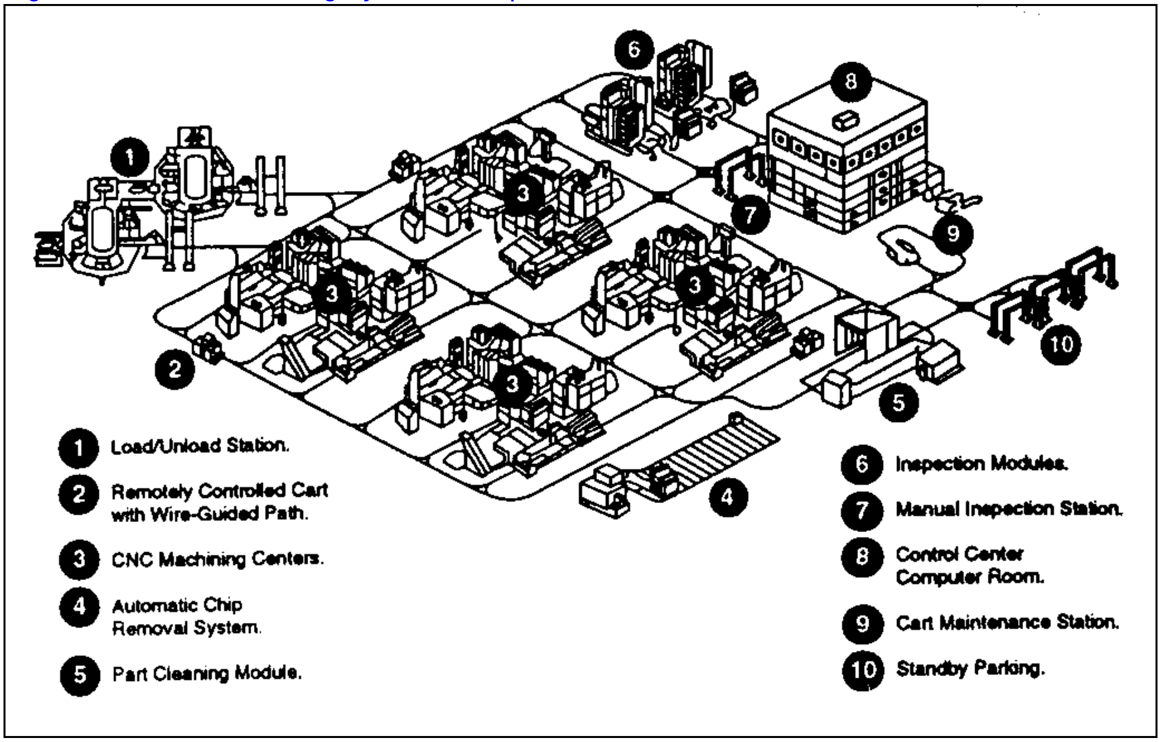
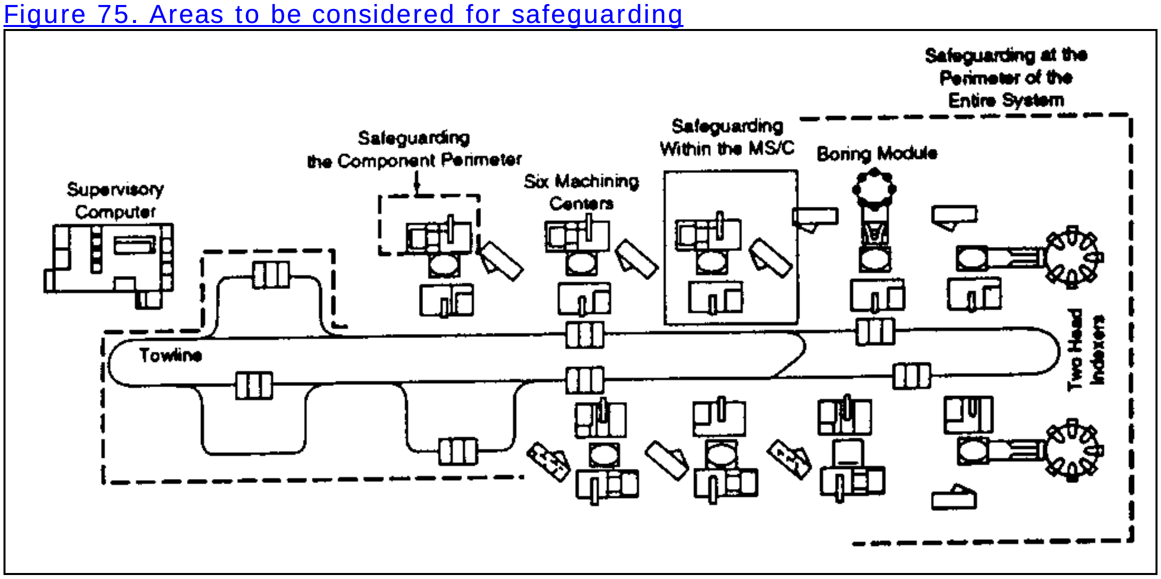


Figure 75. Areas to be considered for safeguarding



Chapter 8 - Ergonomic Considerations of Machine Safeguarding

The ergonomic considerations of machine safeguarding are as significant to the safety and health of the worker as are the multitude of techniques to accomplish safety and health in the workplace. Worker stress and fatigue can be averted by creditable work setups and well integrated safeguarding. The various industry consensus standards are only now beginning to address this issue. Future evaluations of safeguarding are likely to devote more attention to this aspect.

Chapter 9 - Cooperation and Assistance

Safety in the workplace demands cooperation and alertness on everyone's part. Supervisors, operators, and other workers who notice hazards in need of safeguarding, or existing systems that need repair or improvement, should notify the proper authority immediately.

Supervisors have these additional, special responsibilities with regard to safety in the workplace; encouraging safe work habits and correcting unsafe ones; explaining to the worker all the potential hazards associated with the machines and processes in the work area; and being responsive to employer requests for action or information regarding machine hazards. The first-line supervisor plays a pivotal role in communicating the safety needs of the worker to management and the employer's safety rules and policies to the worker.

Sometimes the solution to a machine safeguarding problem may require expertise that is not available in a given establishment. The readers of this manual are encouraged to find out where help is available and, when necessary, to request it.

The machine's manufacturer is often a good place to start when looking for assistance with a safeguarding problem. Manufacturers can often supply the necessary literature or advice. Insurance carriers, too, will often make their safety specialists available to the establishments whose assets they insure. Union safety specialists can also lend significant assistance.

Some government agencies offer consultation services, providing for on-site evaluation of workplaces and the recommendation of possible hazard controls. OSHA funds one such program, which is offered free of charge to employers in every state. Delivered by state governments or private contractors, the consultation program is completely separate from the OSHA inspection effort; no citations are issued and no penalties are proposed. The trained professional consultants can help employers recognize hazards in the workplace and can suggest general approaches for solving safety and health problems. In addition, the consultant can identify sources of other available help, if necessary.

Anyone with questions about Federal standards, about the requirements for machine safeguarding, or about available consultation services should contact OSHA. (See the list of OSHA Regional Offices in the back of this publication.)

Machine Guarding Checklist

Machine Guarding Checklist

Answers to the following questions should help the interested reader determine the safeguarding needs of his or her own workplace, by drawing attention to hazardous conditions or practices requiring correction.

Requirements for all Safeguards

	Yes	No
1. Do the safeguards provided meet the minimum OSHA requirements?	____	____
2. Do the safeguards prevent workers' hands, arms, and other body parts for making contact with dangerous moving parts?	____	____
3. Are the safeguards firmly secured and not easily removable?	____	____
4. Do the safeguards ensure that no object will fall into the moving parts?	____	____
5. Do the safeguards permit safe, comfortable, and relatively easy operation of the machine?	____	____
6. Can the machine be oiled without removing the safeguard?	____	____
7. Is there a system for shutting down the machinery before safeguards are removed?	____	____
8. Can the existing safeguards be improved?	____	____

Mechanical Hazards

The point of operation:

1. Is there a point-of-operation safeguard provided for the machine?	____	____
2. Does it keep the operator's hands, fingers, body out of the danger area?	____	____
3. Is there evidence that the safeguards have been tampered with or removed?	____	____
4. Could you suggest a more practical, effective safeguard?		
5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely?	____	____

Power transmission apparatus:

1. Are there any unguarded gears, sprockets, pulleys, or flywheels on the apparatus?	____	____
2. Are there any exposed belts or chain drives?	____	____
3. Are there any exposed set screws, key ways, collars, etc.?	____	____
4. Are starting and stopping controls within easy reach		

of the operator? ____ ____
5. If there is more than one operator, are separate controls provided? ____ ____

Other moving parts:

1. Are safeguards provided for all hazardous moving parts of the machine including auxiliary parts? ____ ____

Nonmechanical Hazards

1. Have appropriate measures been taken to safeguard workers against noise hazards? ____ ____
2. Have special guards, enclosures, or personal protective equipment been provided, where necessary, to protect workers from exposure to harmful substances used in machine operation? ____ ____

Electric Hazards

1. Is the machine installed in accordance with National Fire Protection Association and National Electrical Code requirements? ____ ____
2. Are there loose conduit fittings? ____ ____
3. Is the machine properly grounded? ____ ____
4. Is the power supply correctly fused and protected? ____ ____
5. Do workers occasionally receive minor shocks while operating any of the machines? ____ ____

Training

1. Do operators and maintenance workers have the necessary training in how to use the safeguards and why? ____ ____
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against? ____ ____
3. Have operators and maintenance workers been trained in how and under what circumstances guards can be removed? ____ ____
4. Have workers been trained in the procedures to follow if they notice guards that are damaged, missing, or inadequate? ____ ____

Protective Equipment and Proper Clothing

1. Is protective equipment required? ____ ____
2. If protective equipment is required, is it appropriate for the job, in good condition, kept clean and sanitary, and stored carefully when not in use? ____ ____

3. Is the operator dressed safely for the job (i.e., no loose-fitting clothing or jewelry)? ____ ____

Machinery Maintenance and Repair

1. Have maintenance workers received up-to-date instruction on the machines they service? ____ ____
2. Do maintenance workers lock out the machine from its power sources before beginning repairs? ____ ____
3. Where several maintenance persons work on the same machine, are multiple lockout devices used? ____ ____
4. Do maintenance persons use appropriate and safe equipment in their repair work? ____ ____
5. Is the maintenance equipment itself properly guarded? ____ ____
6. Are maintenance and servicing workers trained in the requirements of 29 CFR 1910.147, lockout/tagout hazard, and do the procedures for lockout/tagout exist **before** they attempt their tasks? ____ ____

Bibliography

The following texts were used for reference in compiling this manual. This does not constitute an endorsement of the texts by the U.S. Department of Labor.

"Accident Prevention Manual for Industrial Operations," 9th ed. National Safety Council, 1988, Chicago

"Alphabetical Index of Industrial Safety Data Sheets," National Safety Council, 1990-91, Chicago

"Cabinetmaking and Millwork:" Feirer, John; Glenco Publishing Co., Peoria, IL

"Dictionary of Terms Used in the Safety Profession:" Tarrants, W.E., ed.; American Society of Safety Engineers, 1988, Park Ridge, IL

"Disc Grinding-Safe Rules and Methods:" Grinding Wheel Institute, Cleveland

"Electrical Standard for Metalworking Machine Tools," NFPA 79: National Fire Protection Association, 1987, Quincy, MA

"Fundamentals of Industrial Hygiene:" Olishifski, Julian B. and McElroy, Frank E., eds.; National Safety Council, 1988, Chicago

"General Industry Safety and Health Standards," Title 29 Code of Federal Regulations 1910.212-1910.222

"Guards Illustrated," National Safety Council, 1987, Chicago

"Industrial Ventilation, A Manual of Recommended Practice," 20th ed.: American Conference of Governmental Industrial Hygienists, Edward Brothers, 1988, Lansing, MI

"Machine Tool Practice," White, Warren T., Kibbe, Richard R.; Prentice Hall, 1991, New York

"Power Press Safety Manual," National Safety Council, 1989, Chicago

"Safeguarding of Machinery," BS 5304: British Standards Institute, 1975, London

"The Use, Care, and Protection of Abrasive Wheels," ANSI B7.1-1988: American National Standards Institute, New York

"Safety Recommendations for Grinding Wheel Operation:" Grinding Wheel Institute, Cleveland

"Safety Requirements for the Construction, Care and Use of Cold Headers and Cold Formers," ANSI B11.7-1985, American National Standards Institute, 1985, New York

"Safety Requirements for the Construction, Care and Use of Drilling, Milling, and Boring Machines," ANSI B11.8-1985, American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Horizontal Injection Molding Machines," ANSI B151.1-1990, American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Lathes," ANSI B11.6-1984: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Iron Workers," ANSI B11.5-1975: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Mechanical Power Presses," ANSI B11.1-1988: American National Standards Institute, New York

"Safety Requirements for the Construction, Care and Use of Metal Sawing Machines," ANSI B11.10-1990: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Packaging and Packaging-Related Converting Machinery," ANSI B155.1-1986: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Power Press Brakes," ANSI B11.3-1982: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Fasteners, Rivet Setting Equipment." ANSI B154.1-1984: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Shears," ANSI B11.4-1983: American National Standards Institute, New York

"Safety Requirements for the Construction, Care, and Use of Single and Multiple-Spindle Automatic Screw/Bar and Chucking Machines," ANSI B11.13-1983: American National Standards Institute, New York

"Safety Requirements for Woodworking Machinery," ANSI 01.1-1975: American National Standards Institute, New York

"Safety Specifications for Mills and Calenders in the Rubber and Plastics Industries," ANSI B28.1-1967: American National Standards Institute, New York

"Safety Standard for the Mechanical Power Transmission Apparatus," ANSI B15.1-1984: The American Society of Mechanical Engineers, New York

"Standard Handbook for Mechanical Engineers," 9th ed: Baumeister, Theodore, ed.; McGraw-Hill, 1987, New York

4

OSHA INSTRUCTION

Directive Number: CPL 2-1.35 | **Effective Date:** March 26, 2002
Subject: National Emphasis Program on Amputations

ABSTRACT

Purpose: This directive describes policies and procedures for implementing a National Emphasis Program (NEP) to identify and reduce the workplace hazards which are causing or are likely to cause amputations.

Scope: This instruction applies OSHA-wide.

References: OSHA Instruction CPL 2-0.102A, November 10, 1999, Procedures for Approval of Local Emphasis Programs and Experimental Programs.

Cancellations: OSHA Instruction CPL 2-1.33, National Emphasis Program on Amputations., November 9, 2001**.**

State Impact: See paragraph V

Action Offices: National, Regional, and Area Offices

Originating Office: Directorate of Compliance Programs

Contact: Paul Cyr (202) 693-1866 or
Willie F. Robinson (202) 693-1827 or
Kim-Anh Nguyen (202) 693-1934
Directorate of Compliance Programs
200 Constitution Avenue, NW, Room N3107
Washington, DC 20210

By and Under the Authority of
John L. Henshaw
Assistant Secretary

Executive Summary

On February 28, 1997 Instruction CPL 2-1.24 established and implemented a *National Emphasis Program on Mechanical Power Presses* as part of the Agency=s strategic goal of reducing amputations in general industry workplaces. In order to capitalize on the success of the Program, OSHA, through this Instruction CPL 2-1.35, *National Emphasis Program on Amputations* is administratively revising the Program to target more types of machinery than those listed in CPL 2-1.24, *National Emphasis Program on Mechanical Power Presses*, and allow the Regions and Area Offices to target and schedule inspections in workplaces that are most likely to use the selected machinery. In addition to mechanical power presses, this Program targets all types of power presses (including press brakes), as well as saws, shears, and slicers, because these machines account for a significant number of amputation injuries in general industry. The machines listed in Appendix A also pose amputation hazards. However, the targeting of machines listed in Appendix A is appropriate only if Regional or Area Offices supplement this National Emphasis Program (NEP) with Local Emphasis Programs focusing on some or all of these machines.

Significant Changes

This Instruction, CPL 2-1.35, *National Emphasis Program on Amputations*, builds upon and expands the existing National Emphasis Program on Amputations. Major changes include:

- In addition to mechanical power presses, all types of power presses (hydraulic, pneumatic, etc.), as well as press brakes, saws, shears, and slicers, will be included in this Program;

- Simplifying paperwork and reporting requirements by the Regions and Area Offices by streamlining the targeting and site selection process, inspection coding, and program evaluation criteria.

Table of Contents

I. Purpose. This directive describes policies and procedures for implementing a National Emphasis Program (NEP) to identify and reduce workplace machine hazards which are causing or are likely to cause amputations.

II. Scope. This instruction applies OSHA-wide.

III. References.

A. OSHA Instruction CPL 2-0.102A, November 10, 1999, Procedures for Approval of Local Emphasis Programs and Experimental Programs.

B. OSHA Standards at Subpart O, Machinery and Machine Guarding.

C. OSHA Standards at Subpart P, Hand and Portable Powered Tools & Other Hand Held Equipment.

D. OSHA's Safety and Health Management Guidelines, 54 FR 3904, January 26, 1989.

E. OSHA Instruction CPL 2.25I, January 4, 1995, Scheduling System for Programmed Inspections.

F. Executive Order 12196, Section 1-201.

G. OSHA Standard 29 CFR 1960.16.

H. OSHA Instruction STP 2-0.22B, March 21, 2001, State Plan Policies and Procedures Manual (SPM).

I. OSHA Instruction CPL 2.103, September 26, 1994, Field Inspection Reference Manual (FIRM).

J. OSHA Publication 3157, A Guide for Protecting Workers from Woodworking Hazards.

K. OSHA Technical Links Web Page, Machine Guarding, http://www.osha-slc.gov/SLTC/machineguarding/index.html.

IV. Cancellation. OSHA Instruction CPL 2-1.33, 11-09-2001, National Emphasis Program on Amputations.

V. Federal Program Change. This instruction describes a Federal Program Change for which State adoption is not required. States are asked to keep their Regional

Administrators informed of State-developed local emphasis programs, experimental programs, local problem solving projects, etc., especially any that relate to State Strategic Plan goals. They should also coordinate the assignment of an IMIS identifier code with their Regional Administrator and submit the coding instructions necessary for IMIS and OPTMS Strategic Plan tracking, as appropriate.

VI. Action. OSHA Regional Administrators, Area Directors and National Office Directors must ensure that the policies and procedures set forth in this directive are followed. Regional Administrators must also ensure that the State Consultation Program Managers and the State Plan State Designees in their Regions are apprised of the contents of this NEP and its required Area Office Outreach initiatives. Regional Administrators are to encourage Consultation Programs' involvement in this Agency-wide effort.

VII. Application. This instruction applies to general industry workplaces where saws, shears, slicers, press brakes, and power presses of all types are present. This instruction also applies to workplaces identified pursuant to paragraph IX(C).

VIII. Background. OSHA believes that the failure to guard machinery is a primary cause of amputation. OSHA has determined that CPL 2-1.24, *National Emphasis Program on Mechanical Power Presses*, which had been in effect since February 28, 1997, needs to be expanded because of the significant number of amputations that have resulted from the operation of saws, shears, slicers, and power presses of all types. The goal of OSHA's enforcement policy is to achieve effective worker protection.

The operation of saws, shears, slicers, and power presses can be extremely dangerous, and compliance with OSHA's machine guarding and safeguarding standards needs to be improved. Injuries involving these machines often result in death or permanent disability, and OSHA's inspection history indicates that employee exposures to these unguarded or inadequately guarded machines occur in many workplaces. Subparts O and P of 29 CFR 1910 provide for safety measures that need to be used for the safe operation of saws, shears, slicers, and power presses. These machines are covered by 29 CFR 1910.212, .213, and .217. This NEP provides additional information on how to identify and guard against hazards associated with these machines.

The machines identified by this directive were determined from three sources: a 1990 NIOSH research project on machine safety, the OSHA IMIS database, and BLS data. The NIOSH project reported that workers who operate and maintain machinery suffer approximately 18,000 amputations and over 800 deaths each year. Consolidation of the NIOSH, OSHA, and BLS data revealed that saws, shears, slicers, and presses, are machines that frequently cause amputations.

A. **Saws:** The two types of saws most frequently identified as causing amputations are table saws and radial arm saws. These types of saws are used primarily in woodworking shops and manufacturing maintenance shops. Compliance Safety and Health Officers (CSHOs) should consider other types of saws including, but are not limited to, hand held saws, chop saws, miter saws, and band saws.

The guards normally used on many of these saws are self-adjusting to the thickness of the material being cut, meaning that, by themselves, they do not necessarily prevent contact with the saw blade. However, when used in conjunction with push sticks or push blocks as required under 29 CFR 1910.213(s)(9), these safeguards can minimize the potential for injuries. For repetitive sawing operations or for jobs when standard guards cannot be used, jigs, featherboards, or a combination of the two can be used to minimize or eliminate employee exposure during sawing operations. See 1910.213 (a)(15). When the saws are used for ripping, additional safeguards are required in the form of spreaders and/or anti-kickback fingers. See 1910.213(c), (d), (e), and (f). For saws used to cut material other than wood (metal, plastic, meat, etc.), safeguarding of moving parts and points of operation is required under 1910.212 and .219.

B. **Shears**: Mechanical power shears are self-contained machines using a mechanically driven ram for the shearing action. The ram moves a non-rotary blade at a constant rate past the edge of a fixed blade. The machine components generally consist of the frame, ram, blades, hold-down(s), guards, drive, clutch, brake, motor, and controls. According to OSHA=s database, shear-associated amputation injuries occurred primarily on three types of equipment:

- Squaring shears used in metal working shops to cut sheets of metal;
- Alligator shears used to cut metal stock in fabrication shops and scrap metal in scrap yards; and
- Guillotine shears used in many industries, such as the paper and plastic film industries, to trim or cut/slice rolls and slabs of paper, plastic film, and other materials.

C. **Slicers:** The most common slicers are meat and food slicers. These are powered machines that use a rotary blade to cut sections of meat or other foods into thin slices.

D. **Power Presses:** This NEP covers all types of power presses, including, but not limited to, mechanical power presses, hydraulic presses, pneumatic presses, and press brakes. Power presses are powered machines used to work on metal or other material with cutting, shaping, or combination dies attached to plungers, platens, or slides (rams). A press consists of a stationary bed or anvil, and a slide. The slide has a controlled reciprocating motion toward and away from the bed surface and at right angles to it. It is guided in the frame of the machine to give a definite path of motion. Power presses are used in a wide variety of industries to punch, shear, and form metal, metal products, and other materials.

Requirements for safeguarding of the referenced machines can be found at Subparts O and P of 29 CFR 1910. See Appendix C for a list of related ANSI and ASME standards. Compliance Officers need to make an initial determination if a machine in an establishment is one of the pieces of equipment listed/described above.

Requirements for safeguarding of hand held portable powered tools (saws, shears, etc.) are found in 29 CFR 1910.243.

IX. Program Procedures. This NEP includes four major field activities: program approval, outreach, targeting/selection, and inspection. Inspections are to begin immediately upon the effective date of this directive.

A. Program approval. Each Area Office's inspection program must be approved by the Regional Administrator and the Regional Solicitor. This is most easily accomplished by setting out the targeting and selection system in a Regional Program Directive, as for a Local Emphasis Program. Other forms of documentation may, however, be used at the discretion of the Regional Administrator.

B. Outreach. Each Regional and Area Office must develop and continue to offer outreach programs that support the purpose of this NEP to identify, reduce workplace hazards associated with saws, shears, slicers, and power presses of all types. Programs may include letters to employers, professional associations, and local unions, or other activities designed to involve employee and management stakeholders in the identification and elimination of hazards associated with these machines. The Office of Public Affairs will provide support to the Regional and Area Offices. The employers with ten or fewer employees are to be included in the outreach effort, but are not to be included in the inspection activities. At the discretion of the Regional and Area Offices, outreach materials may either be mailed directly or made available upon request to employers, professional associations, and local unions. The attached appendices and a PowerPoint7 presentation summarizing this NEP provide useful information which may be used, in whole or in part, by the Regional and Area Offices.

C. Site Selection. Inspections conducted under this NEP must be scheduled and conducted pursuant to the following priorities.

1. The intent of the NEP is to target workplaces with machines that cause (or are capable of causing) amputations and workplaces where amputations have occurred, in order to reduce amputation injuries while maximizing the Agency's scarce inspection resources.

2. Establishments with ten or fewer employees are <u>not</u> to be inspected, <u>but are to be included in the outreach effort</u>.

3. Inspections must concentrate on industries and establishments where saws, shears, slicers, and power presses are used and where there have been in amputations involving these types of machines.

4. Developing Inspection Lists. Area and Regional Offices will develop lists of such establishments to be inspected, using the sources described below:

   <u>Standard Industrial Classification (SIC) Codes</u>. Using the most recently available Dun and Bradstreet employer list prepared by the National Office, each Area Office will prepare a master list of establishments in the SICs in the tables below.

   <u>National Data</u>. The SICs listed are those which, based on five years of nationwide IMIS data, had the highest number of violations of 29 CFR 1910.212, .213, and .217 and also had BLS reported amputation injuries in 1998 and 1999.

   NOTE: OSHA has addressed hazards which produce workplace injuries by developing standards designed to reduce those hazards. The machine guarding provisions of 29 CFR §§ 1910.212, .213, and .217 were developed, in part, to address machine hazards that can cause, and have caused, amputations. Thus, in developing this NEP, OSHA used IMIS data from October 1996 through September 2001 to ascertain the 10 industries (by 4-Digit SIC Code) that received the greatest number of 1910.212 violations, the 10 industries that received the greatest number of 1910.213 violations, and the 10 industries that received the greatest number of 1910.217 violations. After developing the three lists, OSHA reviewed 1998 and 1999 BLS data regarding reported amputations for each one of the industries on the respective lists. If the BLS data indicated that an industry had zero reported amputations during both of these periods, OSHA removed that industry from the list and added the industry with the next greatest number of violations of the relevant standard, such that there again would be ten industries on a particular list. The process continued until the ten industries with the greatest number of standard-specific violations, and which also had BLS reported amputations, were identified. This process provided assurance that the NEP is focused on industries with both a significant number of amputation-related hazards and amputation injuries.

The 10 industries listed under each OSHA standard are listed in alphabetical order (not in order of their SIC Code numbers or the total number of citations for the particular industries), and there is some "industry" redundancy for the three standards (e.g. "Fabricated Metal Products, Not Elsewhere Classified" is listed under 1910.212, .213, and .217).

The listed SICs also cover industries with varying numbers of establishments. For example, according to Dun & Bradstreet, March 2002:

SIC 2542; 854 establishments
SIC 2434; 3351 establishments
SIC 3089; 7,748 establishments
SIC 3599; 19,028 establishments

1910.212 All Machines

SIC Code	Industry
3499	Fabricated Metal Products, Not Elsewhere Classified
3443	Fabricated Plate Work (boiler shops)
3441	Fabricated Structural Metal
3599	Industrial and Commercial Machinery and Equipment, Not Elsewhere Classified
3442	Metal doors, Sash, and Trim
3469	Metal Stampings, Not Elsewhere Classified
3496	Miscellaneous Fabricated Wire Products
3714	Motor Vehicle Parts and Accessories
3089	Plastic Products, Not Elsewhere Classified
3444	Sheet Metal Work

1910.213 Woodworking Machinery

3499	Fabricated Metal Products, NEC

2431	Millwork
2451	Mobile Homes
3089	Plastic Products, NEC
2421	Sawmills & Planning Mills
2434	Wood Kitchen Cabinets
2511	Wood Household Furniture, Except Upholstered
2541	Wood Office & Store Fixtures, Partitions, Shelving, & Lockers
2448	Wood Pallets & Skids
2499	Wood Products, NEC

1910.217 Power Presses

3499	Fabricated Metal Products, Not Elsewhere Classified
3443	Fabricated Plate Work (boiler shops)
3441	Fabricated Structural Metal
3429	Hardware, Not Elsewhere Classified
3442	Metal Doors, Sash, Frames, Molding, and Trim
3469	Metal Stampings, Not Elsewhere Classified
3496	Miscellaneous Fabricated Wire Products
3714	Motor Vehicle Parts and Accessories
2542	Office & Store Fixtures, Partitions, Shelving, & Lockers, Except Wood
3444	Sheet Metal Work

5. Area Offices will add to the master list individual general industry establishments where amputation injuries or fatalities related to saws, shears, slicers, and power presses have occurred in the last five years. Local evidence of amputations will be based on IMIS accident data and, if available, workers' compensation data, OSHA 200 and OSHA 300 data, NIOSH data, and other reliable sources of information (e.g., reports of amputations from hospital admission, Emergency Medical Services, fire department, and police reports). In all cases, the basis for development of the master list and additions to it must be documented.

6. Establishments on the master list prepared pursuant to IX(C)(4) are to be arranged alphabetically by company name. Additions to the master list from the list prepared pursuant to IX(C)(5) are to be arranged alphabetically and added to the bottom of the master list.

   Based on local knowledge, Regional and Area offices may delete establishments that are not likely to have the targeted machinery, or firms known to be out of business, documenting the basis for such determinations. Further, any establishment [other than those where amputations are known to have occurred] having had a comprehensive safety inspection in the previous 24 months will be deleted from the list.

Once the master list, with additions, is completed, each establishment is to be assigned a sequential number starting at the top of the list with number one. The random numbers table (see the most current version of OSHA instruction CPL 2.25) will then be applied to create the first cycle of five to fifty establishments. Subsequent cycles will then be created in the same way until all establishments on the list have been assigned to a cycle. Cycles may be created all at once or as needed, and need not be the same size.

Inspections may then be scheduled using the first cycle list. Establishments on the cycle list may be inspected in any order so that area office resources are efficiently used. Once a cycle is begun, all establishments in the cycle are to be inspected before a new cycle is begun, except that carry-overs will be allowed, as provided for in OSHA Instruction CPL 2.25I, at paragraph B.1.b.(1)(e)(1).

If cycles are not prepared, establishments on the inspection list are to be inspected in the order determined by the application of the random numbers table.

D. Inspection Procedures. Inspections initiated under this NEP will be scheduled and conducted in accordance with provisions of the FIRM, except as noted below.

1. Once an inspection has been scheduled and assigned, the OSHA IMIS database will be searched for the employer=s citation and fatality/accident history prior to the opening conference. This can be accomplished by conducting an establishment search in the IMIS Database Access section on the CSHO Home Page of the OSHA web site.

2. At the opening conference the CSHO will inquire of the employer whether any of the referenced types of machines are present in the workplace. If any of these machines are present in the workplace the CSHO must conduct a thorough inspection of the machine(s) with particular attention to employee exposure to nip points, pinch points, shear points, cutting actions, and other point(s) of operation. When possible, the CSHO also should evaluate employee exposures during any of the following:

- Regular operation of the machine.
- Setup/threading/preparation for regular operation of the machine.
- Clearing jams or upset conditions.
- Making running adjustments while the machine is operating.

- Cleaning of the machine.
- Oiling or greasing of the machine or machine parts.
- Scheduled/unscheduled maintenance.
- Lockout/tagout.

3. The CSHO will review all relevant OSHA 200 and OSHA 300 logs at the establishment for amputation injuries or hazards.

4. Inspections routinely will be limited to hazards associated with power presses, saws, shears, and slicers, but the CSHO may expand the scope of the inspection beyond those machines if other hazards or violations are observed during the walkaround or documented in the OSHA 200 and OSHA 300 logs. Inspections will be scheduled beginning the current fiscal year, and will continue until further notice or until all establishments on the list have been inspected.

5. Because the nature of this program may yield a number of significant cases, Area Directors, Supervisors, Team Leaders, and CSHOs should ensure that the requirements for case development are being met.

X. Scheduling and Resource Allocation. This is a National initiative, which affects existing inspection scheduling priorities, as indicated below. Area Offices must develop and implement targeting systems which are suited to the Region's resources.

A. Resources. Regional Administrators must ensure that adequate resources are designated for this NEP.

B. Planning. Each Regional Administrator will report, to the Director of Compliance Programs, the number of NEP inspections that are planned for each fiscal year.

C. Priority. Inspections conducted under this NEP have a lower priority than inspections conducted under Site Specific Targeting (SST), but have a higher priority than other programmed inspections. When possible, inspections conducted under this NEP will be combined with SST inspections and/or other programmed and unprogrammed inspections. This NEP may be combined with other existing initiatives, such as Local Emphasis Programs which identify targets on a different basis. Regional or Area offices may also supplement this NEP with LEPs focusing on some or all of the machines in Appendix A.

XI. Coordination.

A. National Office. This NEP will be coordinated in the Office of General Industry Compliance Assistance, Directorate of Compliance Programs. Questions and comments should be directed to the National Office Coordinator.

B. Field. Each Regional Administrator will name a coordinator for this National Emphasis Program.

XII. Consultation Programs. Area Offices should develop Local Emphasis Programs (LEP) on hazardous machinery associated with amputations in concert with the Consultation Project in the same state jurisdiction. The development and implementation of outreach programs for the LEPs may be a joint activity for the Area Office and Consultation Program. When appropriate, 21(d) Consultation Projects are encouraged to develop their own strategic approaches to address the need to reduce injuries and accidents related to saws, shears, slicers, and power presses.

XIII. Training. Because of the technical nature of some of these inspections and/or machines, CSHOs who conduct inspections under this NEP, and consultation staff, must have had adequate training or experience with both general and specific machine guarding and safeguarding concepts and techniques.

A. The OSHA Training Institute (OTI).

The OTI provides training materials to CSHOs, consultation staff, and employers. Also, additional sessions of the OTI's mechanical power press and machine guarding courses can be made available. Technical training at the OTI can be expanded to include the use of a stop time measuring device to measure the safety distance on a mechanical power press, should it be determined that such training is needed.

B. Additional Training.

1. On-the-Job Training. Area Directors and supervisors must ensure that inexperienced CSHOs also receive on-the-job training by accompanying experienced compliance officers during these NEP inspections.

2. Enforcement and Compliance Issues. Continuing guidance regarding enforcement and compliance issues will be provided by the office of General Industry Compliance Assistance as new issues arise.

XIV. Federal Agencies. This instruction describes a change that affects Federal agencies. Executive Order 12196, Section 1-201, and 29 CFR 1960.16, maintains that Federal agencies must follow the enforcement policy and procedures contained in this Directive.

XV. Program Evaluation. Area Offices will collect data relevant to the effectiveness of this NEP and submit it to the Regional Office. The Regional Office, after summarizing the information, will forward it to the National Office after the end of each fiscal year. At a minimum the evaluation should respond to the requirements of CPL 2-0.102A, Section D.

XVI. IMIS Coding. All General Industry inspections **(programmed and unprogrammed)** must be coded as an **amputation hazard** in the IMIS by marking "**amputations**" in the Strategic Plan Activity item 25(f) on the OSHA 1, when there is potential worker exposure to an amputation hazard.

Any settlement agreement (formal or informal) where the employer commits to implementing or improving a safety and health program must be designated as such by entering the informal conference date in item 13A on the OSHA Form 167I and then marking item 13D, "S&H Prgm Initiated." Any settlement agreement where the employer commits to providing OSHA 200 and OSHA 300 data in future years must be identified by entering the informal conference date in item 13A on the Form 167I and then marking item 13C, "OSHA 200 and OSHA 300 Required" and entering the number of years the data must be provided.

Current instruction for completing enforcement forms OSHA-1, OSHA-7, OSHA-36, and OSHA-90 and Consultation Request Form-20 and Visit Form-30 will be applied when recording inspections conducted under this NEP as follows:

A. Enforcement.

1. The OSHA-1 Form for any programmed inspection covered under this national emphasis program for amputations will be marked "PLANNED" (Item 24h) and "NATIONAL EMPHASIS PROGRAM" (Item 25d). Record "**amputate**"in the space in item 25d.

2. Whenever an OSHA-7 is completed by a Federal office and the applicable complaint alleges the presence of amputation hazards, complete the OSHA-7 in the usual manner, and record "**amputate**" in the space in item 50.

3. Whenever an OSHA-36 is completed by a Federal office and the inspecting CSHO is able to identify at the site of the fatality/catastrophe the presence of amputation hazards, complete the OSHA-36 in the usual manner, and record "**amputate**" in the space in item 36.

4. Whenever an OSHA-90 is completed by a Federal office and the applicable referral case has amputation hazards as one of the subjects, complete the OSHA-90 in the usual manner and record "**amputate**" in the space in item 30.

B. Consultation. Whenever a visit is made in response to this NEP, a Consultation Request Form and/or Visit Form is to be completed as follows:

1. Complete the Consultation Request Form-20 in the usual manner and record "**amputate**" in the space in item 25.

2. Complete the Visit Form-30 in the usual manner and record "**amputate**" in the space in item 28.

XVII. Appendices. The Appendices and a PowerPoint® presentation summarizing this NEP contain information developed to assist employers, employees, and compliance officers in the implementation, training and outreach requirements of this Program. The Area Office may use its discretion in selecting whatever materials it deems appropriate for outreach purposes.

APPENDIX A

Other Machines

•Bending, rolling, and shaping machinery
•Boring, drilling, milling, and planing machinery
•Conveyors, both gravity and powered
•Food and beverage processing and packaging machinery
•Grinding and polishing machinery
•Printing Machinery

APPENDIX B

Sample Employer Self-inspection Checklist

Answers to the following questions should help the interested reader to determine the safeguarding needs of his or her own workplace by drawing attention to hazardous conditions or practices requiring corrections.

Requirements for All Safeguards

1. Do the safeguards provided meet the minimum OSHA requirements?
2. Do the safeguards prevent workers= hands, arms, and other body parts from making contact with dangerous moving parts?
3. Are the safeguards firmly secured and not easily removable?
4. Do the safeguards ensure that no objects will fall into the moving parts?
5. Do the safeguards permit safe, comfortable, and relatively easy operation of the machine?
6. Can the machine be oiled without removing the safeguard?
7. Is there a system for shutting down the machinery and locking/tagging out before safeguards are removed?
8. Can the existing safeguards be improved?

Mechanical Hazards

The Point of Operation:

1. Is there a point-of-operation safeguard provided for the machine?
2. Does it keep the operator=s hands, fingers, body out of the danger area?
3. Is there evidence that the safeguards have been tampered with or removed?
4. Could you suggest a more practical, effective safeguard?
5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely?

Power Transmission Apparatus:

1. Are there any unguarded gears, sprockets, pulleys, or flywheels on the apparatus?

2. Are there any exposed belts or chain drives?

3. Are there any exposed set screws, key ways, collars, etc.?

4. Are starting and stopping controls within easy reach of the operator?

5. If there is more than one operator, are separate controls provided?

Other Moving Parts:

1. Are safeguards provided for all hazardous moving parts of the machine, including auxiliary parts?

Nonmechanical Hazards

1. Have appropriate measures been taken to safeguard workers against noise hazards?

2. Have special guards, enclosures, or personal protective equipment been provided, where necessary to protect workers from exposure to harmful substances used in machine operation?

Electrical Hazards

1. Is the machine installed in accordance with National Fire Protection Association and National Electrical Code requirements?

2. Are there loose conduit fittings?

3. Is the machine properly grounded?

4. Is the power supply correctly fused and protected?

5. Do workers occasionally received minor shocks while operating any of the machines?

APPENDIX C

Related ANSI and ASME Standards

1. ANSI B11.1-1988 (R1994) Mechanical Power Presses

2. ANSI B11.2-1995 Hydraulic Power Presses

3. ANSI B11.3-1982 (R1994) Power Press Brakes

4. ANSI B11.4-1993 Shears

5. ANSI B11.5-1988 (R1994) Ironworkers

6. ANSI B11.6-1984 (R1994) Lathes

7. ANSI B11.7-1995 Cold Headers and Cold Formers

8. ANSI B11.8-1983 (R1994) Drilling, Milling, and Boring Machines

9. ANSI B11.9-1975 (R1997) Grinding Machinery

10. ANSI B 11.10-1990 (R1997) Metal Sawing Machines

11. ANSI B11.11-1985 (R1994) Gear Cutting Machines

12. ANSI B11.12-1996 Roll-Forming and Roll-Bending Machines

13. ANSI B11.14-1996 Coil-Slitting Machines

14. ANSI B11.15-1984 (R1994) Pipe, Tube, and Shape Bending Machines

15. ANSI B11.16-1988 Metal Powder Compacting Presses

16. ANSI B11.17-1996 Horizontal Hydraulic Extrusion Presses

17. ANSI B11.18-1997 Machinery and Machine Systems for Processing Strip, Sheet, or Plate From Coiled Configuration

18. ANSI B11.19-1990 (R1997) Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards

19. ANSI B5.37-1970 (R1994) External Cylindrical Grinding Machines (Centerless)

20. ANSI B5.42- 1981 (R1994) External Cylindrical Grinding Machines (Universal)

21. ANSI B65.1-1995 Printing Press Systems

22. ANSI B65.3-1991 Safety Standard for Guillotine Paper Cutters

23. ANSI B7.1-2000 Use, Care, and Protection of Abrasive Wheels

24. ANSI B151.5-1982 (R1988) Plastic Film and Sheet Winding Equipment

25. ANSI B151.20-1999 Plastic Sheet Production Machinery

26. ANSI B155.1-1994 Packaging Machinery and Packaging-Related Converting Machinery

27. ANSI B177.1-1997 Three Roller Printing Ink Mills

28. ANSI O1.1-1992 Woodworking Machinery

29. ASME B5.52M-1980 (R1994) Mechanical Power Presses, General Purpose Single Point

30. ASME B15.1-1996 Mechanical Power Transmission Apparatus

31. ASME B15.1A-1997 Addenda to B15.1-1996

32. ASME B15.1B-1998 Addenda to B15.1-1996

33. ASME B20.1-1996 Conveyors and Related Equipment, with Interpretations A and B

34. ASME B20.1A and B20.1B Addenda to B20.1-1996

35. ASME/CEMA 350-1988 Screw Conveyors

36. ASME/CEMA 401-1994 Unit Handling Conveyors - Roller Conveyors - Non-Powered

37. ASME/CEMA 402-1992 Unit Handling Conveyors - Belt Conveyors

38. ASME/CEMA 403-1985 Unit Handling Conveyors - Belt Driven Live Roller Conveyors

39. ASME/CEMA 404-1985 Unit Handling Conveyors - Chain Driven Live Roller Conveyors

40. ASME/CEMA 405-1985 Packaging Handling Conveyors - Slant Conveyors

Index

Risk Assessment & Reduction: A Look at the Impact of ANSI B11.TR3

By ROBERT N. ANDRES

Risk assessment is not a new term—but it took impetus from Europe to bring it more fully into the domestic machine lexicon. This article explores how several groups, each with their own insight, came together to not only incorporate the best of what Europe had to offer, but improve on it. Over the past four years, a new document—ANSI B11.TR3—has been conceived and brought to life through the efforts of more than 70 ANSI subcommittee members and observers. It is bringing about a paradigm shift in the way tasks and hazards, risk assessment, and the incremental and cumulative effects of risk reduction are assessed, leading toward innovation and away from the "cookie-cutter" approach to machine safeguarding that often ignores the realities of the workplace.

Here's what's been said about this document:

"The greatest stride forward in the field of safety in the past 25 years."

—*Fred Manuele, P.E., CSP, author and ASSE Fellow*

". . . fills the gap where no consensus standard exists. We know how important this document will be in promoting safety in the workplace."

—*Richard Sauger, OSHA Standards Development Group*

". . . a document that is of great importance in the U.S."

—*Jim Howe, assistant safety director, UAW*

"Risk assessment has gone from a novel, untested concept to a practical method to improve safety through design. This is a great improvement over EN1050."

—*Bruce Main, P.E., CSP, Design Safety Engineering*

". . . critical in promoting safety-through-design."

—*Wayne Christensen, director, NSC Safety-Through-Design Program*

". . . With the release of the document, a paradigm shift toward more cooperative efforts between the suppliers and users . . . and toward documenting risk assessments . . . is taking place."

—*Steve Dukich, product manager, Rockwell Automation*

". . . a great tool, since 'prescriptive safeguarding' often fails to recognize workplace realities."

—*Mike Taubitz, global safety liaison, General Motors Corp.*

ANSI B11.TR3, "Risk Assessment and Risk Reduction: A Guide to Estimate, Evaluate and Reduce Risks Associated with Machine Tools" is a "technical reference," not a standard. After four years of work by a diverse cadre of more than 70 committee members and observers, it was released in November 2000. Ostensibly written to serve only as a guide for the writers of B11 (Machine Tool) standards, it is already having great influence throughout the world.

Although described as a paradigm shift in safety, what is occuring in TR3 is not revolutionary, as its findings, concepts and methodology are really quite simple:

1) Zero risk simply does not exist. No matter what protective measures are taken for a given machine, system or process, some degree of "residual risk" will always exist.

2) Risk assessment is best accomplished with input from many disciplines.

3) Suppliers, users and modifiers of machines and processes all share responsibility for proper risk assessment and communication of residual risk.

4) Hazard identification is a key element in risk assessment, but many hazards can be overlooked in conventional hazard analysis. Identification and analysis of tasks is essential in ensuring that all relevant hazards and potentially hazardous situations are addressed.

5) The safety hierarchy provides the basis for application of protective measures to reduce risk.

6) Selected "safeguards" and other protective measures should be appropriate to the desired degree of risk reduction.

injury was low and that far-more-serious injury could result if employees attempted to bypass safeguards.

"While the debate [continued], a very serious near-hit occurred in an assembly plant when a skilled trades employee jumped over a safety mat without pulling the servo disconnect. While he was in the cell, the robot arm moved suddenly, and he narrowly escaped serious injury. The debate was over and a major principle was established: Employee tasks and task requirements must be considered before prescribing safeguards!"

THE IMPORTANCE OF SAFETY IN THE DESIGN STAGE

For decades, safety professionals have advocated that good safety practice in the design and use of machines or processes is based on the application of the hierarchy of controls, commonly called the "safety hierarchy":

- Eliminate the hazard.
- Provide engineering controls.
- Warn.
- Train.
- Provide and use personal protective equipment (PPE).

The higher-order controls—elimination and engineering—are preferred, but to be most cost-effective, such controls must be implemented during concept and design stages. Thus, engineers must be fully competent to perform necessary analysis and design. Unfortunately, engineers typically receive little or no safety-related training; they have few engineering "tools" to assist them; and simple methods to assess risk in general industry have not existed.

The confusion regarding roles and responsibilities of engineering and safety personnel also contributes to subsequent deficiencies. Engineers without a background in safety design usually leave safeguarding issues to safety professionals, who often become involved late in the process—when they can only decry what has and has not been done.

THE RISK ASSESSMENT PROCESS

The challenge of developing a risk assessment protocol was no easy task. Bruce Main, president of Design Safety Engineering, says something was needed that "more appropriately reflected the product liability circumstances of the U.S. than the 'manufacturer is responsible for everything' approach of EN1050" and other European standards. In Europe,

WHAT IS "TASK-BASED" HAZARD IDENTIFICATION?

Mike Taubitz, global safety liaison for General Motors (GM), provides some history: "In 1986, the United Auto Workers and GM hosted a joint annual conference, the theme of which was 'Design-In Safety.' It was the cornerstone for future efforts.

"Ultimately, it came to be recognized that many maintenance tasks could not be performed according to stated policy due to machine and safeguarding design. Only by changing machine design and safeguarding could we allow risk to be reduced and concurrently improve production. The question was how."

Taubitz adds, "In 1994, GM established a new Engineering for Health and Safety function. The new group was soon charged with developing a robotics specification that would provide common safeguarding for automated body shops in assembly plants. A cross-functional team of engineers, management and union safety professionals began work and embraced a couple of important issues that would guide future accomplishments.

"First, every issue was to be dealt with openly and second, the realities of the workplace would not be ignored. In other words, the group would deal affirmatively with situations where power had to be on and the employee could have exposure to a hazardous condition. Without a defined methodology, the team undertook the first steps to perform a task-based risk assessment for a major project inside the company. It proved to be an important cornerstone for future developments.

"The importance of the 'task-based' approach proved itself in early 1996, when a dispute over robot logic occurred with the controls engineering group. GM, as with most of industry, employed the use of servomotor disconnects which allowed power to remain on the programmable logic controllers while isolating the potentially hazardous energy of motion. However, pulling and locking the servo disconnect also eliminated input-output power on the end effector.

"Union representatives familiar with downtime and maintenance issues pointed out that tasks like diagnostics and intentionally cycling the gripper in manual mode could not be accomplished without 'I-O' power. Controls engineers were concerned that an employee could receive a pinching injury from the gripper and were unwilling to change the design specification. The joint team felt strongly that the risk of such a minor

For decades, safety professionals have advocated that good safety practice in the design and use of machines or processes is based on the application of the hierarchy of controls, commonly called the "safety hierarchy."

safety standards are the law, but they focus on the actions of the machine manufacturer. In the U.S., consensus safety standards are only guidelines, while OSHA regulations, which currently affect only the employer, are the law.

Risk assessment and reduction problems usually stem from interpretations within the risk assessment component. It is a subjective process, even with numbers and quantitative models. The most-common approach is to use both hazard severity and probability when assessing risk. Some approaches also use avoidance, frequency of exposure and other factors.

However, the overall goal of reducing risk may be obscured by focusing on the level of risk. "There is no one best risk model for risk assessment," Main says. "Finding a risk model that works within a company and its culture, or within an industry, is more important than which model is chosen." According to Taubitz, "GM's experience suggests 'the simpler, the better.'"

The most-common risk determination models are quantitative, such as that described in BS5304 (the "Lego block" diagrams in STI literature) or qualitative, such as the binary "tree" method (as adapted in Schmersal-USA literature from EN954) or a matrix method (similar to MILSTD 882D, the example selected for inclusion into TR3).

APPROPRIATENESS OF SAFEGUARDING MEASURES

Some safety professionals still espouse a simplistic safety philosophy. For example, use of two-hand controls and guards when running parts, and a policy to lockout when performing maintenance are a typical safeguarding solution. These professionals often believe that management does not enforce lockout only because it puts profit ahead of employee safety.

However, prescriptive safeguards without regard to task do not always work in application, and current standards seldom give any guidance when this occurs. Commitment and enforcement cannot overcome this reality. As Taubitz explains, "It is akin to asking a mechanic to tune-up a car without ever turning on the engine because his/her hand could become entangled in the fan. Spark plug and other parts replacement can be done without power, but it is impossible to set timing and perform diagnostic work without the engine running."

A common result of this approach is capricious safeguarding. For example:

- demand for physical guarding of a power hacksaw sitting in a corner, operating with an automatic shutoff, with no one within 20 ft.;
- dictate for "rear guarding" of a press brake placed against a wall, where there is neither opportunity nor motivation to access the rear of the brake;
- citation for not having a guard on the underside of a coupling on a floor-mounted motor/pump combination, because it is possible for someone to get down on the floor and reach up under the guard to touch the coupling;
- manufacturer's "guard" that must be removed in order to properly adjust a running machine.

Such cases ignore the realities of the workplace. How can a worker form two small, hand-held parts on four-ft. hydraulic press brake equipment using a typical "compliant" light curtain or a holdout device? Does the actual risk posed by the operation warrant such prescriptive safeguards? Are they really used—or do they waste money and possibly pose additional risk?

Safety engineers should deal in probabilities—not possibilities. However, Taubitz brings up a good point that must be considered in the risk reduction process. "It is necessary to get the input of experienced employees when doing a task-based risk assessment. Some do not take kindly to the thought that the posed risk and, therefore, the level of control, might be diminished because of frequency of exposure. What do you say to a skilled trades employee who asks, 'If the hazard is such that I can lose my life, should the safeguarding be any less because the frequency/probability is less?'"

TR3—THE CONCEPT IS BORN

At the 1994 ASSE Professional Development Conference in Las Vegas, NV, the author (then administrator of the Society's Engineering Division) met briefly with Joe Dear, then Assistant Secretary of Labor for OSH. Problems posed by the language and multiple interpretations of 1910.212, the "General Guarding Clause," were discussed; both parties agreed that valuable safety resources were being wasted on unnecessary safeguards, while other needs were being ignored. Dear stated that the best course of action would be to develop a consensus standard on risk assessment and reduction that OSHA could point to as an applicable standard in the enforcement of 1910.212, rather than try to rewrite the section. He ultimately committed several OSHA staff members to help with this task.

In addition, members of the machine tool industry were finding it increasingly difficult to prepare goods for sale in European markets because of the lack of a domestic counterpart to EN292 and EN1050—the European Standard for Risk Assessment and Reduction. The effort to establish this link to Europe was spearheaded by Chuck Carlsson, safety director for the Assn. for Manufacturing Technology (AMT), and John Bloodgood, a consultant to AMT, who represented

TABLE 1 Risk Estimation Matrix

Probability of Occurrence of Harm	Hazard Severity			
	Catastrophic	Serious	Moderate	Minor
Very Likely	High	High	High	Medium
Likely	High	High	Medium	Low
Unlikely	Medium	Medium	Low	Negligible
Remote	Low	Low	Negligible	Negligible

©AMT, 2000. Used with permission.

the Capital Goods Coalition and U.S. industry on various European and International Organization for Standardization (ISO) committees. Joined by Dennis Cloutier and Dave Withrow, long-time members of the B11 community, all saw the need for a domestic standard on risk assessment and reduction in the machine tool industry. According to Jim Howe, UAW's assistant safety director, the union "saw the importance of the European Union standards and their effect on major corporations in the U.S. Risk assessment was being mentioned in standards such as RIA 15.06 (1992), but with very little explanation or detail."

In April 1996, the efforts coalesced, as work began on what was to become a controversial, far-reaching document. An unprecedented appeal for members outside the B11 community brought together subcommittee members and observers from such diverse sectors as the military, System Safety Society, machinery manufacturers and users, UAW, OSHA, NIOSH and consultants in various fields. Thanks to the Internet, ideas were exchanged freely, as the convenience of e-mail brought input from around the world and enabled extensive communication among committee members between meetings.

ANSI B11.TR3 TAKES SHAPE

From the onset, the committee attempted to write a document that would emulate EN1050. The methodology ultimately established is similar and compatible with EN1050 and ISO-14121, with several important improvements.

• Task analysis adds greatly to the hazard identification process, and both tasks and hazards are to be identified before risk assessment is initiated.

• The document addresses the roles of machine supplier and user, as well as any entity involved in modification. It encourages synergism between all parties.

• The methodology does not encourage prescriptive safeguards without regard to specific task demands.

• The focus is on feasible and appropriate risk reduction, and communication of residual risk.

During the development process, several issues were uncovered.

• A major paradigm shift and culture change is needed to accept that "zero" risk does not exist.

• Ignoring this fact leads to inadequate communication of "residual risk" to the user.

• Higher-order controls are usually only feasible when integrated into a design at an early stage.

• Prescriptive safeguards often ignore high-risk tasks.

• Such safeguards also generalize without regard to risk, often resulting in misapplication of resources.

• Task-based risk assessment is a significant contributor to the safety-through-design process.

• The type of risk assessment model used is not nearly as important as the methodology used and employment of the basic hierarchy of controls for risk reduction.

As a result, several new terms were incorporated into the document.

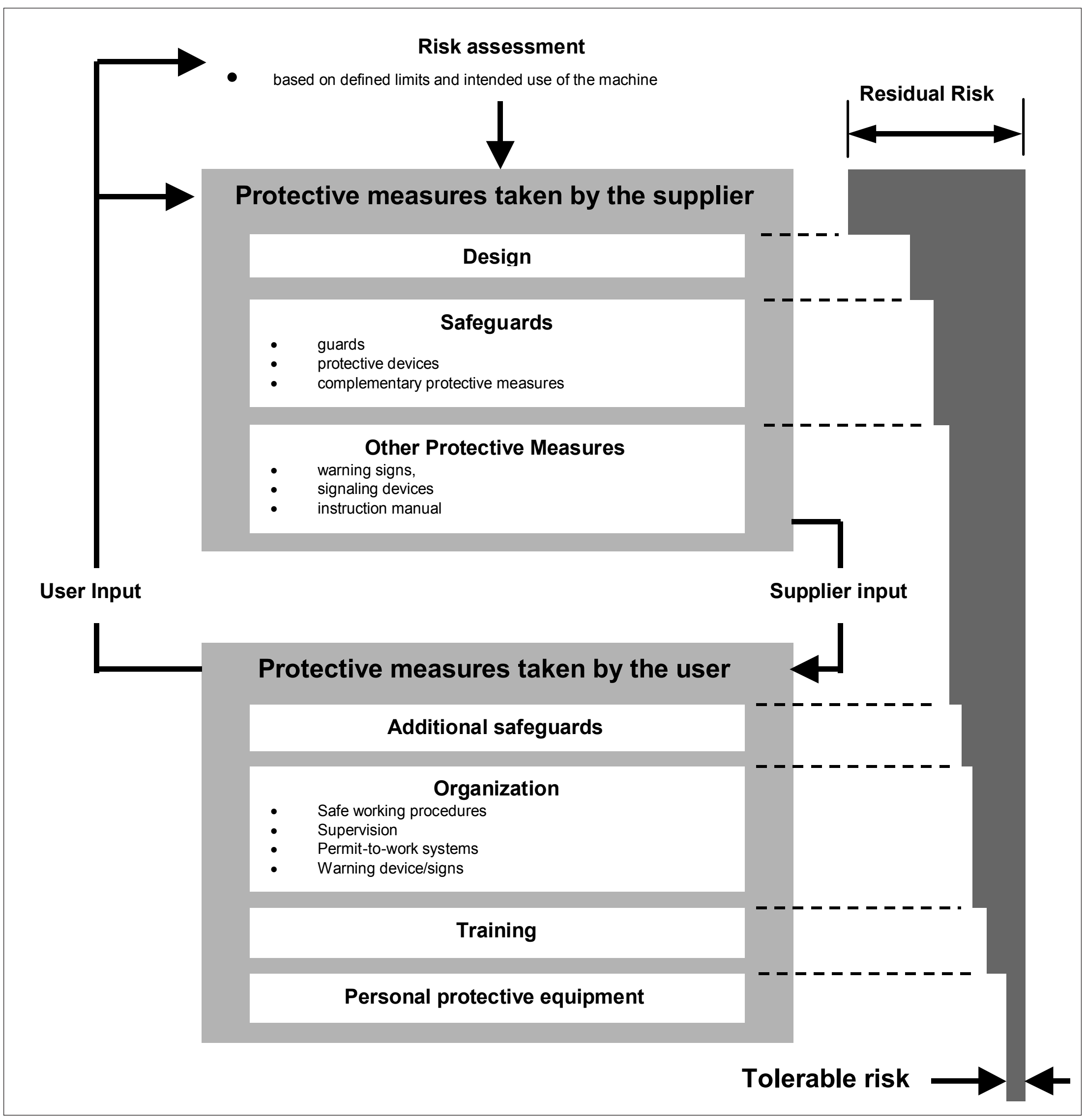
• *Harm* is defined as "physical injury to health of people." References to property were intentionally omitted because damage to property is generally beyond the scope of the safety discipline.

• A *hazard* is defined as "a potential source of harm," and a *hazard area* or *hazard zone* is the area or space where the hazard is immediate or impending. A *hazardous situation* (also known as a task/hazard pair) is a circumstance in which a person is exposed to the hazard(s).

• The *lifecycle* of a machine, often neglected in hazard identification and risk assessment, includes everything from "design and construction" of the machine to "decommissioning and disposal."

• *Protective measures* are those steps taken throughout the design, manufacture, installation, use, maintenance and disposal of the machine to reduce risk of injury. The committee found this phrase more appropriate than *"safeguarding,"* which has

FIGURE 1 Cumulative Efforts by Supplier and User to Reduce Risk



"Risk assessment has gone from a novel, untested concept to a practical method to improve safety through design. This is a great improvement over EN1050."

been historically used in domestic standards.

•*Reasonably foreseeable misuse* is largely a legal term. TR3 defines it as the "predictable use of a machine in a way not intended by the supplier or user" resulting from human behavior.

•*Residual risk* is that which is present after all protective measures have been applied. The goal is to reduce risk as much as practicable for a given task/hazard pair (hazardous situation), recognizing that the level of risk that is *tolerable or acceptable* in a given instance may be influenced by numerous factors.

A WALK THROUGH TR3

The following discussion summarizes the content of ANSI B11.TR3.

The Need for Multidisciplinary Collaboration

Hazard identification and risk assessment are dramatic examples of the need for multidisciplinary input. Everyone looks at a machine or process differently. The installer may see one set of hazards, while the operator and maintenance personnel will see others. Sales personnel may be able to share valuable input from other users, and outside consultants can add their multidisciplinary experience.

Setting Limits of the Machine

The risk assessment process begins by first determining the limits of the machine/system. This helps define what the designer intended with regard to use, space, time, interface and environmental requirements. Taking a machine beyond its design limits introduces unforeseen hazards—and may greatly increase risk.

Hazard Identification & Severity: Using Tasks to Identify Relevant Hazards

Hazard identification is the basic element in the risk assessment process. In evaluating a machine/system over its lifecycle, much more must be considered than hazards at the point of operation. Some hazards may be easily identified and addressed during the design process. However, if tasks to be performed on or in conjunction with a machine/system are not considered, many hazards may be ignored. Thus, the identification process is extended to include:

•packing, transportation, unloading and installation;

•commissioning, setup, startup and try out;

•all modes of operation;

•production setup, tool changes, jam clearing;

•planned (and unplanned) maintenance, troubleshooting, major repair, crash recovery, housekeeping;

•decommissioning and disposal.

The two primary elements of risk are 1) severity of the most-credible injury that could result from a hazardous situation; and 2) probability of that occurrence.

Adopting commonly used terminology and guidelines, the severity of harm example used in the document lists four levels. Because the nature of actual costs comes into play, these levels reflect the worker's ability to return to productive activity:

1) **Catastrophic:** Death or permanently disabling injury or illness that would prevent return to work. This category may also include serious injuries to many people.

2) **Serious:** Severe debilitating injury or illness. Such an injury might prevent return to work at the same job, but would permit return to work at some point.

3) **Moderate:** Significant injury or illness requiring more than first aid. Although lost time may result, the injured party would be able to return to work at the same job within a short period of time.

4) **Minor:** No injury or slight injury requiring no more than first aid. This would mean little or no lost time.

Factors Affecting Probability of a Hazardous Event

Probability of the occurrence of harm takes into account frequency, duration and extent of exposure; level of training and awareness of affected parties; and how the hazard presents itself. The following factors are considered when estimating probability:

•exposure to a hazard;

•personnel who perform the task(s).

•machine and task history, including history of near-hits;

•workplace environment;

•human factors/ergonomic considerations, including motivation to be exposed to the hazard;

•reliability of safety functions;

•ability to maintain (and the possibility of circumventing or defeating) protective measures.

Estimating the Probability of a Hazardous Event

The document example defines four levels for the probability of occurrence of harm:

1) **Very likely:** Near certain to occur.

2) **Likely:** May occur.

3) **Unlikely:** Not likely to occur.

4) **Remote:** So unlikely to occur as to be near zero.

Consider these analogies. Suppose a turtle crosses an eight-lane freeway in southern California during rush hour. Even with his PPE—it is *very likely* the turtle will be killed.

The turtle crosses a two-lane road with moderate traffic in upstate New York. The probability of getting hit is *likely*—but not as high as on the California freeway.

The turtle crosses a dirt road in New Mexico at 3 a.m. on Monday. It is not likely any traffic will be present, so the probability of the hazardous incident is *unlikely* to *remote.*

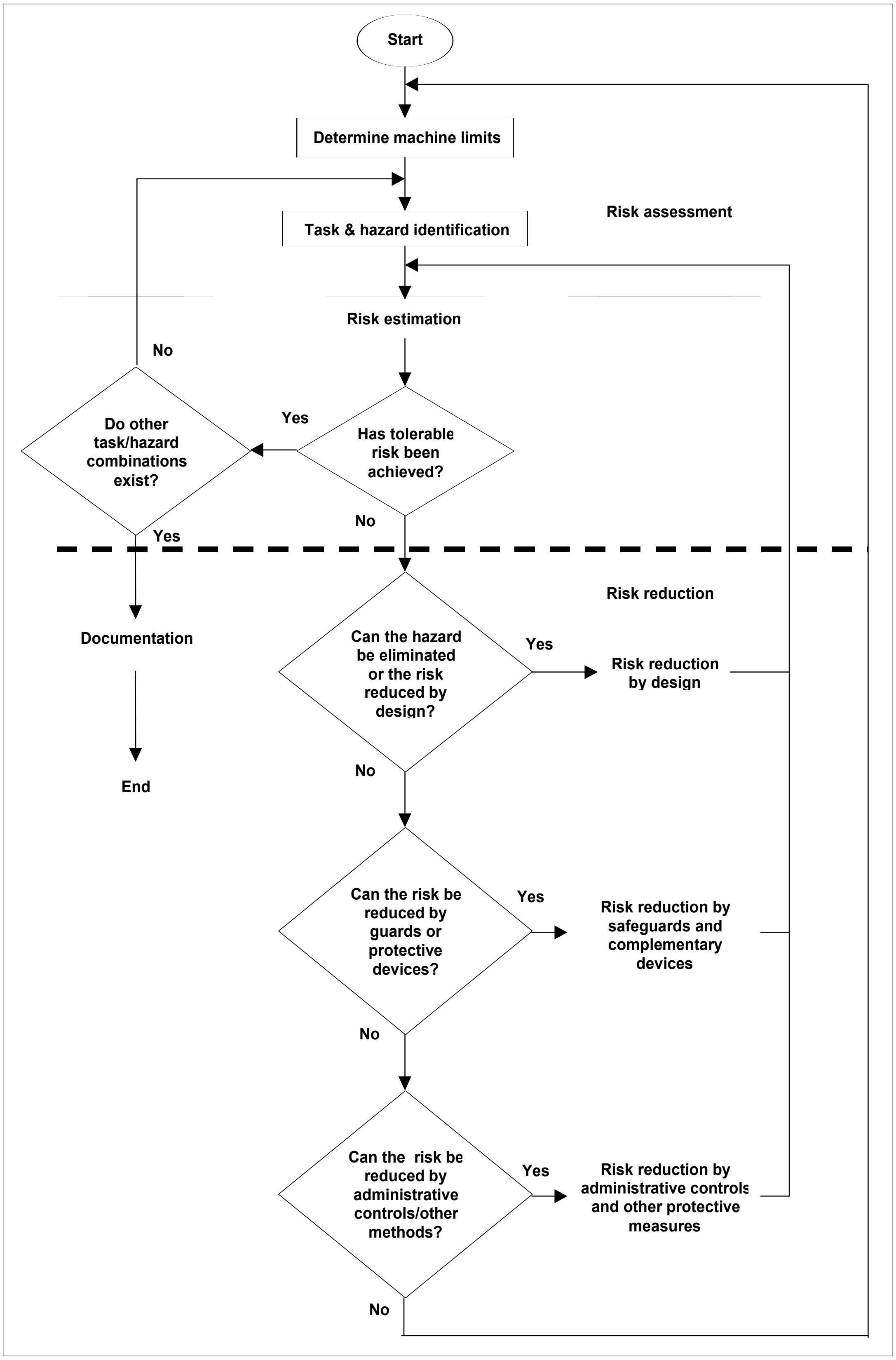
In each case, the hazard severity has remained the same. Only the probability has changed.

Using Hazard Severity & Probability to Determine Risk

Risk is determined by equating hazard severity and probability. By nature, the entire process is highly subjective. One can cite almost as many models for determining risk as industries and organizations to develop them. A model is just a tool; other tools may also be available. The thinking process involved in the analysis—not the conclusion—is the crucial element.

The list of hazards and probabilities given earlier is only an example. The risk determination matrix (Table 1) selected for ANSI B11.TR3 is based on MILSTD 882D (although it is not identical). Other matrices and charts are avail-

FIGURE 2 Cumulative Efforts by Supplier and User to Reduce Risk



Risk is determined by equating hazard severity and probability. By nature, the entire process is highly subjective.

able. Some are quantitative; others, like this example, qualitative.

Risk Reduction: The Cumulative Efforts of the Supplier & User

If the level of risk identified is not tolerable, it must be reduced. In most machines, however, the supplier can only do so much. The supplier must then communicate to the user what has been done, and *what remains to be done* to reduce risk. The user must perform a risk assessment to ensure that all hazards are addressed and appropriate protective measures are taken.

The risk reduction effort emphasizes application of the safety hierarchy in the selection of protective measures. Safety always begins at the design stage. Not only is "engineering out" the hazard the most-effective protective measure, it is generally the least expensive. As noted, the hierarchy approaches risk reduction in this order:

1) Eliminate the hazard or reduce its effects by design.

2) Apply safeguards—barrier guards, protective devices and control systems—appropriate to the degree of risk reduction desired.

3) Implement administrative controls, such as warnings, information for use, training, supervision and safe work practices.

Figure 1 shows the incremental and cumulative efforts of the supplier and user.

Eliminate the hazard or reduce its effects by design.

Appropriate Protective Measures for the Desired Degree of Risk Reduction

Every protective measure—from those taken by the designer of the machine to those taken by the ultimate user—provides an incremental reduction in risk. The greater the *degree* of risk reduction demanded of a protective measure, the more important it becomes that the measure will provide the safety function when required.

For example, the door on a bank vault is thick and secure because it must deliver a high degree of ensurance that it will perform its function. An exterior door on a house provides less reliability, but considerably more protection than a closet door in the same house because the desired degree of risk reduction varies.

Therefore, doesn't it make sense that industrial safeguarding (protective) measures also be risk appropriate? On one hand, does a facility want a spring-operated single-contact pushbutton E-Stop determining whether a dangerous machine will stop when needed? On the other, who wants to spend thousands of dollars on a full barrier enclosure for equipment that poses low risk? Risk assessment is the tool to facilitate intelligent decisions.

The Need for Validation & Documentation

The risk assessment and reduction process is iterative (Figure 2). After a reduction measure is applied, risk estimation must be repeated. Has the application of safeguards or other protective methods introduced additional hazards? If so, the process must be repeated. In some cases, one measure may achieve tolerable risk. In other cases, more than one measure may need to be applied.

Regardless of the cumulative efforts of suppliers, modifiers and users, some degree of residual risk will always exist with any machine. No matter how much is done, all stakeholders must take responsibility for safety. Throughout the risk assessment and reduction process, all tasks, hazards and risks must be identified. Whatever risk remains after all protective measures available to the given entity have been taken, the remaining risk must be communicated to the next in line.

Consider this scenario. A machine manufacturer knows, and can properly address, hazards posed by the rotating flywheel and clutch by using physical guarding. But the manufacturer is also aware of hazards that may arise during operation and maintenance that it cannot directly address. After taking feasible steps to reduce risk (e.g., installing properly spaced two-hand control actuators in a 'control-reliable' system), the manufacturer must communicate the following information to the user:

- what has already been done to identify and reduce risk;
- the machine's limits and foreseeable use and misuse, and any additional protective measures that must be taken by the user;
- need for the user to conduct his/her own task-based risk assessment and apply appropriate protective measures to address particular use(s).

CONCLUSION

Although TR3 was written specifically for the B11 community for inclusion in the B11 Machine Tool Standards, it has application to a wide variety of machines and processes. It presents a paradigm shift in thinking about safeguarding machines.

The procedure and methodology:

- takes a shared approach to responsibility, recognizing that all parties can play a significant role in assessing and reducing risk;
- identifies more hazards than traditional methods;
- focuses on effective and appropriate risk reduction measures;
- can reduce legal liability for manufacturers, modifiers and users;
- virtually eliminates prescriptive safeguarding by requiring justification;
- is compatible with, but superior in many ways to European counterpart(s);
- provides a proven, practical methodology that allows application of the safety hierarchy during the design process for enhancement of safety and productivity.

The advent of ANSI B11.TR3 is a first step toward ensuring that safety will be moved toward the front of the machine design process; that protective measures to reduce risk will be applied in a scientific and logical manner to best utilize available resources; and that domestic machine manufacturers are helped to conform to worldwide standards. What the future holds is anyone's guess. However, TR3 has already made its mark in the development of the latest revision of RIA 15.06 (the robot safety standard) and several B11 standards now in process. ■

REFERENCES

Assn. for Manufacturing Technology (AMT). "Risk Assessment and Risk Reduction—A Guide to Estimate, Evaluate and Reduce Risks Associated with Machine Tools." ANSI B11.TR3-2000. McLean, VA: AMT, November 2000.

Taubitz, M. "Task-Based Hazard Identification, Risk Assessment and Risk Reduction: A Paradigm Shift from Prescriptive Safety." *Proceedings of Safety 2001.* Des Plaines, IL: ASSE, 2001.

ACKNOWLEDGMENTS

The author gratefully acknowledges special input from Bruce Main of Design Safety Engineering, David Felinski of AMT, and James Howe of the United Auto Workers International Union, as well as the valuable contributions of the 27 active participants on the ANSI B11.TR3 subcommittee.

***Robert N. Andres,** CSP, CPE, CMfgE, is CEO of OSHEX Associates Inc., Baldwinsville, NY. He is a consultant in the field of machine and facility safety, and noise/vibration control. Andres is a past administrator of ASSE's Engineering Division, and a member and past president of the Society's Central New York Chapter. He serves on the ANSI B11.3 and B11.20 subcommittees, and chairs the ANSI B11.TR3 subcommittee.*

For More Information

Copies of ANSI B11.TR3 are available from:

Assn. for Manufacturing Technology
7901 Westpark Dr.
McLean, VA 22102-4206
Phone (800) 524-0475
www.mfgtech.org

READER FEEDBACK

Did you find this article interesting and useful? Circle the corresponding number on the reader service card.

YES	30
SOMEWHAT	31
NO	32

Defining the Boundaries of Safety

When it comes to machine safety, operator protection and machine access get a large share of attention, but perimeter guarding of a hazardous machinery area is just as important.

by Russ Wood

Manufacturing operations in today's plants increasingly require machinery work cells to perform more tasks and deliver greater processing flexibility. Accompanying this increase in work-cell flexibility is an increased need for more flexible work-cell perimeter guarding systems.

Fixed barriers and metal guards with safety interlocks deliver the desired safety requirements by physically preventing someone from entering the hazardous area of a work cell. This also increases the difficulty of entering this area, which slows access when the work cell needs service or maintenance. In various situations, a plant can use a combination of fixed barriers with safety light curtains and safety mats to provide a more suitable perimeter-guarding solution for the entire hazardous area.

Rather then present a barrier to entry, light curtains and pressure-sensing safety mats react to the presence of someone. If a perimeter-guarding light beam is broken or if someone steps on a safety mat, these devices initiate a safe condition by sending a stop signal to the machinery controllers. To ensure a reliable safety circuit, the designs deliver a run signal until a beam is blocked or sufficient pressure is sensed. A stop signal is sent to the machinery controller, which brings the equipment to a stop in a safe state.

Nonphysical Barriers

The advantages of using safety light curtains and safety mats for perimeter guarding require users to consider their basic operation and operating environment to develop an effective solution. Perimeter guarding requires that all points of entry must be monitored or blocked to prevent the undetected entry into a hazardous area of a machine work cell.

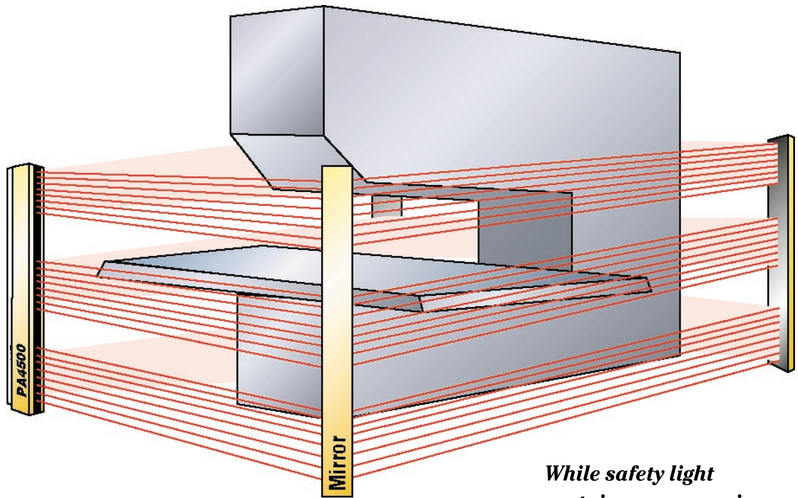


ILLUSTRATION: SCIENTIFIC TECHNOLOGIES INC.

While safety light curtains may experience problems in dusty or misty areas, their coded infrared beam provides immunity from weld flash. Most safety light curtains use a tight focus to minimize interference from other safety devices. This unit guards automated machinery on all four sides with the aid of corner mirrors.

The benefit of easy accesses presented by light curtains and mats means that these devices do not prevent someone from entering a work cell. Because neither device provides a mechanical barrier, the machines they guard must be able to stop at any point of the operating cycle, coming to a safe condition within a predictable amount of time. For example, a clutch press must complete a full cycle before coming to a stop in a variable amount of time and is not suitable for this type of guarding.

The use of safety light curtains and safety mats used in perimeter guarding requires that their safety output switches work in a "latch" or "guard" mode. Someone crossing the perimeter sensed by the safety light curtain or safety mat momentarily breaks a beam or applies sufficient pressure as they move through the perimeter. Because of this, the light curtains and safety mats will not allow the energy to be restored to the work cell.

Once the guarded device stops, it can only be restarted by a separate reset switch. This

PHOTOS: SCIENTIFIC TECHNOLOGIES INC.

A safety mat installation provides area and perimeter guarding. The mats are secured to the floor with a yellow trim element that can also serve as a visual indication perimeter of the guarded work cell.

reset switch must be located outside the hazardous area of the work cell. The reset switch must be located so that the entire area can be monitored to make sure no one is at risk before actuating the reset switch. It should be a key-controlled switch, and it may be appropriate to combine this with a four-digit combination switch or a trapped-key switch to further enhance machine safety.

Safety light curtains use invisible infrared beams. To aid workers on the plant floor, a visual indication or awareness barrier should be used to identify the hazard area to reduce the inadvertent tripping of the light curtain. This may take the form of a low railing, a suspended chain or painting the guarded area yellow-orange.

Additional warning signs should also be placed in appropriate locations. Pilot lights on the safety device and the guarded machine will benefit operators and maintenance personnel when they approach the guarded work cell.

Safety Checks and Reliability

When a light curtain is powered up, it first must enter a "faulted" condition. This prevents activation of the work cell should someone still be inside the hazardous area. The operator will need to use the separate reset switch and check the area before activating the perimeter-guarding light curtain.

The integrity of the perimeter-guarding system should be checked periodically – at least at each power-up. Checking integrity at each break and at each shift change is recommended. These procedures should be included as part of an operator's job description. Periodic checks of the guarded equipment and safety equipment are also recommended.

In the case of mechanical brakes on a machine, their tendency to wear can change the stopping time. Periodic checks of this stopping time may require the perimeter-guarding mat or light curtain to be moved further from the machine.

In addition to safety equipment, the safety-related control functions must be "control reliable." This means that a single failure of a control component will not cause an unsafe condition and require special safety switches and relays.

Placement and Dimensions

The area sensed by safety light curtains used in perimeter guarding is referred to as the sensing field. The safety light curtain must be placed at a distance far enough away from the hazardous area to prevent someone from reaching over, around or through the light beam to come into the proximity of the hazardous area. Should someone walk through the perimeter light fence, it must also be far enough away to prevent him from reaching the hazardous machine before it stops.

Unlike guarding at an operator station in a work cell where someone must come in close proximity to a moving part of a machine, the vertical distance

Consider All Safety Guarding Requirements

Using any safety device begins with the application of the same basic safety analysis principles used to safeguard any machine. Elements include a safety review, developing corrective procedures and appropriate training, as well as the use of the necessary safety equipment.

No single piece of safety equipment works in all situations. While safety light curtains and safety mats provide an active means of flexible safeguarding, they are not always the best solution.

Radiation, heat, vapors or sprays emitted from a machine will not be stopped by a light curtain or a safety mat. A mechanical barrier is more suitable for these situations.

By the same token, a working environment that generates dust, vapors, smoke, sprays or caustic material may affect the optics of a light curtain. Check to determine if spills of oil or cutting fluids will affect the performance of a safety mat. Safety mats are designed to work in many, but not all, environments. Determine if the specific fluids used in a machinery work cell will degrade the working surface of a safety mat or its safety circuits. A malfunctioning safety device builds a false sense of security and is worse than no safety device at all.

Finally, because today's work environments feature more technology and regulatory complexity than ever before, one must make sure that the safety product complies with necessary national and local safety and operating regulations.

between light beams can be farther apart because the distance between an individual and the hazardous machine is greater. In some work cells, it is possible to use a single beam to guard two or more sides of a work cell with the use of mirrors. Using mirrors, however, can affect the scanning distance and beam alignment.

Safe Mounting Distance

The distance between a perimeter-guarding light curtain and the hazardous areas in a work cell requires some analysis. The safe mounting distance of a safety light curtain or a safety mat from the hazardous machinery area depends on the time needed to stop the equipment. Safety mats are usually involved in area monitoring; however, they can play a role in perimeter guarding where smoke, haze, dust or other environmental conditions preclude an optical device. The safety mat needs to be wide enough so that someone cannot step over it to defeat its intended purpose.

The safe mounting distance of the safety mat can be determined by the equation:

$$S = (63 \text{ inches}/s + T) + 47.2 \text{ in.} - 0.4H$$

S is the calculated minimum distance measured in inches in a horizontal plane from the farthest edge of the perimeter-guarding device.

H is the distance above the reference plane in inches.

s is the approach of the individual.

T = t1 + t2 where T is a measure of the overall stopping performance.

t1 is the maximum time delay measured between the actuation of the safety mat/light curtain and its controller relays when in the "off" state

t2 is the time delay of the guarded machine. This is the time the machine takes to stop or to remove the risk of a hazard after receiving the output signal from the safety device.

The t1 and t2 times depend on the reaction time of the safety device and the guarded machine. Both are a function of the application. For safety mats, H is the height of the step in inches and is reduced to zero because they are mounted on the floor.

Walking speed and stride data results from statistical data for the population. This data helps in determining the placement of the safety device. A stride length, which starts and finishes on the same foot, is about 74.8 inches for the 95th percentile of the U.S. population distribution. Additional allowances of about 2 inches are typically used to compensate differences in the sensing area of a mat and the calculated stride when determining the mounting distance. OH

When guarding a perimeter, it is essential that the safety light curtain have a restart interlock or "guard mode" feature in its control circuitry. This means that once the sensing field of the light curtain has been violated, the curtain will continue to send a stop signal to the guarded machine until it is manually reset by an operator using a key switch.

Russ Wood is application engineering manager for Scientific Technologies Inc., Fremont, Calif. Wood has been with STI for nine years and previously held the position of product manager for the Safety Light Curtains product group. He is a graduate of California Polytechnic State University, San Luis Obispo, with a bachelor of science degree in business administration. He can be reached at (800) 221-7060 or via e-mail at Russ_Wood@sti.com.

For detailed information on products for machine guarding and related safety equipment, see the EHS Buyers' Guide listings on pages 93 and 94.

MACHINE GUARDING

I. FREQUENTLY ASKED QUESTIONS CONCERNING MACHINE GUARDING:

A. Can't I rely on the guarding provided by the manufacturer?

The employer is responsible for employee safety. The employer cannot rely on factory made and installed guards to protect employees or to necessarily meet safety requirements. You need to do your homework before you purchase a machine. What are the hazards and what are the legal guarding requirements? Do you want to specify the type of guarding to be installed by the manufacturer or do you want to provide the guarding once you receive the machine?

Purchasing a used machine means the guarding is up to you.

B. Does altering the manufacturer's guards make our company liable?

The employer is responsible for employee safety. If the manufacturer's guards do not provide adequate protection or do not meet safety requirements, it's up to the employer to provide this, whether they do it themselves or go back to the manufacturer.

C. Does this old machine fall under a "grandfather" clause?

The chances of this happening are pretty remote since most grandfather clauses indicate that alterations or changes have not been made to the machine. But even so, "grandfathering" does not protect employees. If a hazard exists, it should be dealt with. Also, "grandfathering" does not apply to workers' comp. If it's a work related injury, the company will pay the cost of the claim.

II. WHAT NEEDS TO BE GUARDED?

A. Point of operation: the area on a machine where work is actually performed upon the material being processed.

1. Example: saws and mechanical power presses. Saw blades require some guarding but access to the cutting surface must be provided to use a saw. Mechanical power press guarding is more stringent. Guards must be designed to prevent reaching over, under, around, or through and into the danger area, or safety devices must be used. **NOTE:** Safety devices may allow for “hands in die” operation, which is very dangerous.

2. Example: back of a mechanical power press. The distance from the opening at the back of a press to the danger area (point of operation) may be 6 feet. However, guarding is still required and the guard opening must not be over 6 inches.

3. Guard opening Table (O-10) and Diagram.

B. Power transmission apparatus: belts, pulleys, shafts, chain and sprockets, gears, collars, couplings, keys, setscrews, etc.

C. Other moving parts: reciprocating tables, conveyor belts, feed mechanisms, etc.

D. Machine guarding must be provided to protect the operator and other employees in the machine area.

III. TYPE OF GUARDING AND DESIGN

A. Joint effort between the supervisor, operator, and safety person.

B. Considerations:

1. Machine function (what does it do?),

2. Manufacturer's recommendations,

3. Safety standards: OSHA, ANSI, etc.,

4. Hazards to operators **and** bystanders,

5. Production vs. non-production, and

6. Ergonomics.

C. Barrier guarding: over, under, around, or through. Example: vee belt and pulley. But, as we discussed, point of operation guarding may not be that black and white.

D. Interlocked barrier guarding. Example: hinged gate with electrical interlock that prevents machine operation unless the gate is closed and in place.

1. Concerns: There are many different types of interlocks. Do your homework prior to purchasing interlocks. ANSI B11.19: 4.1.1.1.4: "The employer shall ensure that barrier guards are installed, maintained, and operated so as to protect against unauthorized adjustment or circumvention by the operator or others." ANSI 4.1.1.2.2: "(1) All interlocked devices used in conjunction with barrier guards shall be of such quality and design that normal operation will not render them inoperative." ANSI 4.2.1.2.5: "Movable barrier devices shall prevent the initiation of the machine tool due to a single component failure of the device." Additionally, "they shall not be easily bypassed by the operator of other unauthorized personnel."

E. Safety devices: two-hand controls/trips, presence sensing devices, pull-outs, and restraints.

1. May be used as the primary safeguard or used in conjunction with barrier guards.

2. Some safety devices protect only the operator and not other employees.

3. Special considerations:

a. Safety distance for two-hand controls/trips and presence sensing devices;

b. Anti-tie down/Anti-repeat for two-hand controls/trips;

c. Tying an employee to a machine applies to pull-outs and restraints; and

d. Allowing parts, pieces, chips, etc. to be thrown from a machine.

F. Safety trip controls: pressure-sensitive body bars, pressure-sensitive mats, trip rods and cables.

1. Must be of the manually resetting type, not automatic.

G. Location/Distance.

H. General requirements:

- fixed to the machine or secured elsewhere (should require a tool to remove),
-metal free from burrs and sharp edges,
-expanded metal, sheet or perforated metal, and wire mesh shall be securely fastened to frame
-shall not offer an accident hazard in itself
-may be wood in the woodworking and chemical industries, where the presence of fumes or where manufacturing conditions would cause the rapid deterioration of metal guards; also in construction work and in locations outdoors where extreme heat or cold make metal guards undesirable, but not any other industries.

IV. SAFE OPERATING PROCEDURES

A. Can you guard all possible hazards or expect guarding to eliminate all injuries?

1. No, so safe operating procedures become critical.

2. However, many more machines could be guarded than are, due to lack of knowledge, inexperience, and misunderstanding of legal requirements dealing with machine guarding.

B. Job Safety Analysis (JSA) or Job Hazard Analysis (JHA)

C. Steps:

1. Operator involvement critical,

2. Break job/task down to simple steps,

3. Identify hazards (include ergonomic), eliminate if possible,

4. Identify Personal Protective Equipment (PPE) needs,

5. Result in Safe Operating Procedure,

6. Re-evaluate.

V. FOLLOW-UP

A. Machine guarding auditing system.

B. Behavior-Based Safety. (Article: Safety Observation).

VI. OTHER CONSIDERATIONS

A. Lockout/Tagout: if a guard is removed or safety device bypassed, lockout applies.

B. Guard inspection and maintenance:

1. Properly mounted and secured,

2. Not damaged,

3. Not creating a hazard,

4. Not bypassed,

5. Testing of safety interlocks, tripwire cables, body bars, and pressure sensitive mats.

6. Safety distances tested and maintained for presence sensing devices and two-hand controls/trips.

7. Additional requirements under the mechanical power press section of OSHA for inspections and recordkeeping of safety devices.

C. Training for operators, setup, and maintenance/repair personnel:

1. Machine operation,

2. Safety features,

3. Hazards,

4. Safe operating procedures, and

5. Lockout/Tagout.

One Hour Safety Presentation

The main goal of the Division of Safety & Hygiene is the reduction of accidents and illnesses in the workplace. Toward this goal, the One Hour Safety presentation is designed to support the delivery of a presentation to co-workers in your workplace to help them understand and promote safer and healthier work environments. It is recommended that you take the DSH Training Center course as a background for using One Hour Safety Presentation to train others at your workplace. Call 1-800-OHIOBWC, option 2, 2, 2 for class dates and locations.

The One Hour Safety Presentation contains:

- Transparency Masters from which films can be made to use on an overhead projector,
- Instructor Notes which gives the instructor suggestions and script notations to use during the presentation, and
- Student Handouts which can be copied for those attending the presentation.

Materials are included for a one-hour presentation on each of these topics:

- ✓ Accident Analysis
- ✓ Bloodborne Pathogens
- ✓ Effective Safety Teams
- ✓ Enhancing Safety through a Drug-Free Workplace
- ✓ Ergonomics Basic Principles
- ✓ Ergonomics Developing an Effective Process
- ✓ Hazard Communication
- ✓ Lockout/Tagout and Safety-related Work Practices
- ✓ Machine Guarding Basics
- ✓ Measuring Safety Performance
- ✓ Powered Industrial Trucks Training Program
- ✓ Respiratory Protection
- ✓ Violence in the Workplace

Applications used:

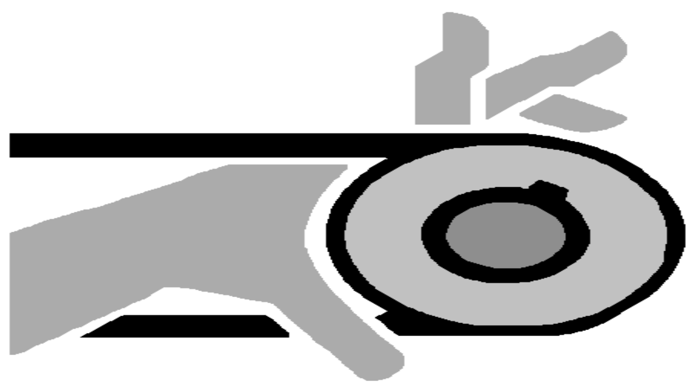
1) Text documents (ending in .txt) can be opened with any word processing program.
2) Microsoft PowerPoint slides (ending in .ppt) can be opened with the Microsoft PowerPoint program. If you do not have PowerPoint and you do have Windows 95, 98, 2000 or Windows NT operating system, you can view the PowerPoint slides by downloading a free PowerPoint Viewer from the following website: http://office.microsoft.com/downloads/default.aspx?Product=PowerPoint&Version=95|97|98|2000|2002&Type=Converter|Viewer
3) Adobe Reader document (ending in .pdf) contains the One Hour Safety Presentation in read-only format. It can be opened when you download Adobe Reader, which is available free of charge at the following website: http://www.adobe.com/products/acrobat/readstep2.html

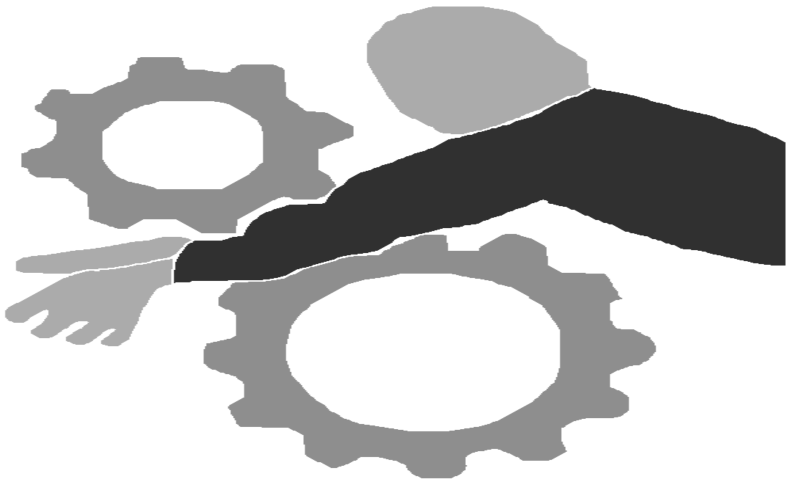
If you have comments or questions about these materials for One Hour Safety Presentation, please e-mail us: OCOSHTrng@bwc.state.oh.us

Transparency Masters

Subpart O – MACHINE GUARDING

- **1910.211 Definitions**
- **1910.212 General Requirements for all Machines.**
- **1910.213 Woodworking Machinery**





Subpart O

- **1910.215 Abrasive Wheel Machinery**
- **1910.216 Mills and Calendars**
- **1910.217 Mechanical Power Presses**
- **1910.218 Forging Machinery**
- **1910.219 Mechanical Power-Transmission**

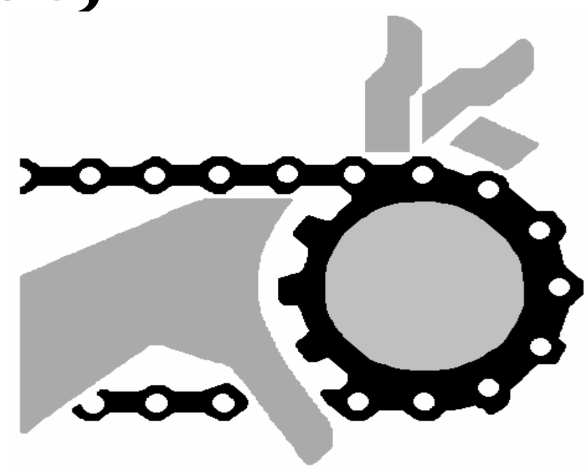
Basics of Machine Safeguarding

- **A good rule to remember is: Any machine part , function, or process which may cause injury must be safeguarded.**
- **And a guard should not allow someone to reach over, under, around or through.**

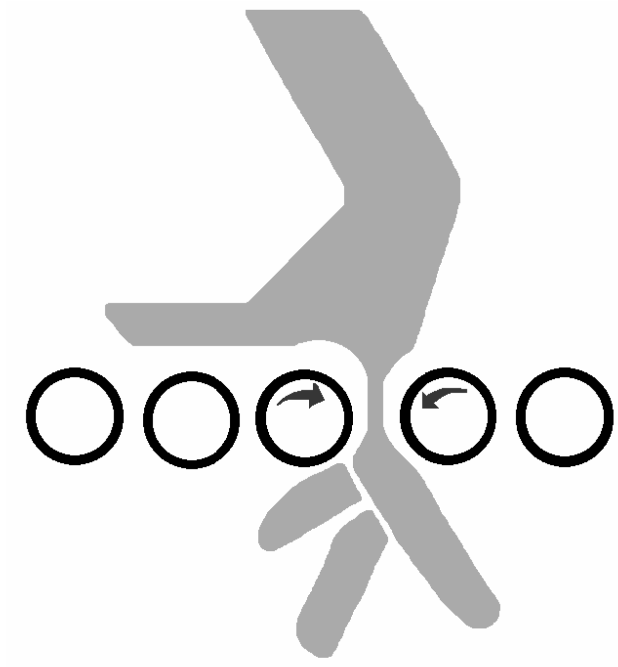
Basics Areas of Safeguarding

- The point of operation
- Power transmission apparatus
- Other moving parts (reciprocating, transverse,

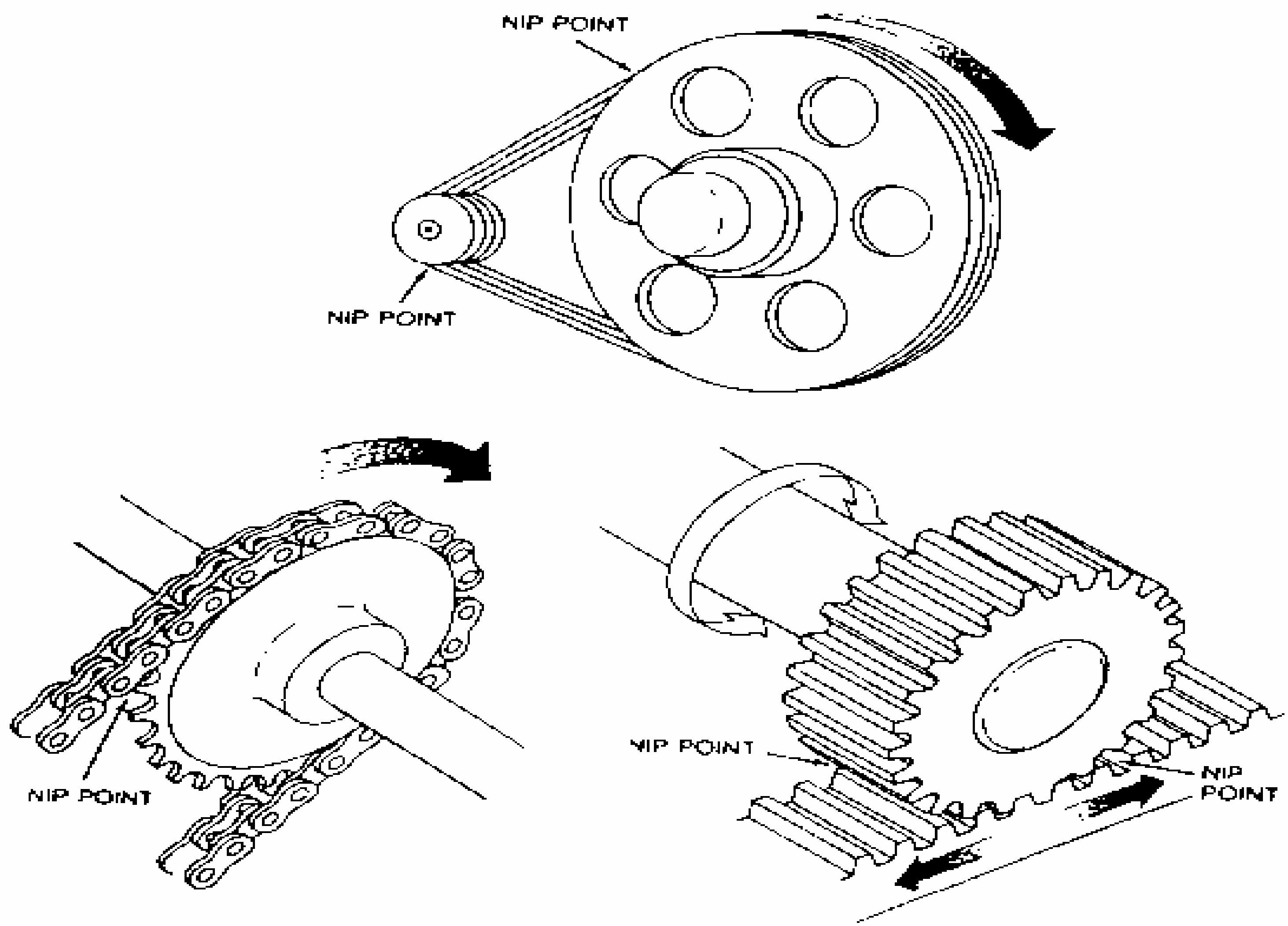
  or rotating)



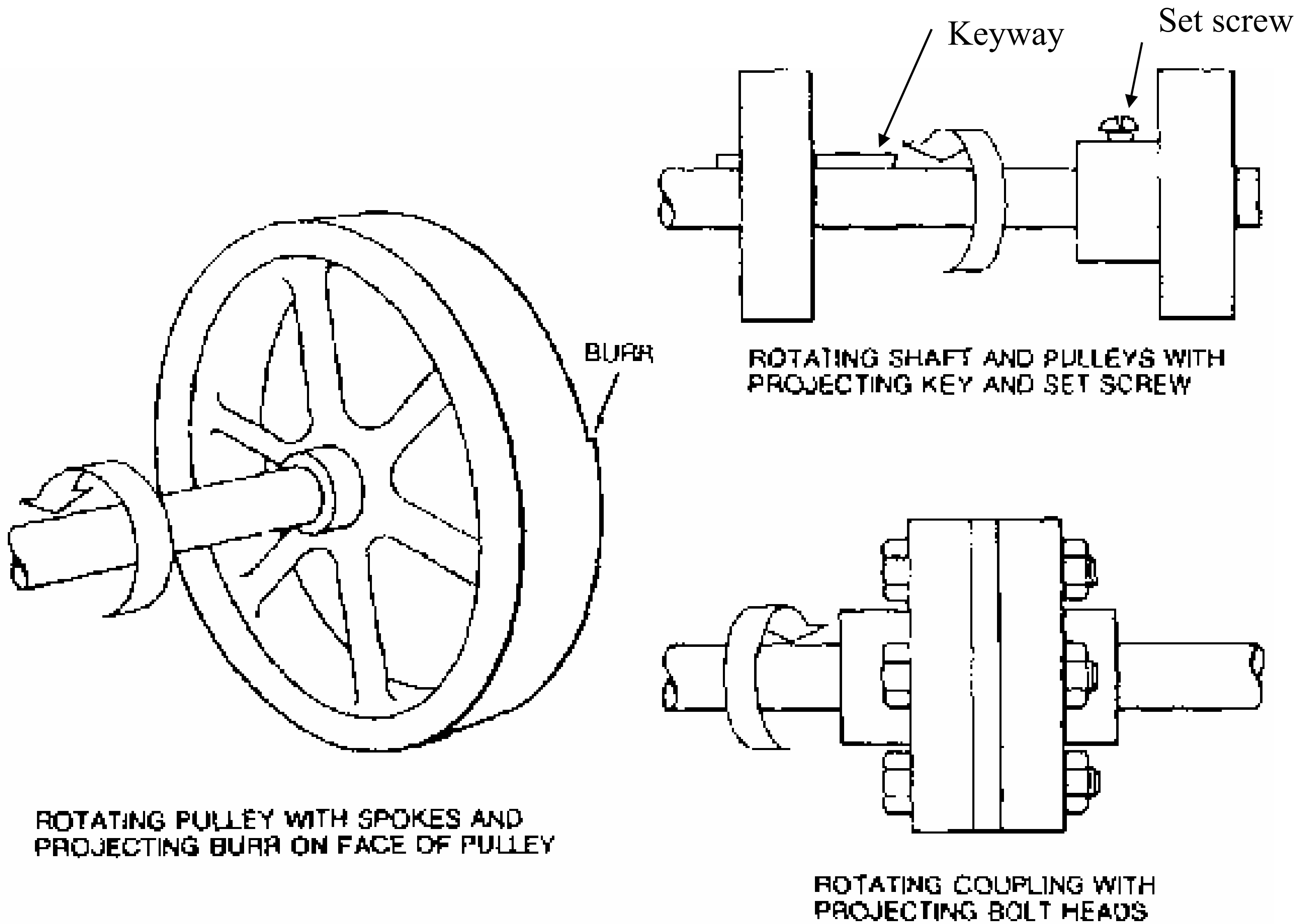
Motions



- **Motions**
  1) **Rotating (including in-running nip points)**
  2) **Reciprocating**
  3) **Transverse**



Nip Points



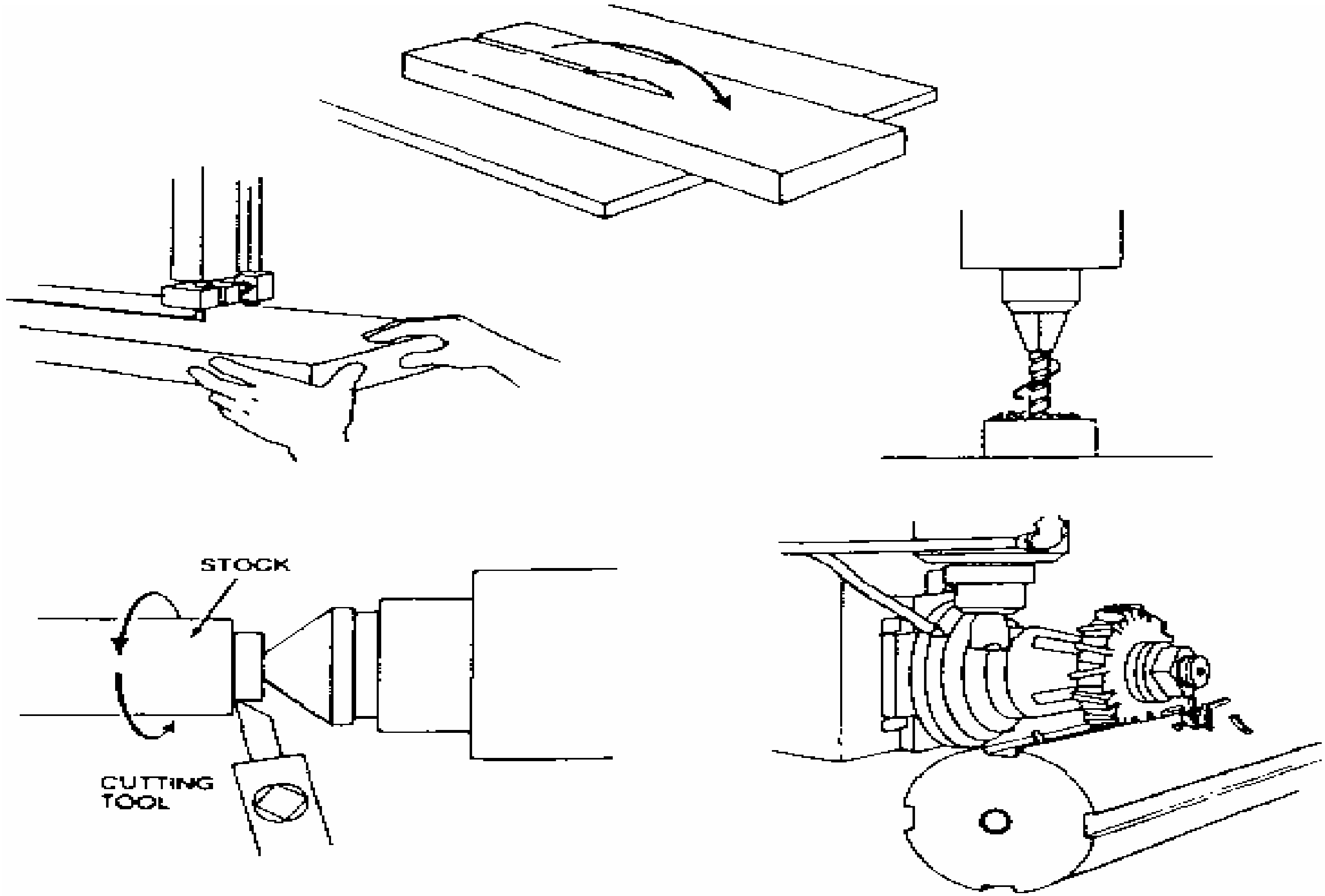
Rotating Hazards

Safeguarding

- **Guards--- Prevents access to the danger areas.**
- **Devices---Controls access to the Point of Operation.**

Actions

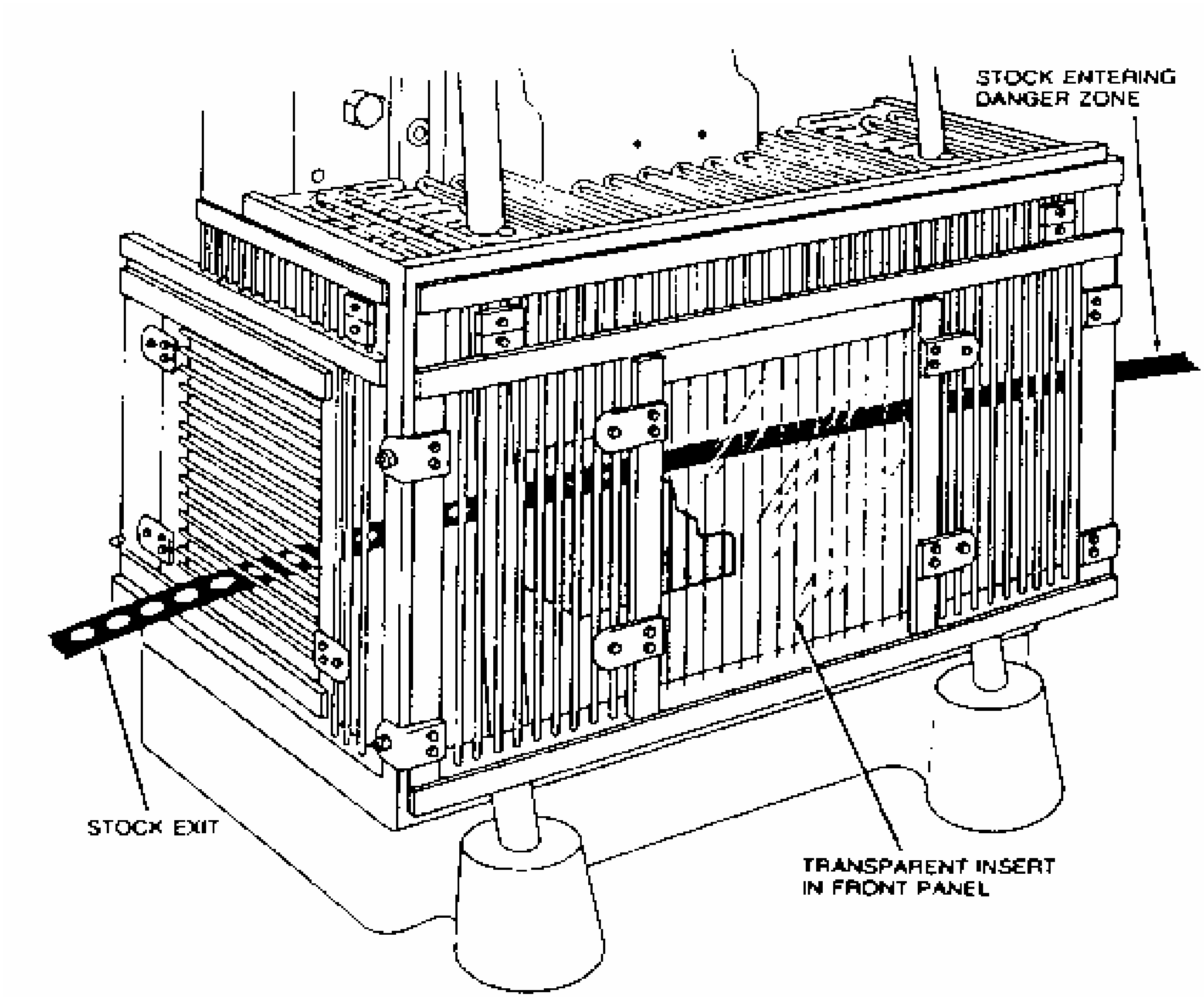
- **Cutting**
- **Punching**
- **Shearing**
- **Bending**



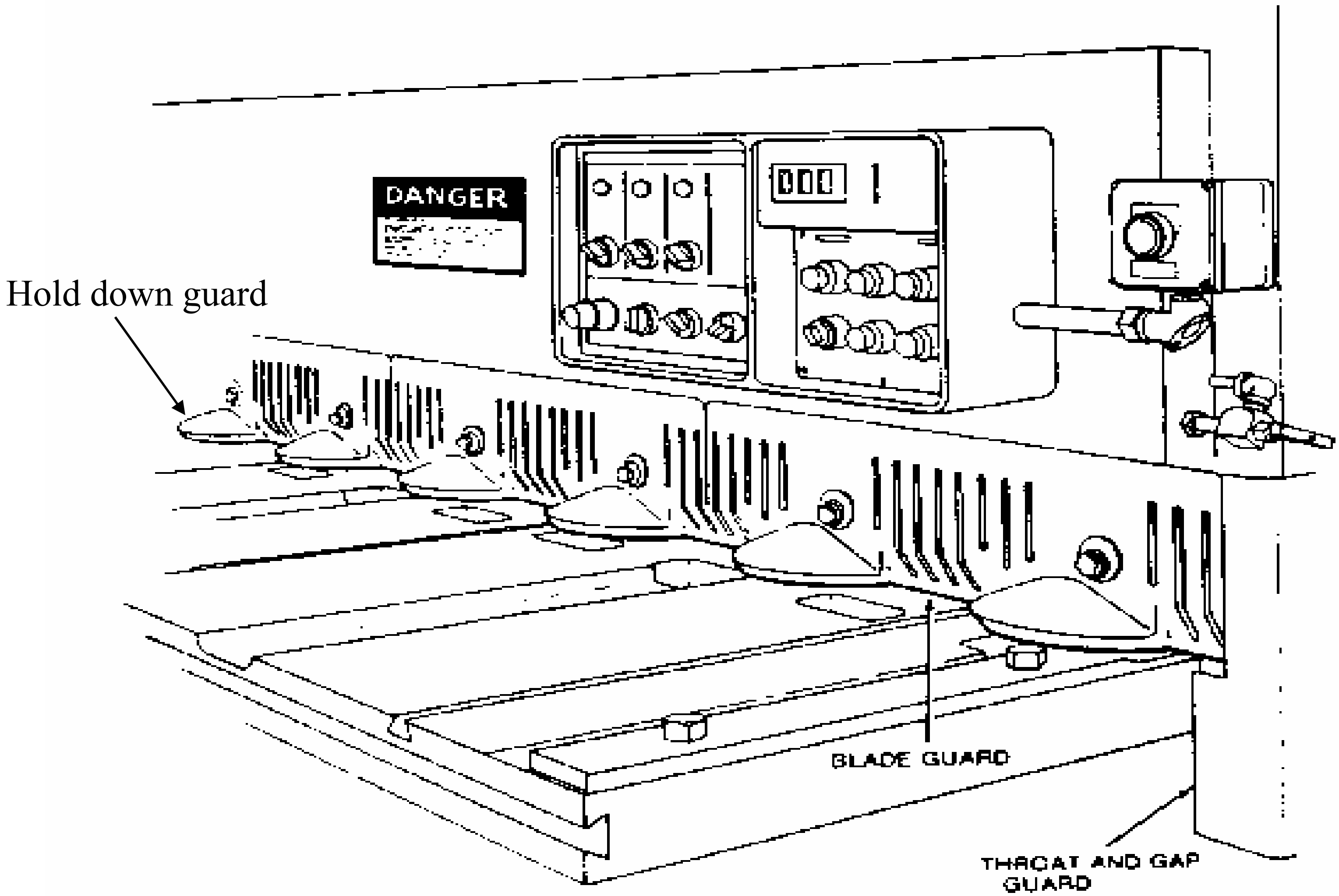
Different Actions

Guards

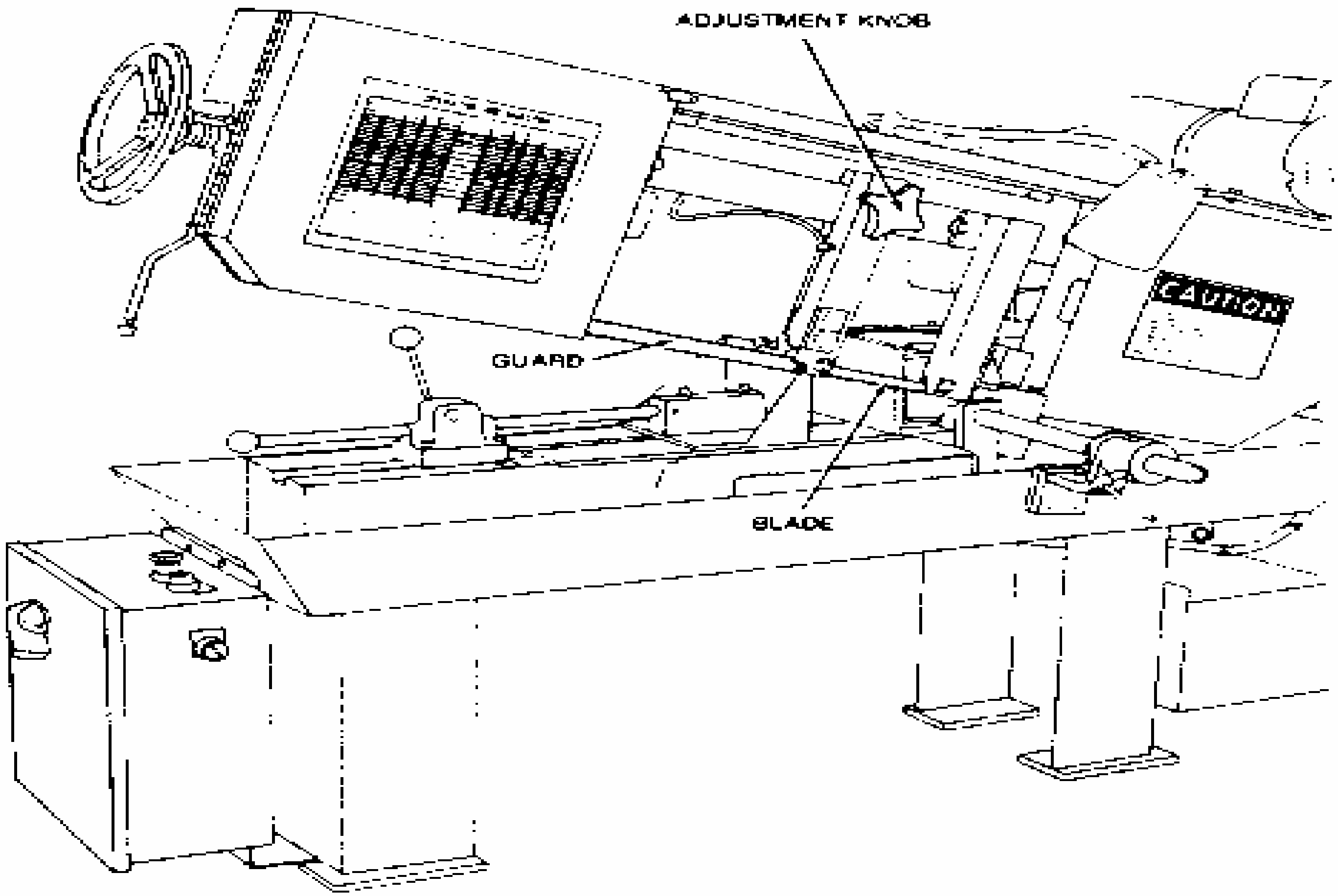
- **Fixed**
- **Interlocked**
- **Adjustable**
- **Self-adjusting**



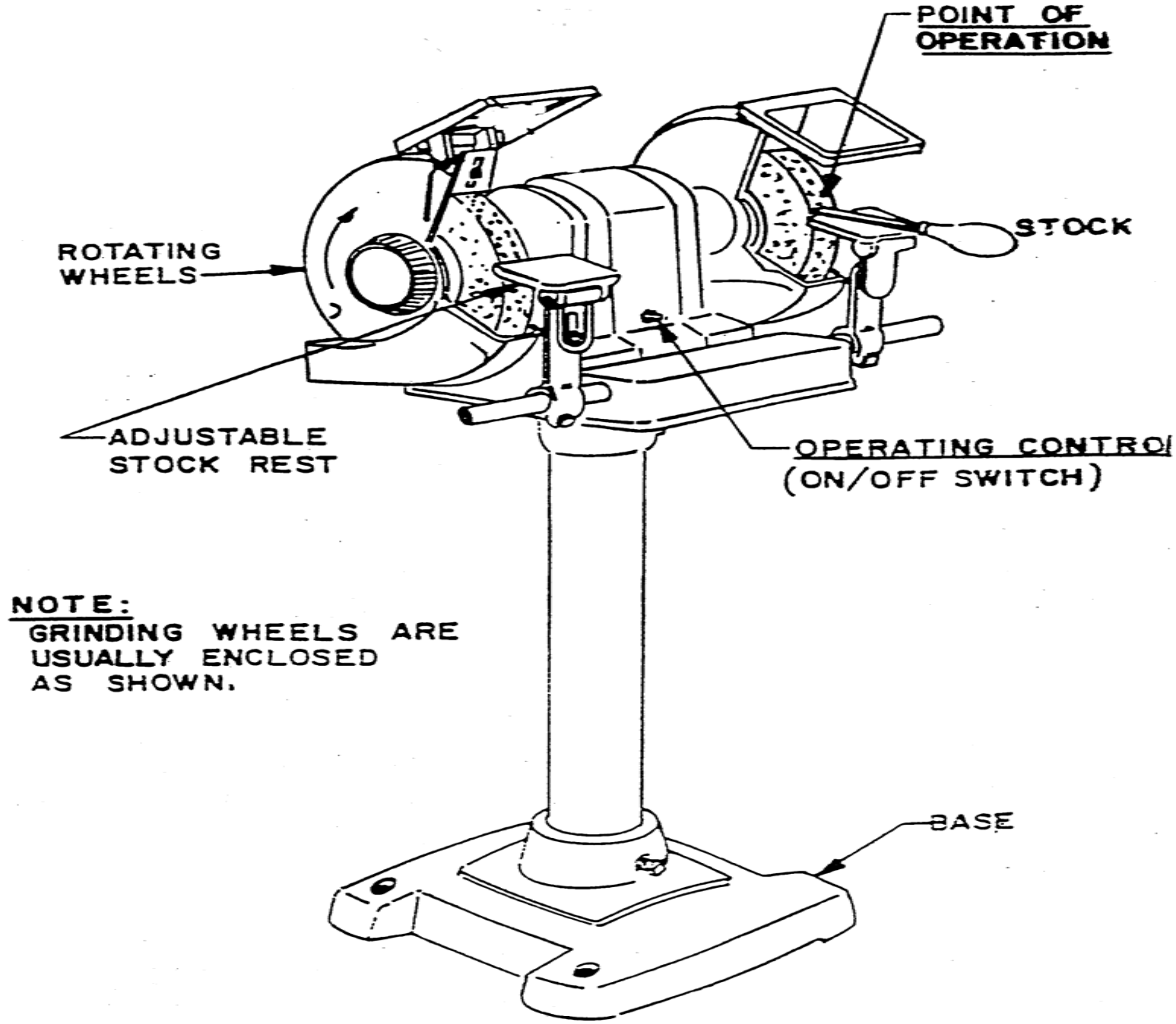
Fixed Guard On A Power Press



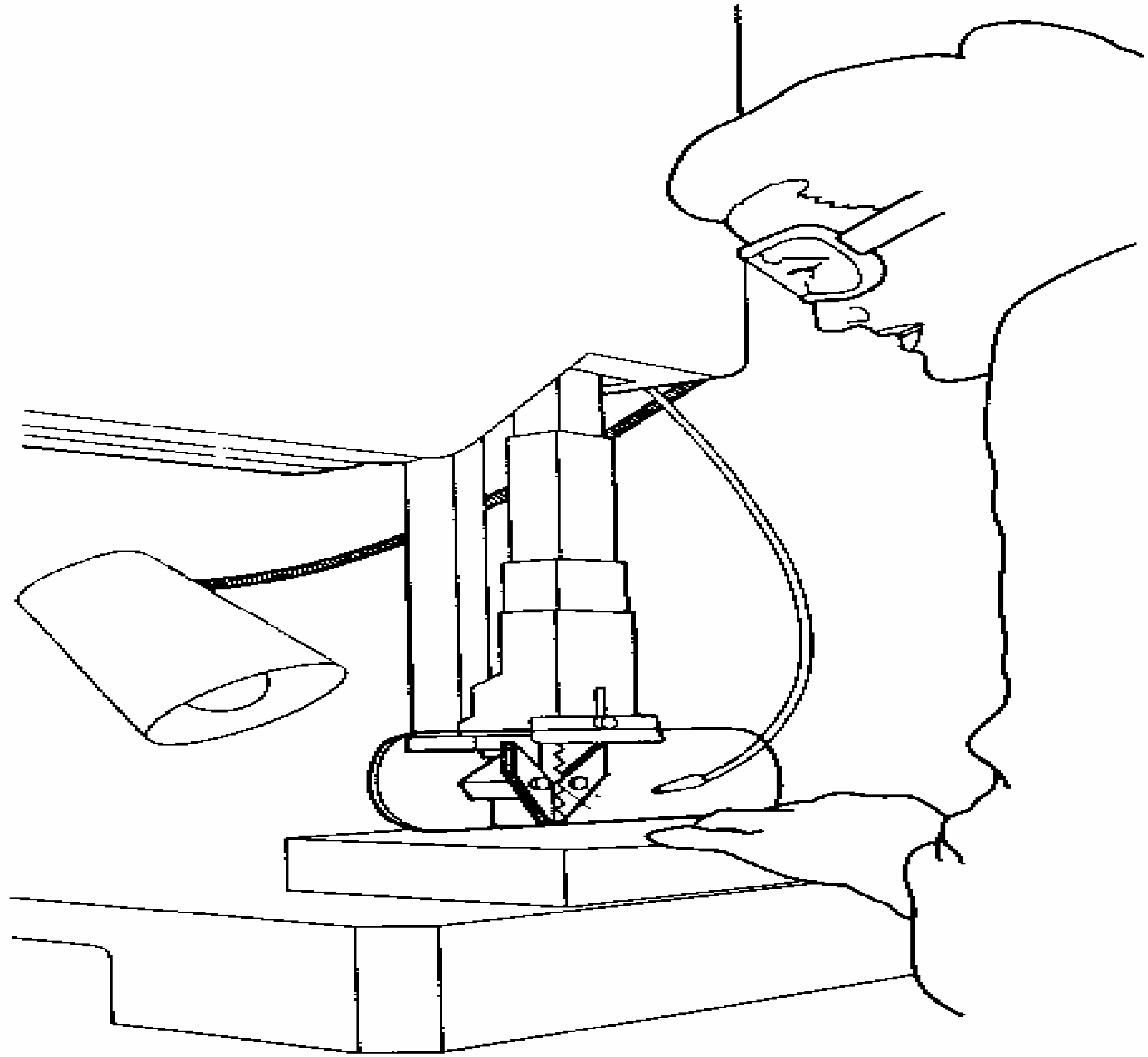
Fixed Guard on a Power Squaring Shear



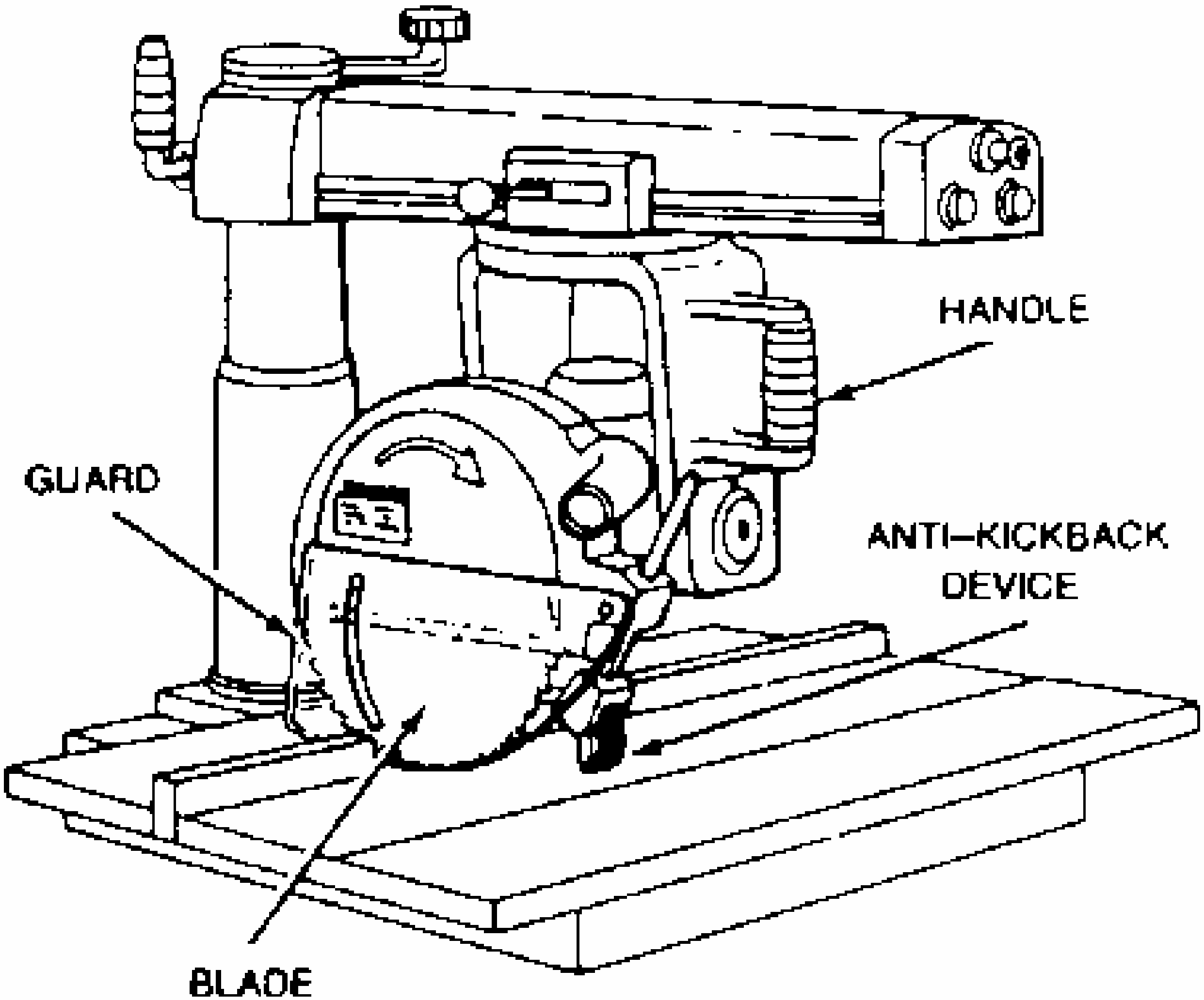
Adjustable Guard On Horizontal Bandsaw



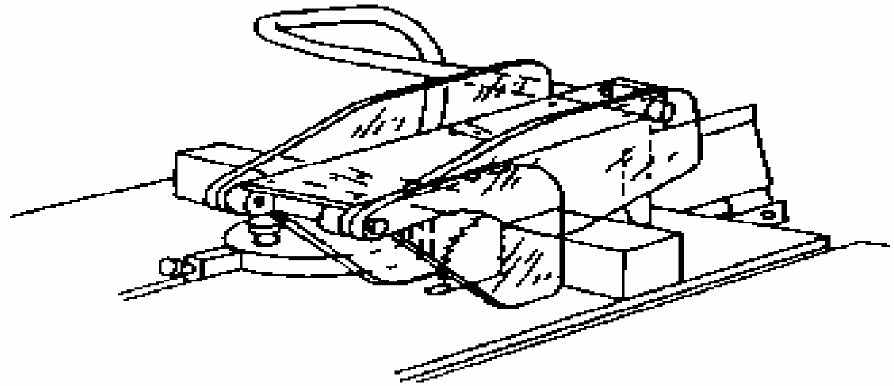
Adjustable Guard On Pedestal Grinder

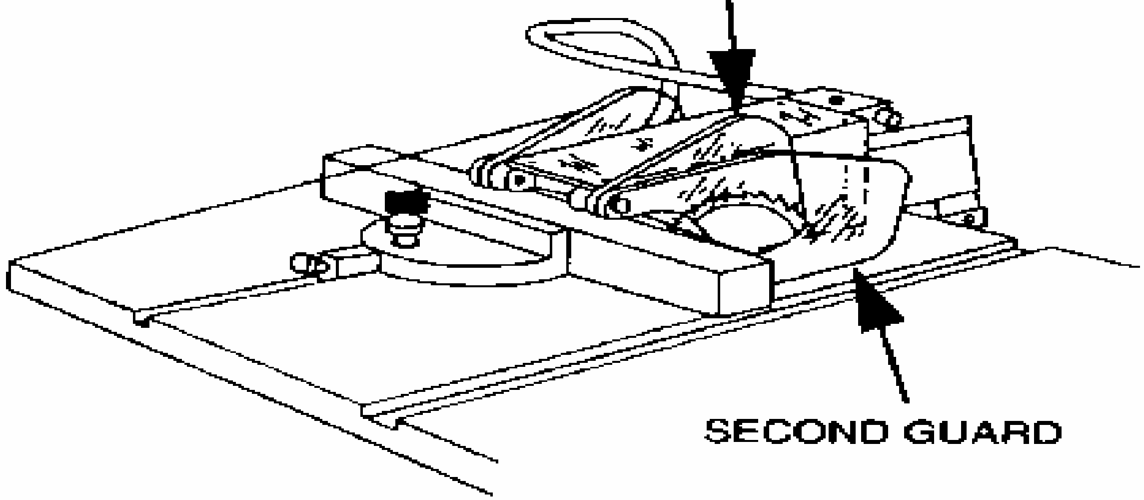


Adjustable Guard On Bandsaw



Self-Adjusting Guard On Radial Arm Saw

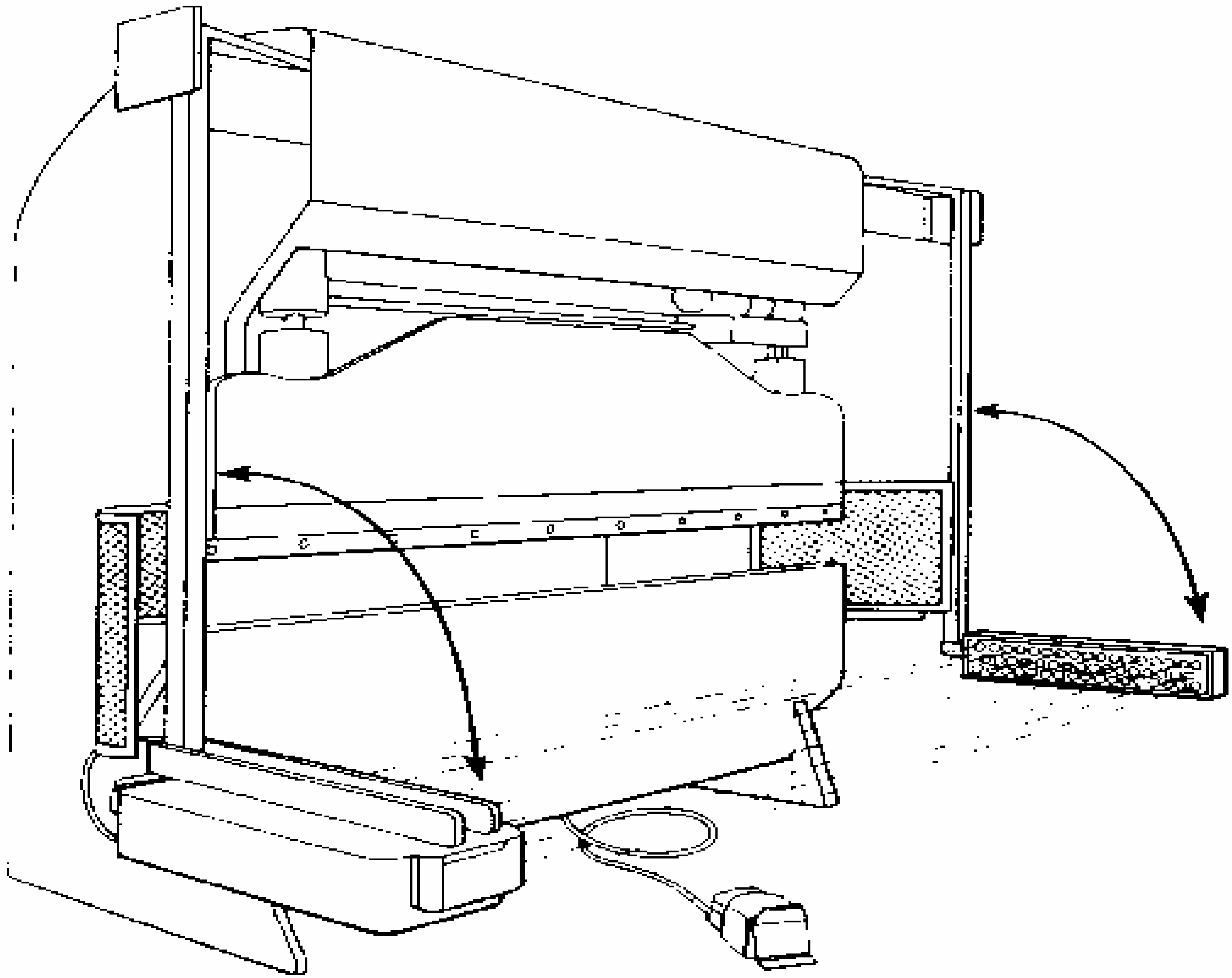




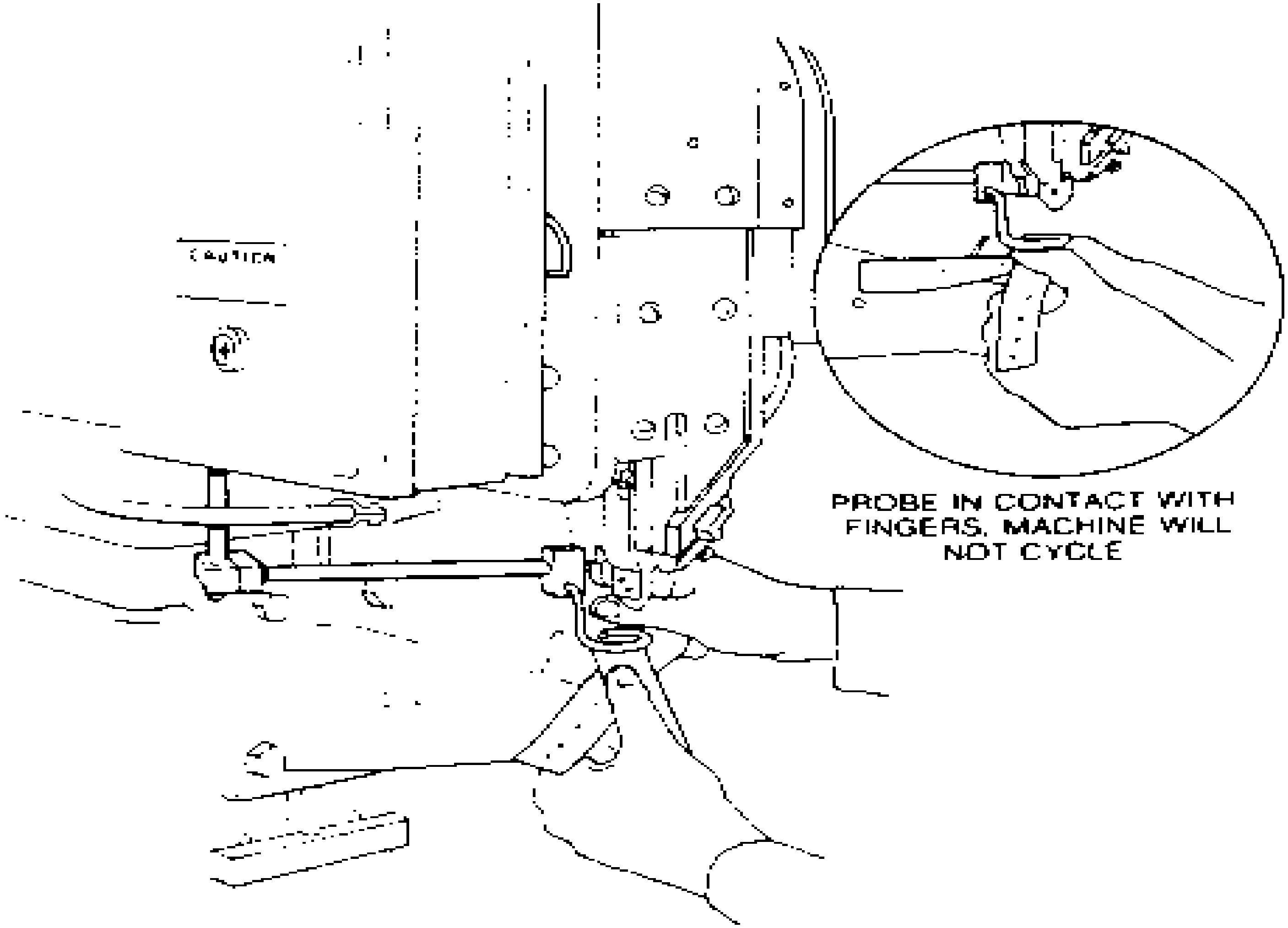
Self-Adjusting Guard Table Saw

Devices

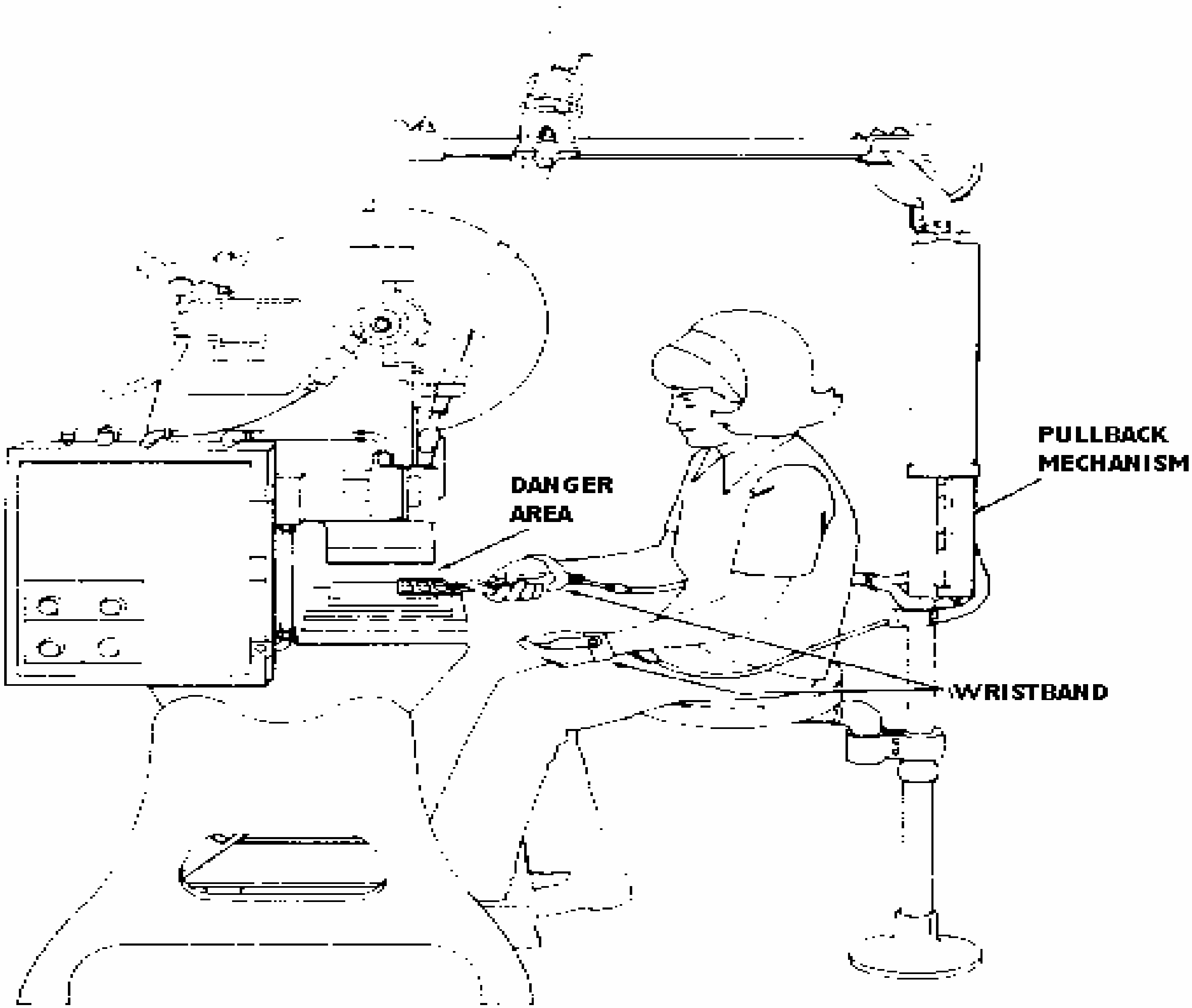
- **Presence Sensing**
    1) **Photo-electrical**
    2) **Electromechanical**
- **Pullback**
- **Restraint**



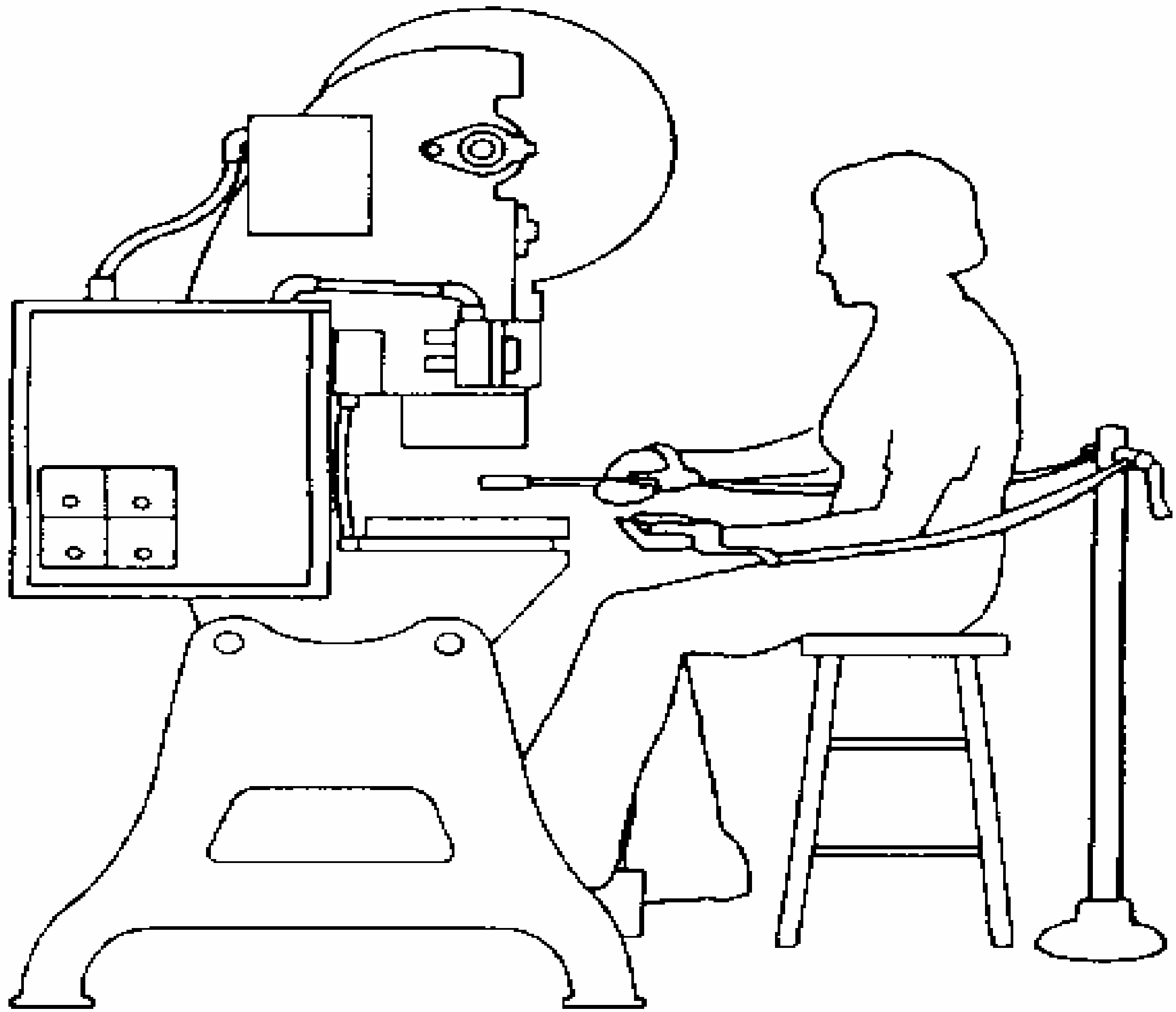
Photoelectric Presence Sensing Device On Press Brake



Electromechanical Sensing Device On An Eye-letter



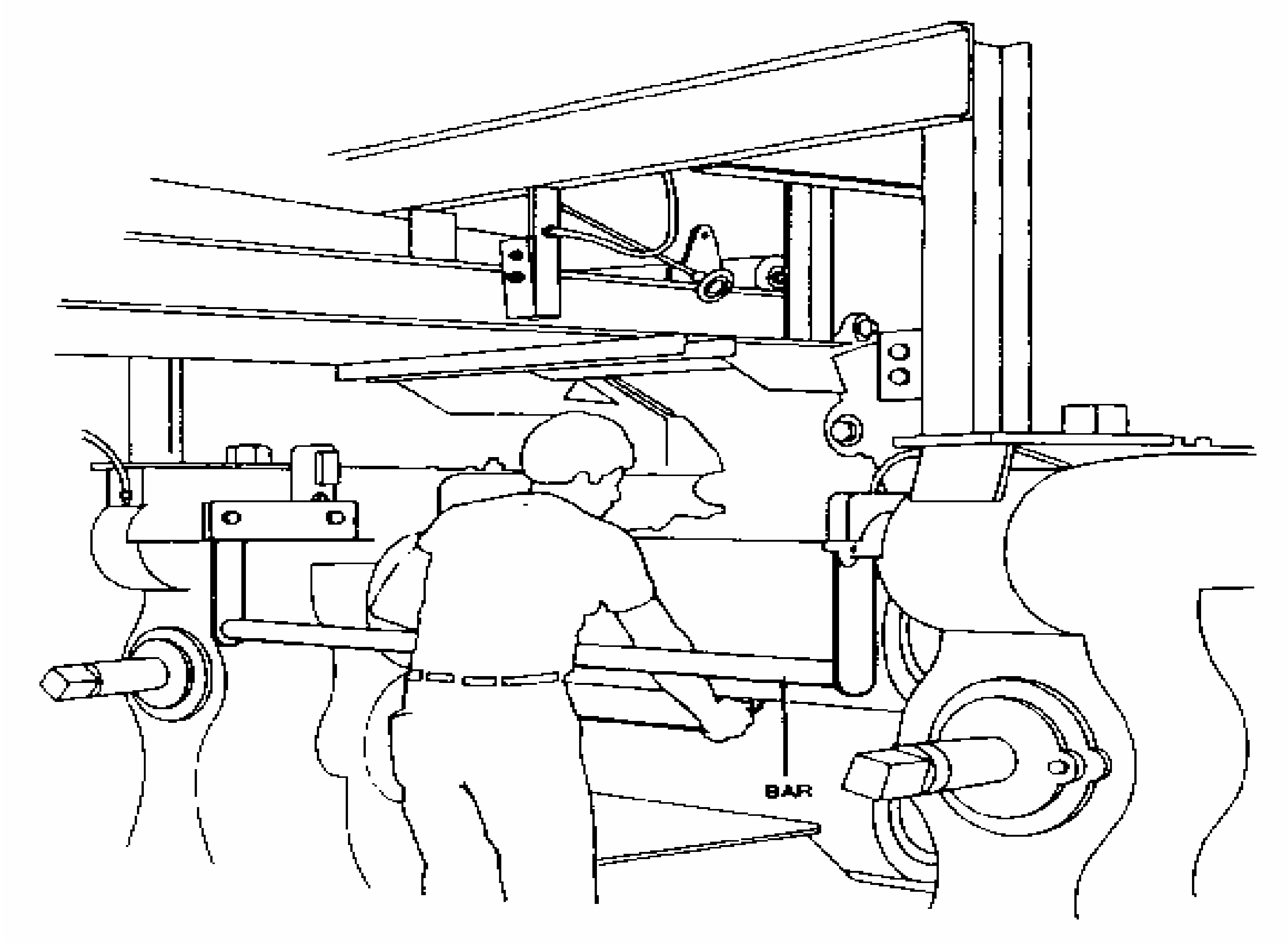
Pullback Device On A Power Press



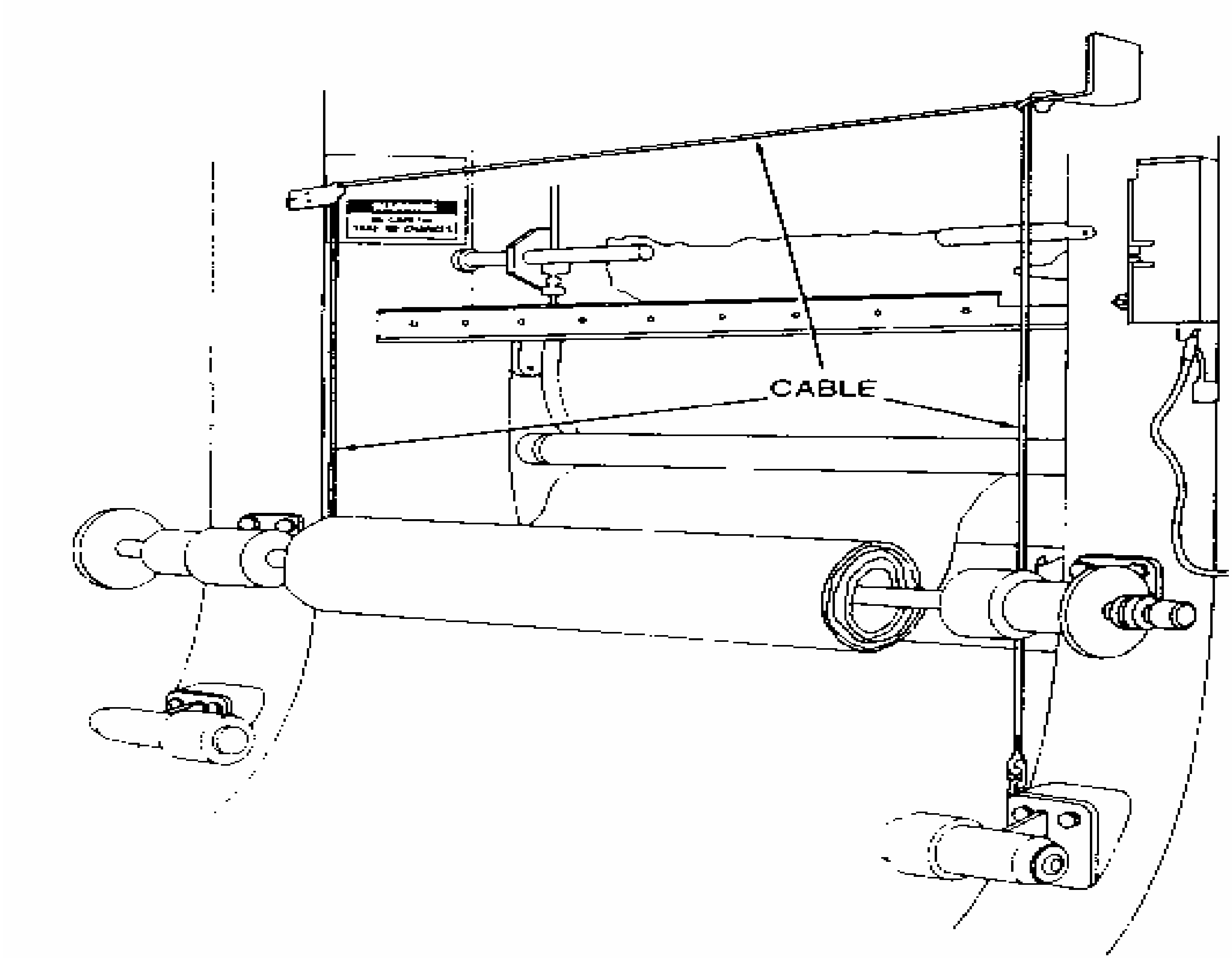
Restraint Device On A Power Press

Devices

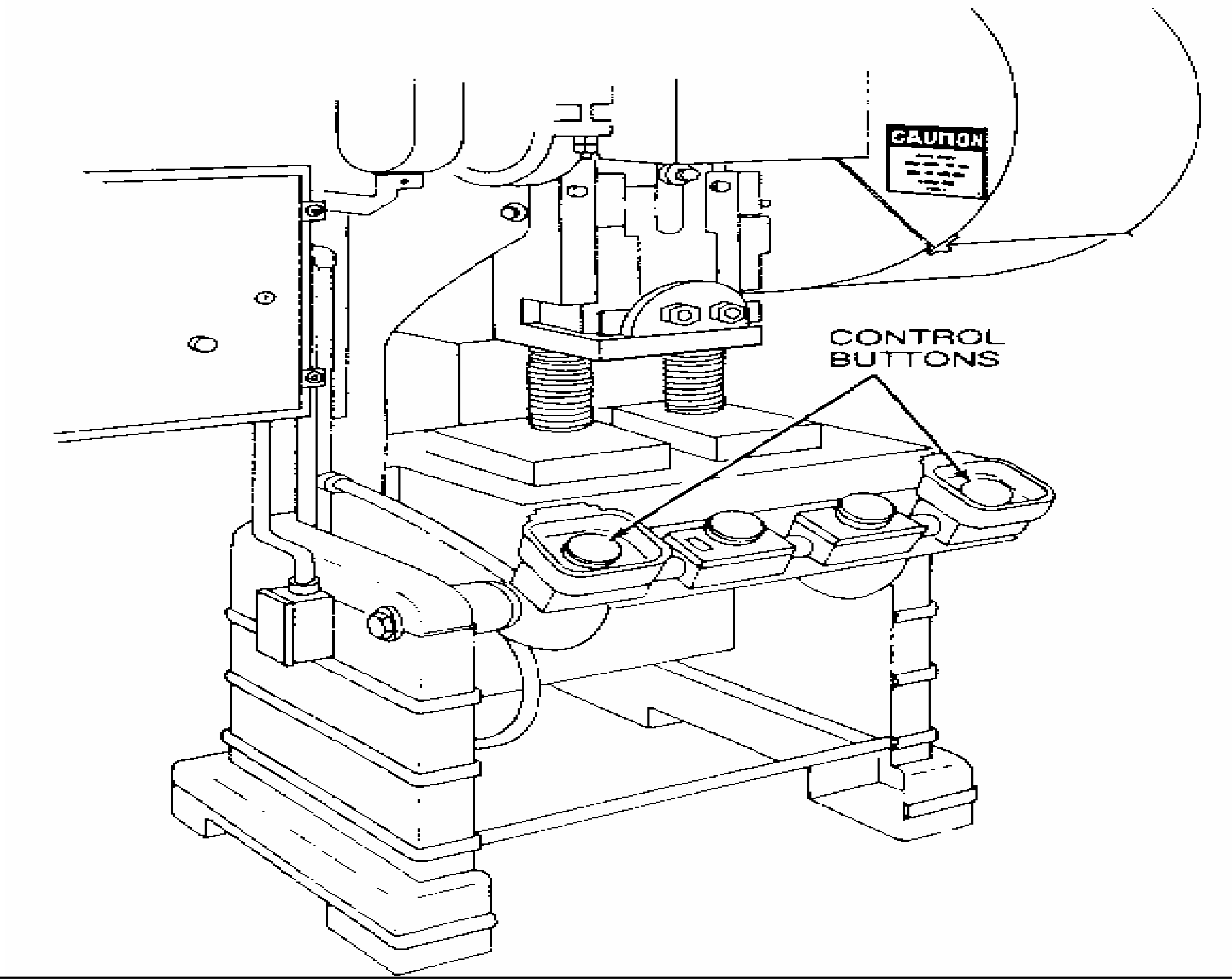
- **Safety Controls**
  - **(a) Pressure-sensitive body bar**
  - **(b) Safety tripwire cable**
- **Two-hand control**
- **Two-hand trip**



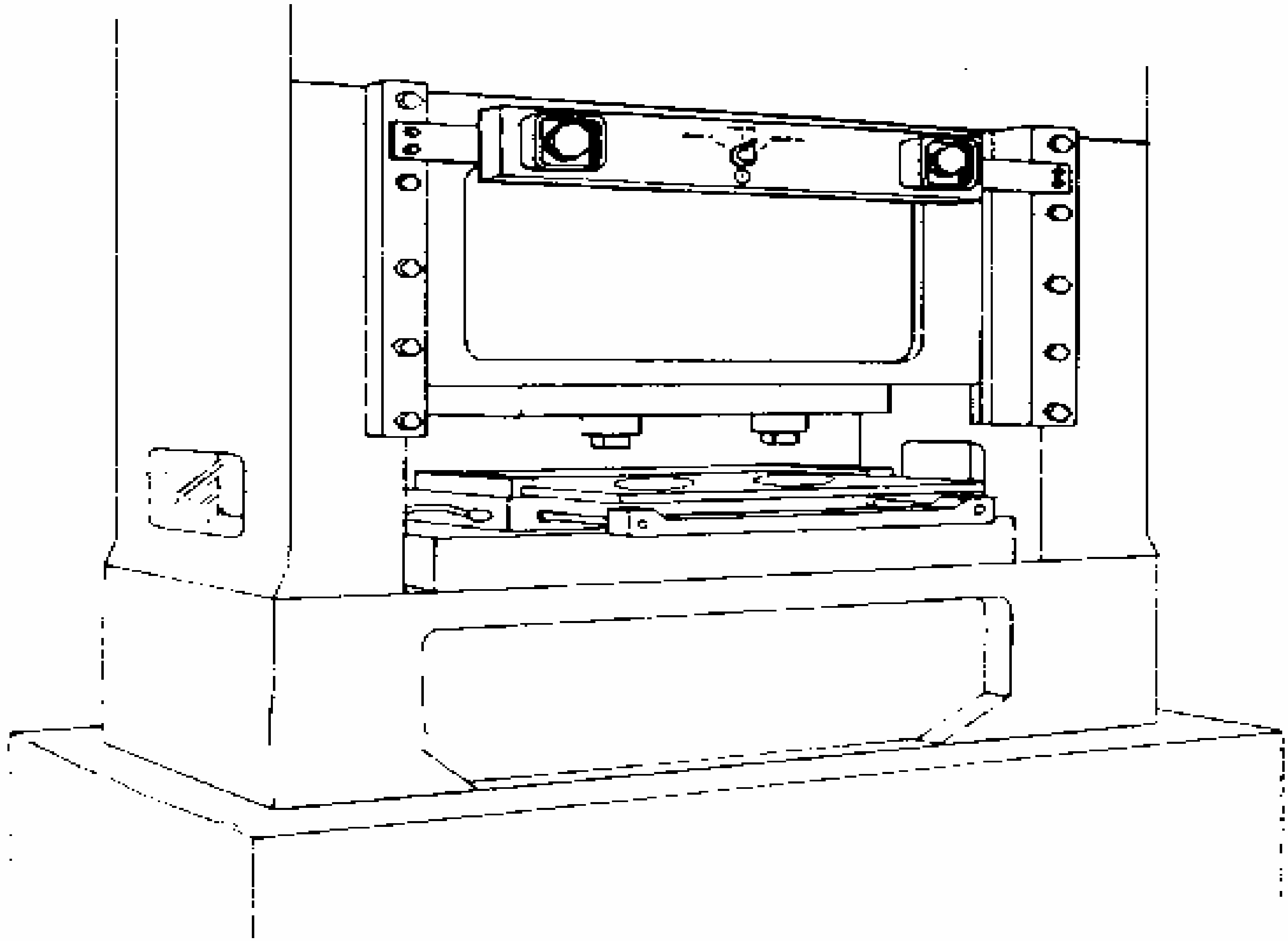
Pressure-Sensitive Body Bar On Rubber Mill



Safety Tripwire Cable On A Calendar



Two-Hand Control Buttons On A Part-Revolution Clutch Power Press

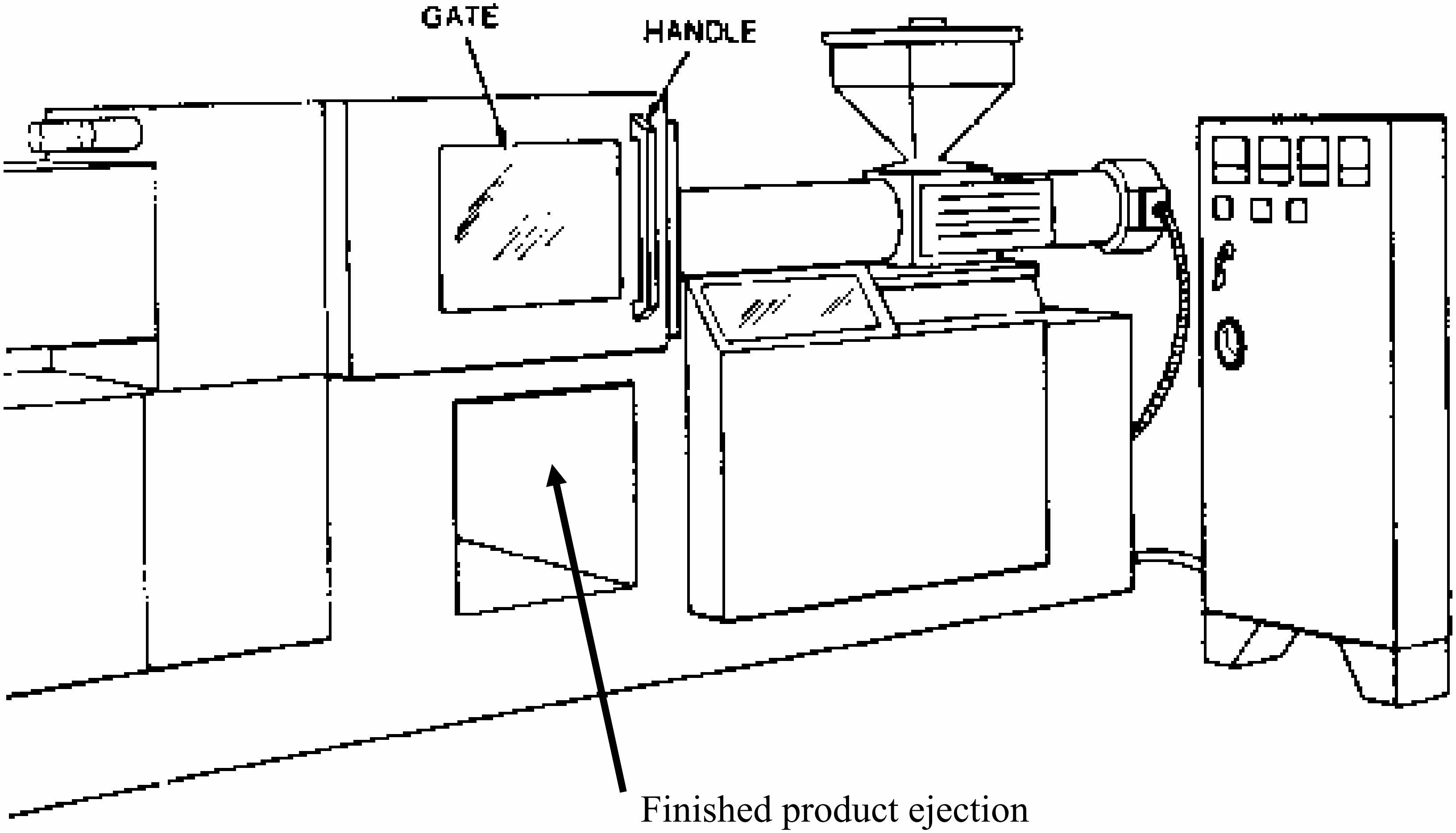


Two-Hand Trip Buttons On A Full-Revolution Clutch Power Press

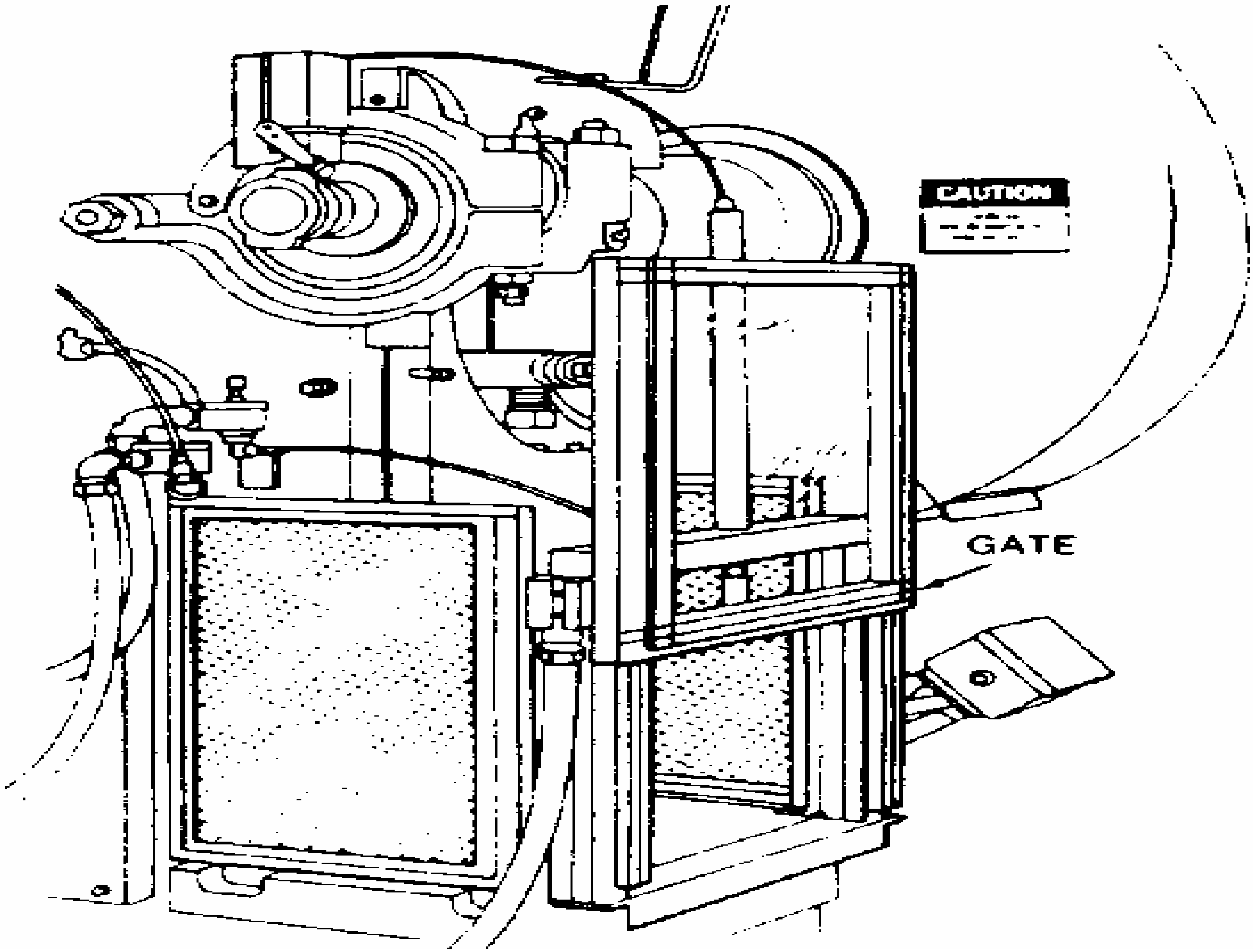
Devices

- **Gates**

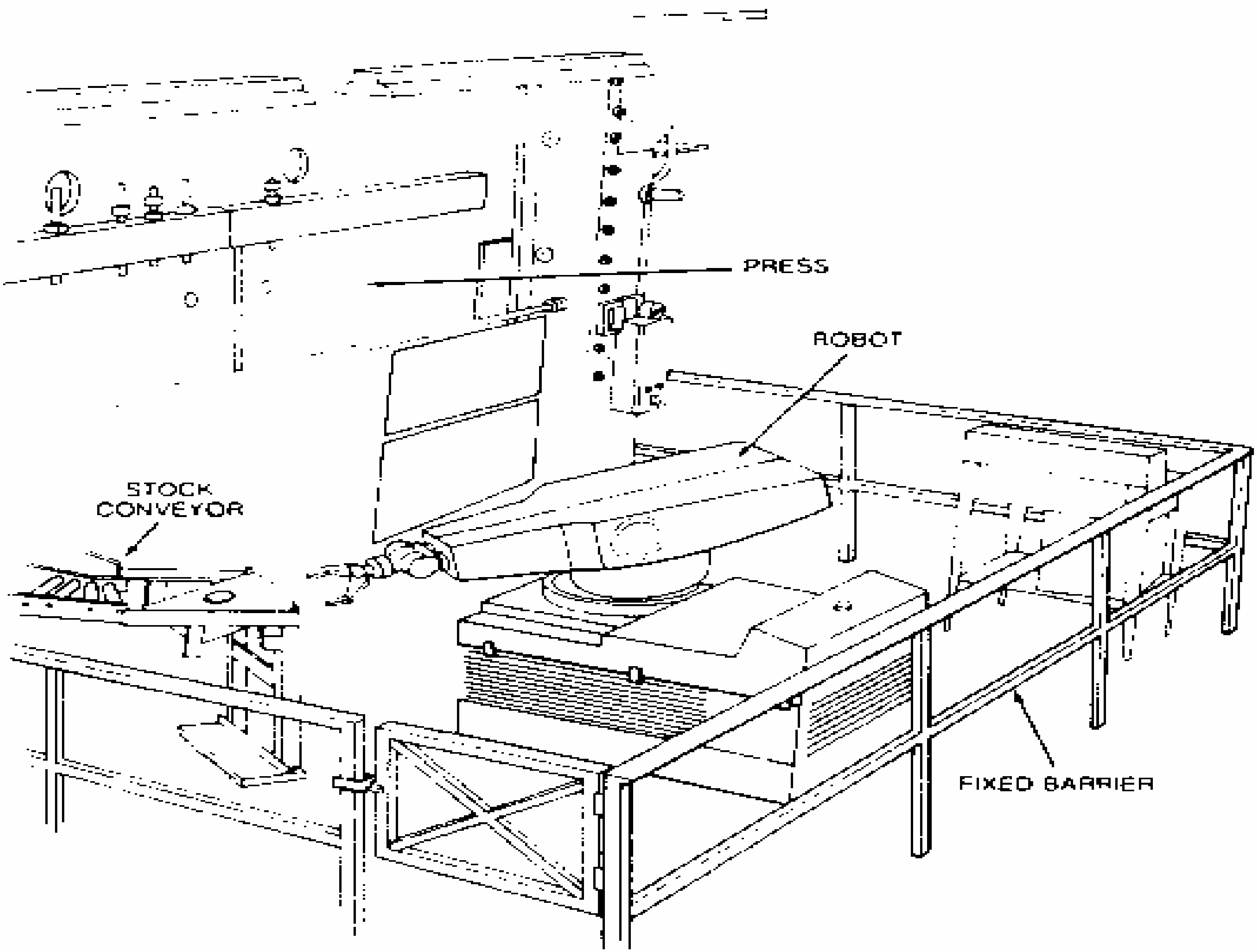
- **Location/Distance**



Horizontal Injection Molding Machine
With Gate Guards

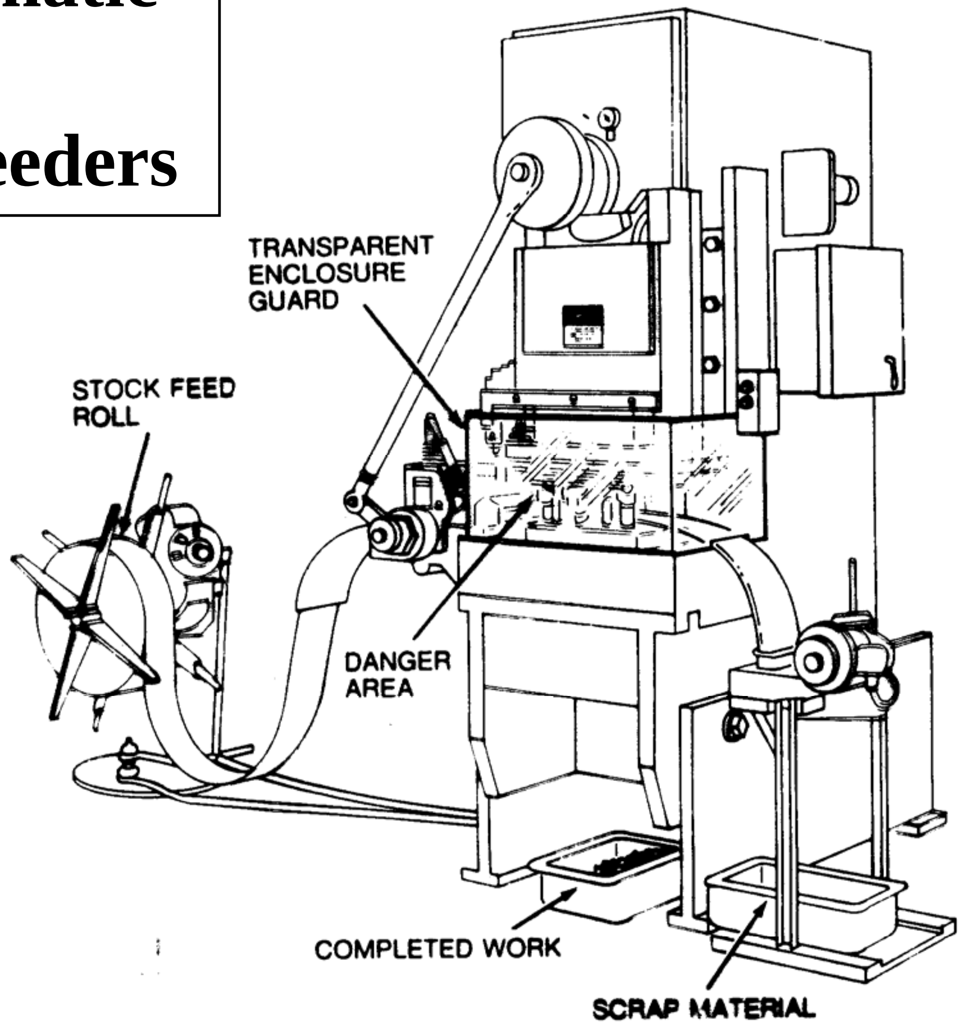


Power Press With Gate Guards



Robot With Fixed Barrier Guards

Power Press With Automatic Feed Guarding feeders



Instructor Notes

Thank you for your interest in teaching the basics of machine guarding to your employees and for promoting self-sufficiency on behalf of the Division of Safety & Hygiene.

A few points to keep in mind while teaching this class to your employees.

Try to do everything you can to get your students “involved” with the information that you will be presenting. This means using actual work place examples wherever possible. Try to use your own machines, your own checklists, your own machine specific hazards, and certainly refer to your company specific procedures when at all possible.

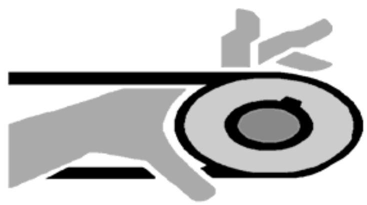
If possible, incorporate some exercises into your training. These exercises might be as simple as small groups reviewing a specific inspection checklist or as involved as having people actually evaluating the guards on a particular piece of equipment. You might even have each person present a review of an operational procedure. The key is to get your class involved so that they are not just listening to you lecture.

Encourage questions and repeat questions for clarity to be sure that everyone has heard and understood. Even if you know the answer, a good technique is to ask the class if anyone can answer the question. On questions where you’re not sure of the answer or there is disagreement within the class, tell the class that you’ll check on it during a break or as soon after the class as possible. Follow-up and make sure everyone gets the information.

Remember, your goal is to teach your employees to be safe and to provide accurate information about machine guarding and about your specific guards on your specific equipment.

Subpart O MACHINE GUARDING

- **1910.211 Definitions**
- **1910.212 General Requirements for all Machines.**
- **1910.213 Woodworking Machinery**



These are the standards covered in Subpart O of the OSHA Machine Guarding standards. There are specific standards like 1910.213 that deal with woodworking machinery but many machines are not specifically mentioned in their own standard. For these machines the requirements of 1910.212 are applicable. American National Standards Institute (ANSI) standards may also give specifics to guarding requirements that are not mentioned in the OSHA standards.

Subpart O

- **1910.215 Abrasive Wheel Machinery**
- **1910.216 Mills and Calendars**
- **1910.217 Mechanical Power Presses**
- **1910.218 Forging Machinery**
- **1910.219 Mechanical Power-Transmission**

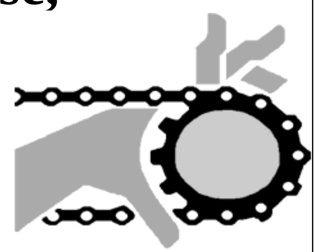
Basics of Machine Safeguarding

- **A good rule to remember is: Any machine part , function, or process which may cause injury must be safeguarded.**
- **And a guard should not allow someone to reach over, under, around or through.**

A guard should not allow a person to reach over, under, around, or through.

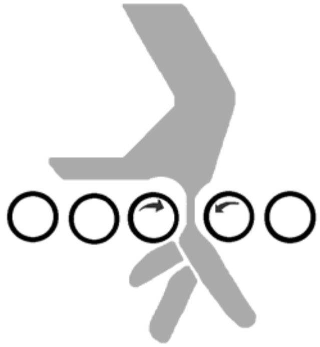
Basics Areas of Safeguarding

- The point of operation
- Power transmission apparatus
- Other moving parts (reciprocating, transverse, or rotating)

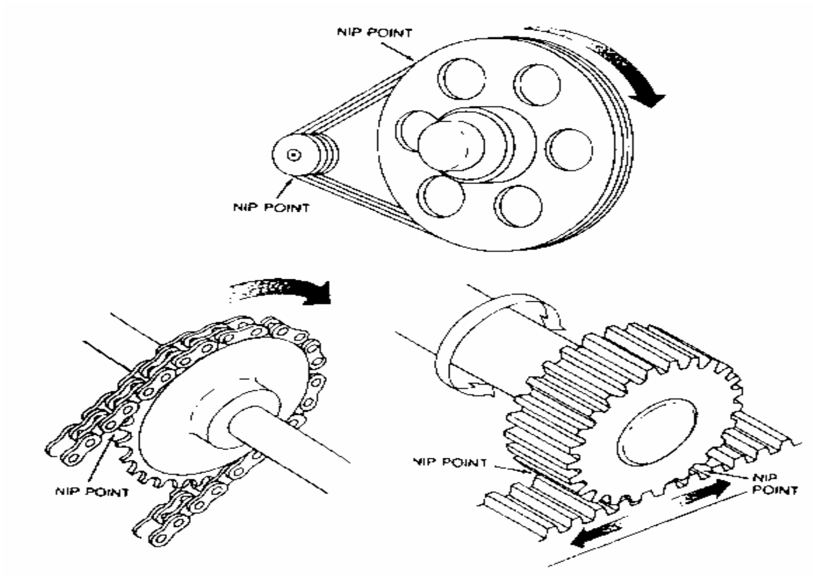


Each of these areas will be emphasized from a guarding standpoint and we'll look at some examples.

Motions

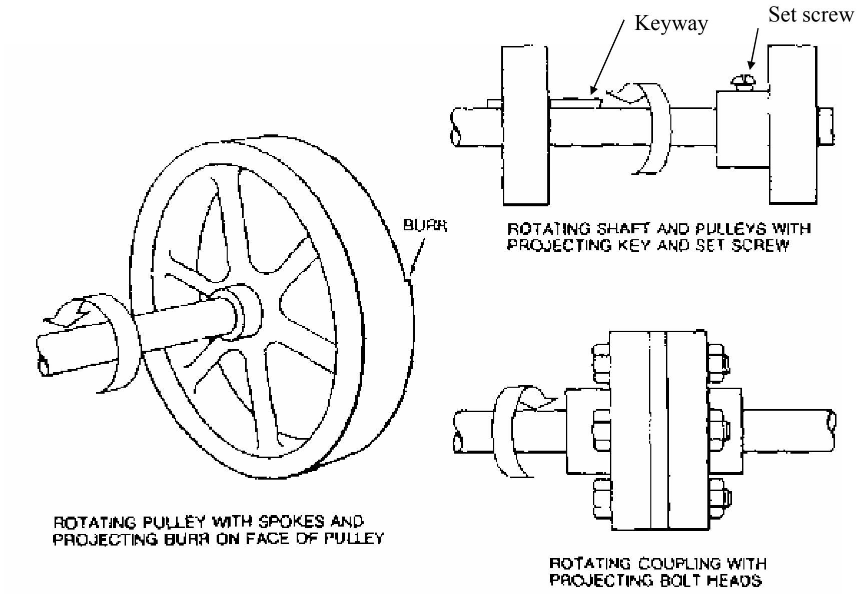


- **Motions**
  1) **Rotating (including in-running nip points)**
  2) **Reciprocating**
  3) **Transverse**



Nip Points

Emphasize the location of the nip points.



Rotating Hazards

Any rotating spokes where someone can get caught in them or that have burrs on them need to be guarded. When you have key ways or set screws or couplings, they must be guarded as well to prevent someone being caught up in them. Rotating shafts that could allow clothing or hair to be caught in them must be guarded as well.

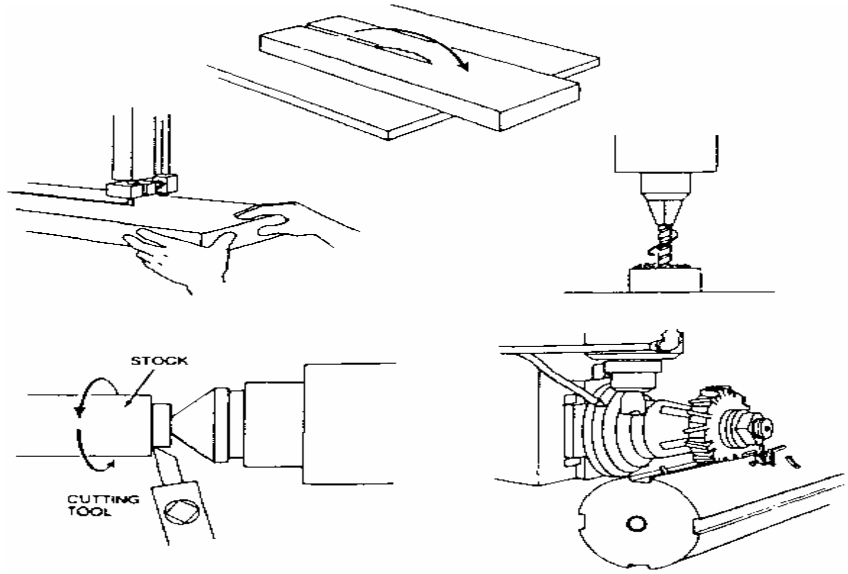
Safeguarding

- Guards--- Prevents access to the danger areas.
- Devices---Controls access to the Point of Operation.

Actions

- Cutting
- Punching
- Shearing
- Bending

The next slide will show pictures of some of these actions that need to be guarded.



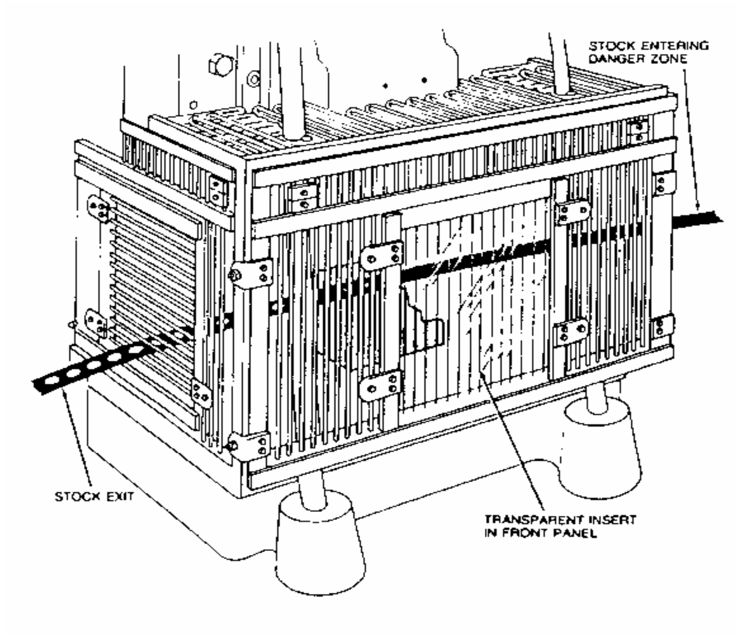
Different Actions

From lower left clockwise: cutter on a lathe, cutting on a bandsaw, cutting on a table saw, drilling with a drill press, and, machining on a mill.

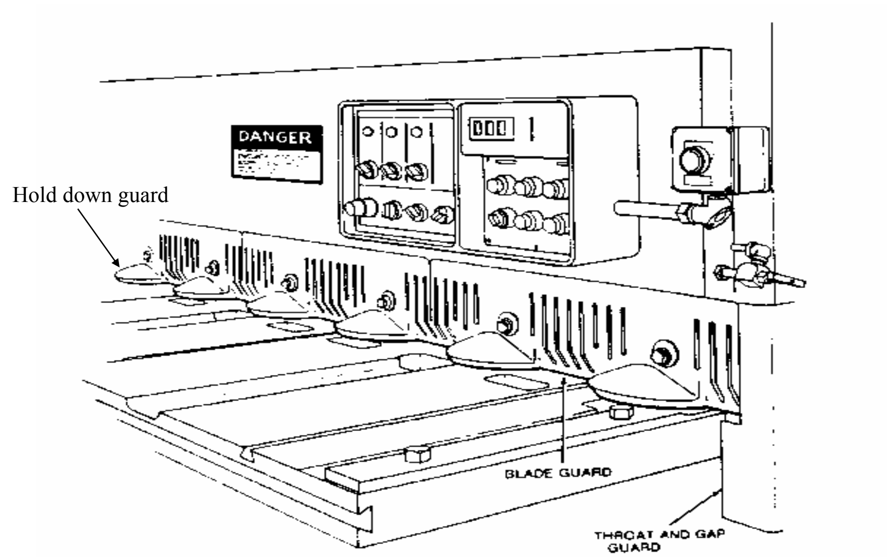
Guards

- **Fixed**
- **Interlocked**
- **Adjustable**
- **Self-adjusting**

The following slides will show examples of each of these types of guards.

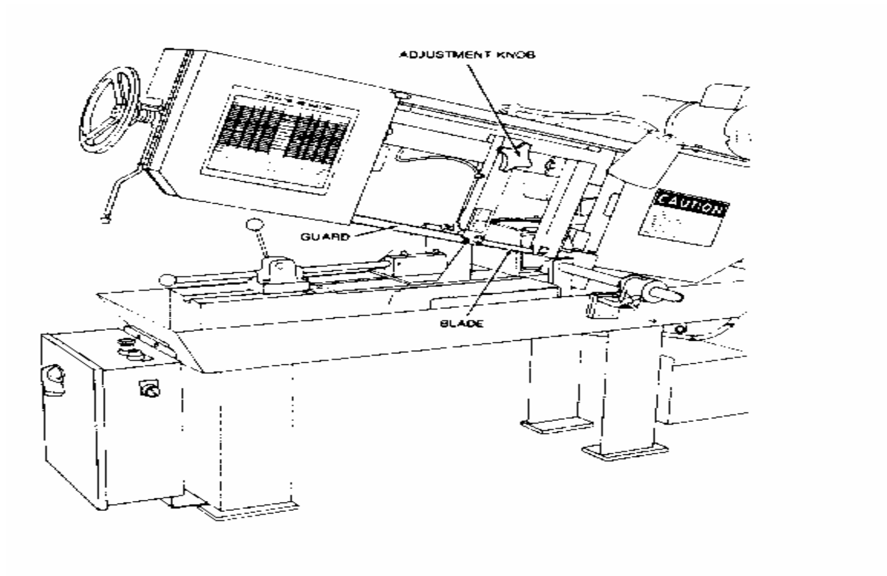


Fixed Guard On A Power Press



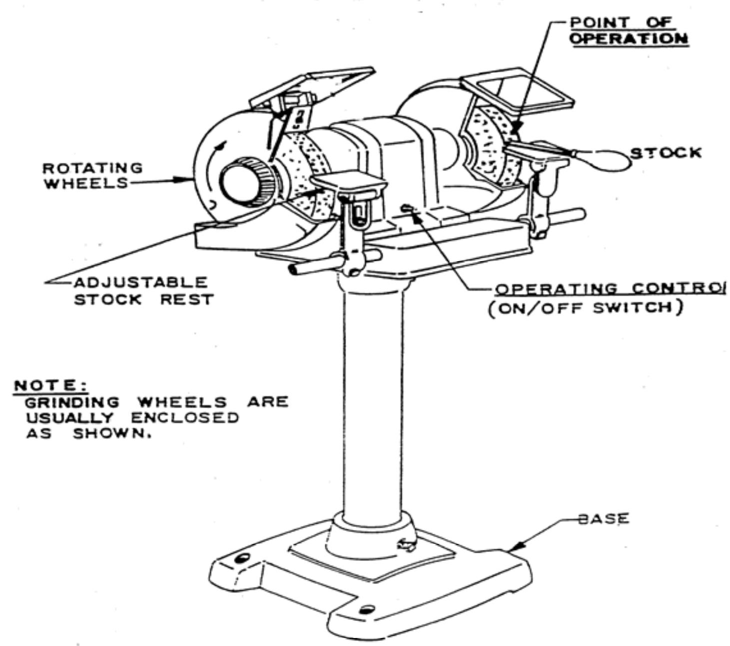
Fixed Guard on a Power Squaring Shear

Not only does the cutting edge have to be guarded but the hold down devices should be guarded as well.



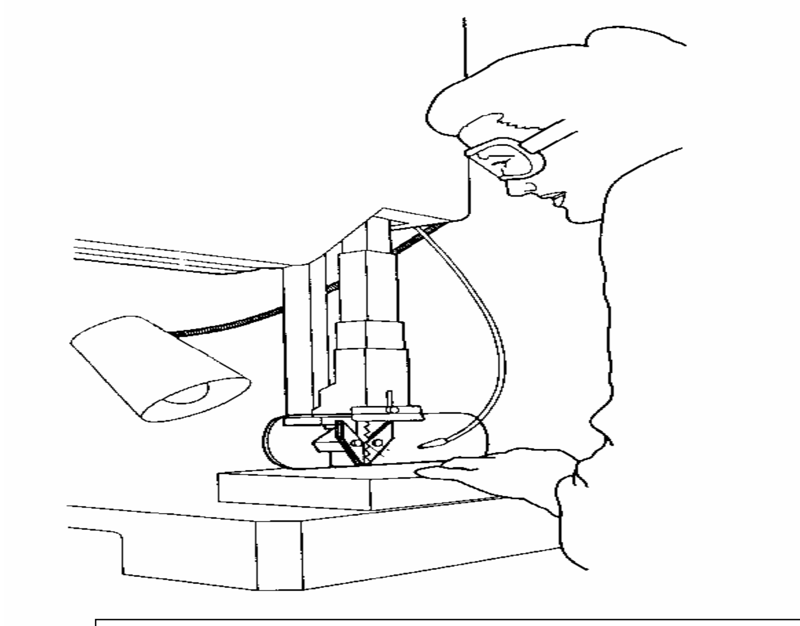
Adjustable Guard On Horizontal Bandsaw

The exposed portion of the blade should only be large enough for the material being cut.

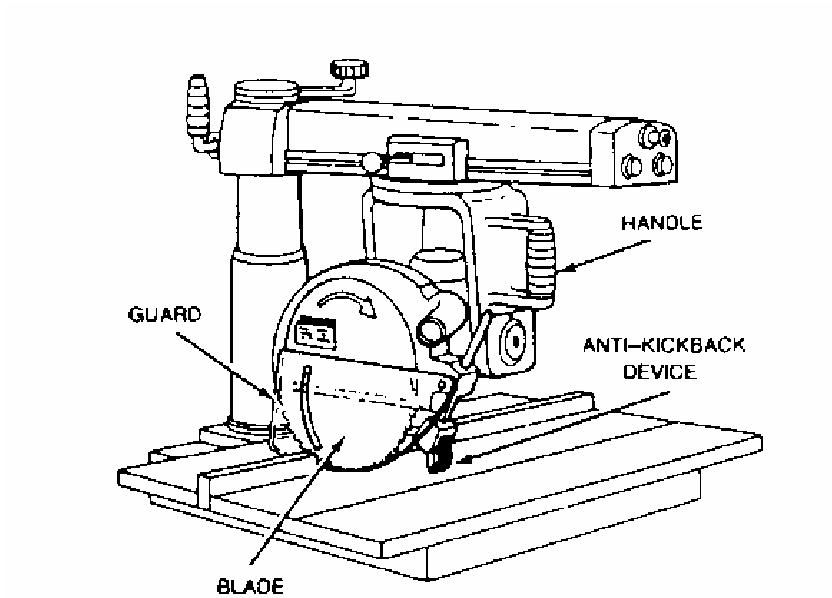


Adjustable Guard On Pedestal Grinder

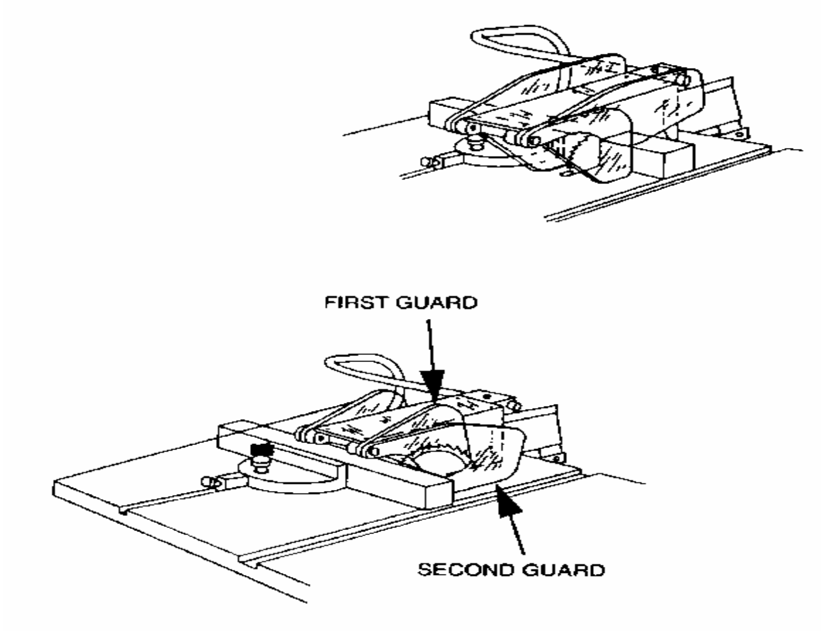
Work rests should be adjusted to one eighth inch from the wheel. Peripheral or tongue guards should be adjusted to one quarter of an inch from the wheel. These guards are to prevent material or the wheel from flying out at the operator in the event the wheel would fracture. The spindle nut guard is a fixed guard that must be in place as well. Pedestal grinders as well as all fixed machinery must be mounted to the floor.



Adjustable Guard On Bandsaw



Self-Adjusting Guard On Radial Arm Saw

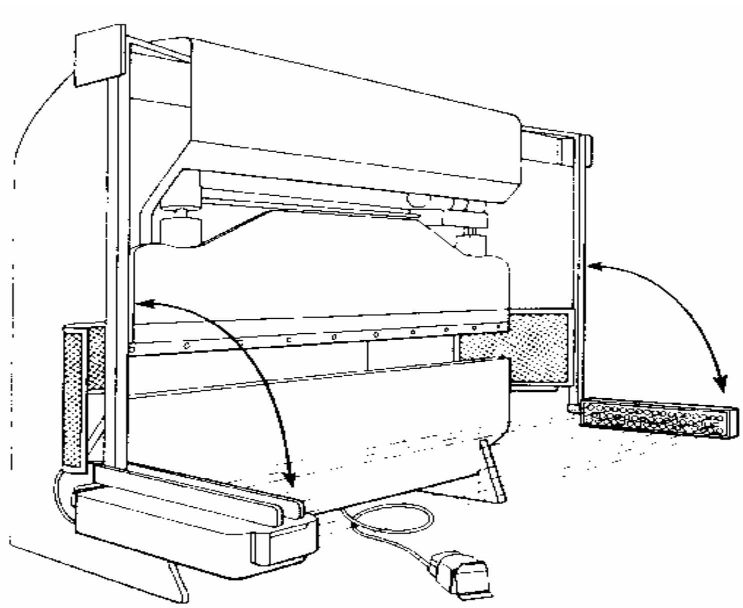


Self-Adjusting Guard Table Saw

Devices

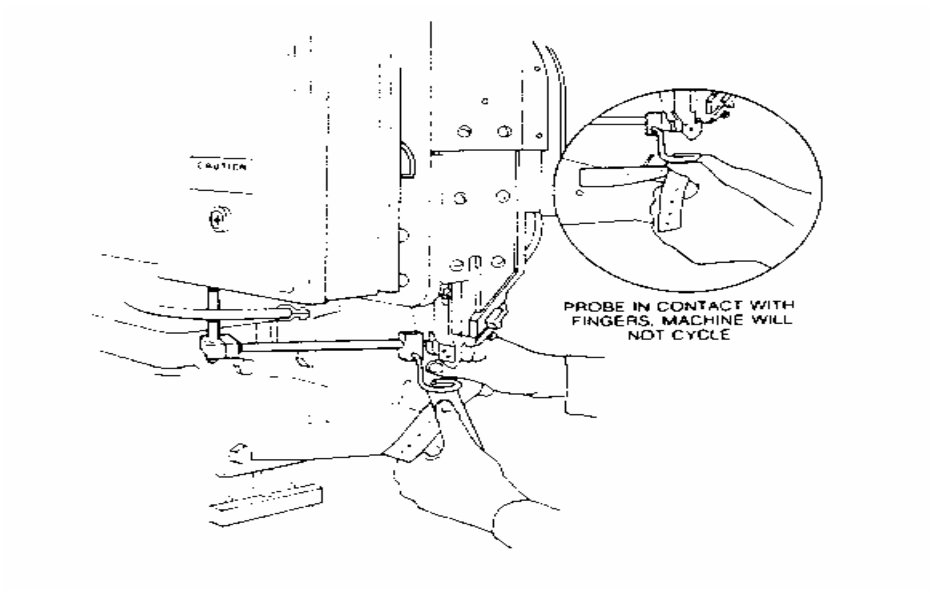
- **Presence Sensing**
  1) **Photo-electrical**
  2) **Electromechanical**
- **Pullback**
- **Restraint**

Devices are used in lieu of guards.



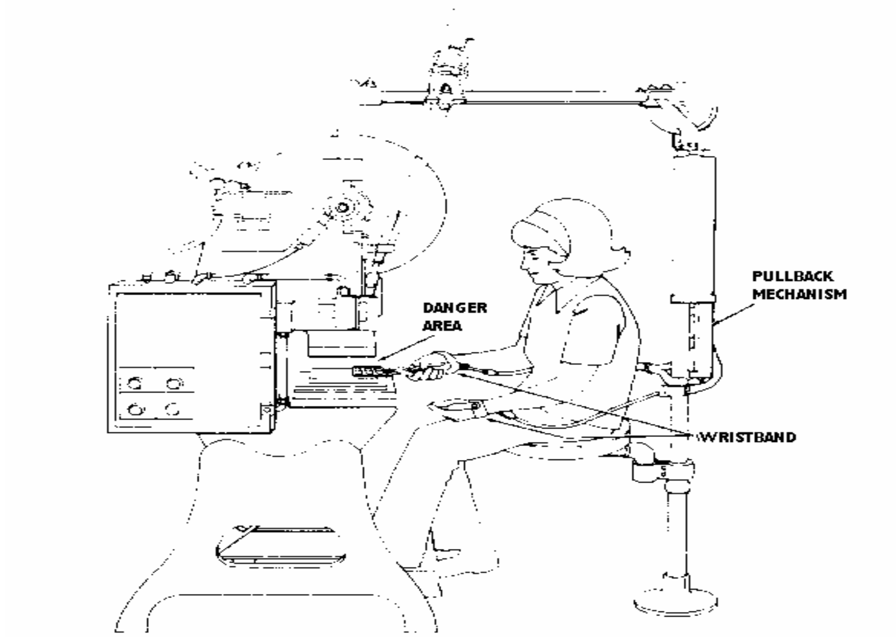
Photoelectric Presence Sensing Device On Press Brake

Photoelectric presence sensing devise, commonly called light curtain, prevent someone reaching into the point of operation by the use of light beams. If someone breaks the beams, the machine stops or will not operate. This shows that the light curtains can be set at horizontal or vertical depending on the material size being fed to the machine.



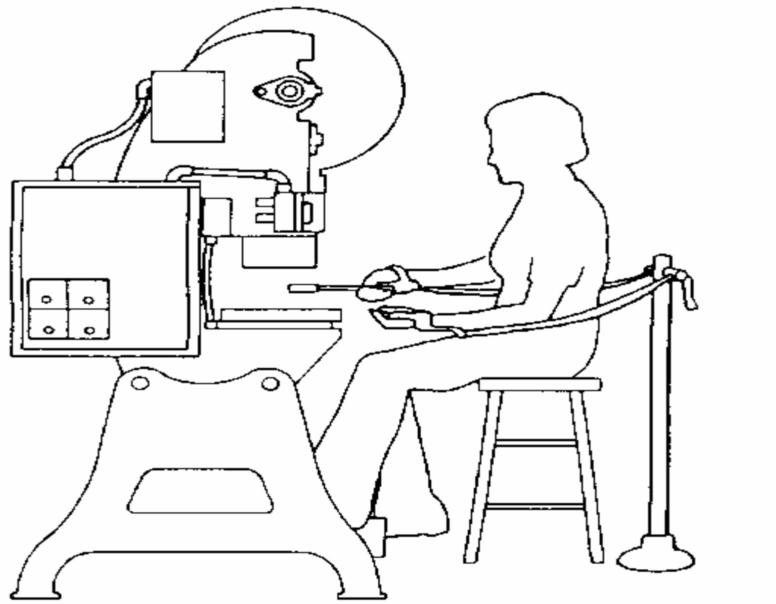
Electromechanical Sensing Device On An Eye-letter

This type of device is used on eye-letters, punches, riveters, and fastening machines. The sensing device that surrounds the point of operation, if touched during operation, will stop the function being performed.



Pullback Device On A Power Press

Pullback devices are commonly used on power presses and press brakes, but may be used to limit access to any point of operation. Pullbacks are connected directly to the flywheel or ram so that as the equipment cycles, the pullback device pulls the hands away from the point of operation.

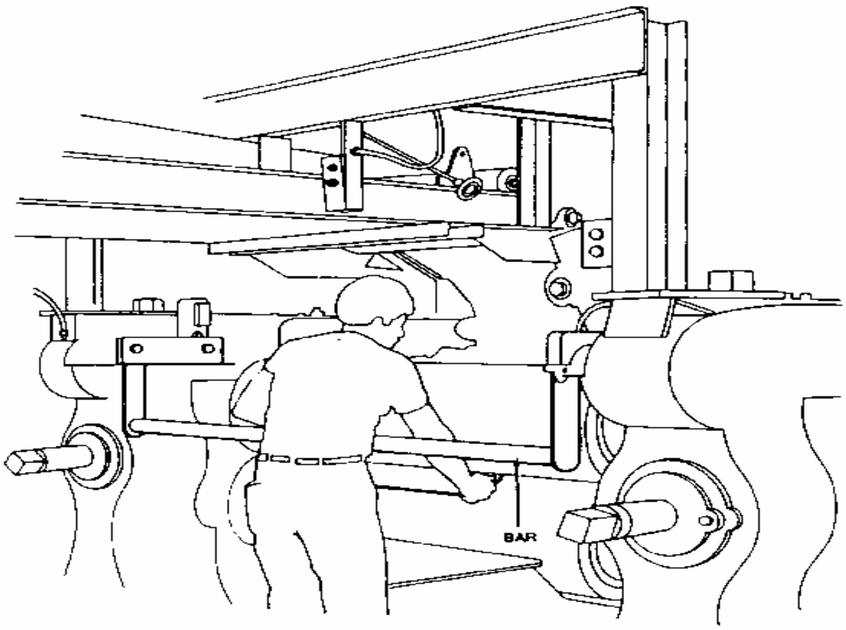


Restraint Device On A Power Press

This device limits the operator from ever reaching into the point of operation. This device as well as the pullbacks require continuous monitoring and supervision. Each time the equipment is set up or operators change, the pullbacks or restraints must be re-adjusted to ensure that the operator cannot reach the point of operation. Documentation of these adjustments should be kept for each machine.

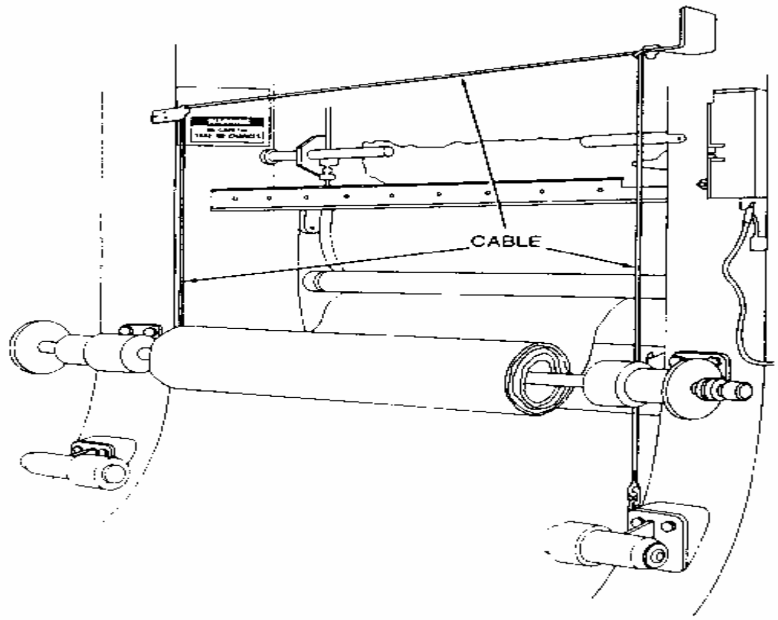
Devices

- **Safety Controls**
  - **(a) Pressure-sensitive body bar**
  - **(b) Safety tripwire cable**
- **Two-hand control**
- **Two-hand trip**



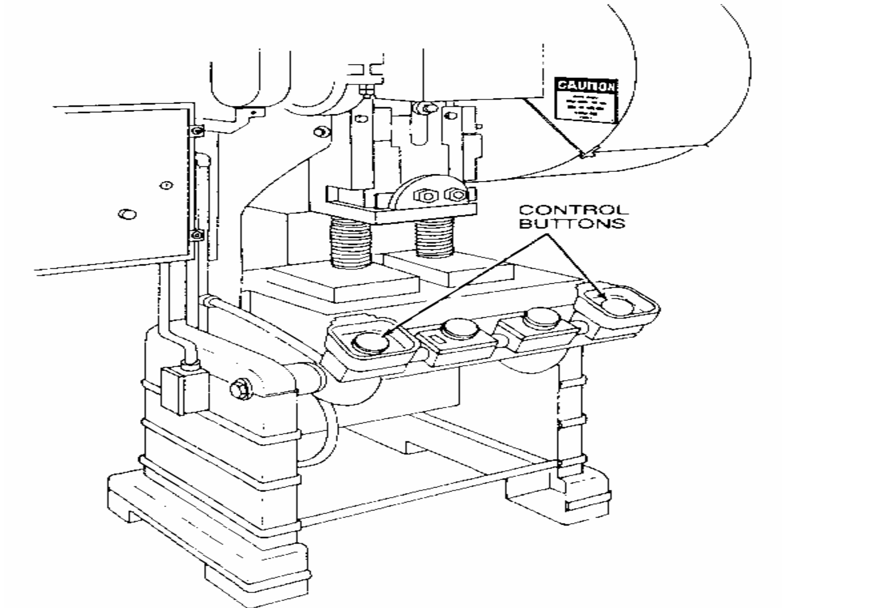
Pressure-Sensitive Body Bar On Rubber Mill

Pressure-Sensitive body bars are used particularly in the rubber industry but may be used where large materials must be fed into a point of operation. There is typically no way of guarding this type of operation. A pressure-sensitive bar, when hit, will stop the machine or in some cases reverse the direction of the machine.



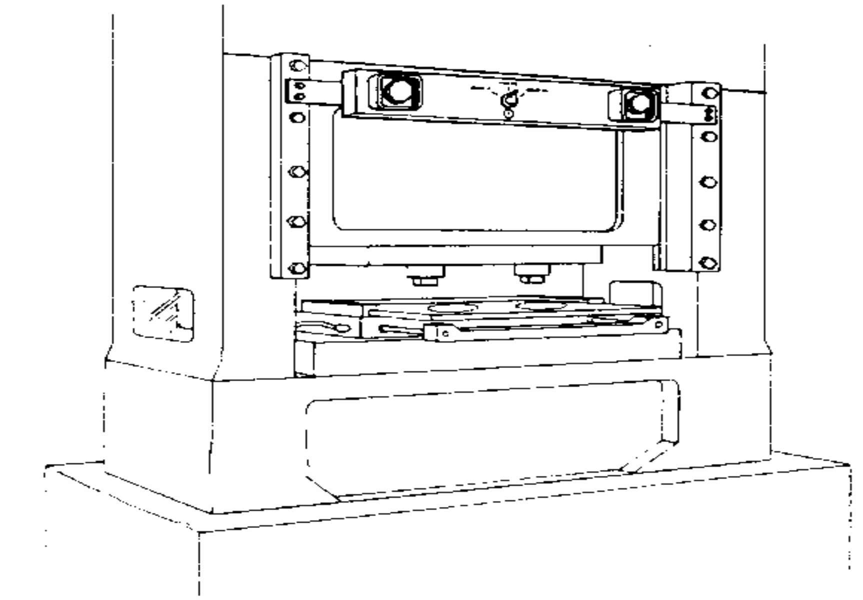
Safety Tripwire Cable On A Calendar

This device is meant to provide emergency stopping of equipment by pulling the cable. Stop cables are commonly used on conveyor systems where it is not feasible to guard the entire conveyor.



Two-Hand Control Buttons On A Part-Revolution Clutch Power Press

Two-hand controls differ from two-hand trips based on engaging points that the press may be stopped at. Two-hand controls can also be used on other equipment such as hydraulic presses. Two-hand controls allow the operator to stop functions at multiple points whereas two-hand trips, once activated, will continue through the full cycle. Two-hand controls will also have emergency stop buttons located between them.



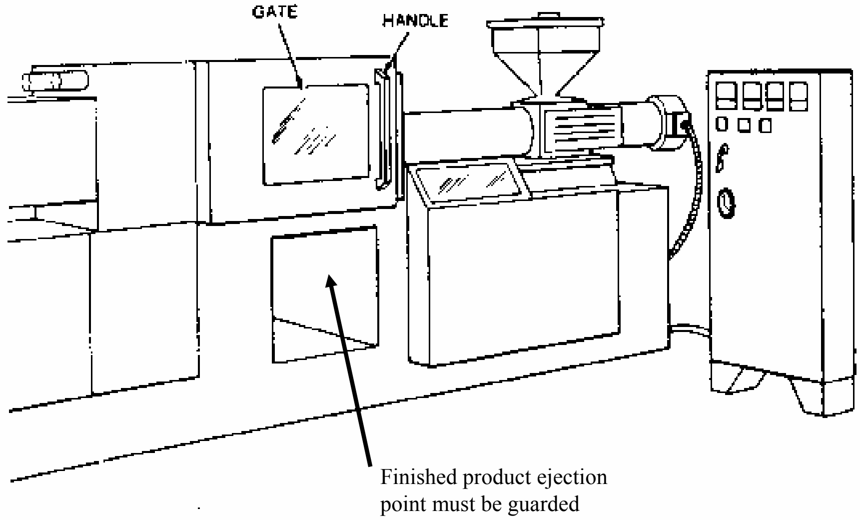
**Two-Hand Trip Buttons On A
Full-Revolution Clutch Power Press**

Two-hand trips do not have emergency stops because once the cycle is started you cannot stop it until it reaches the top of the stroke.

Devices

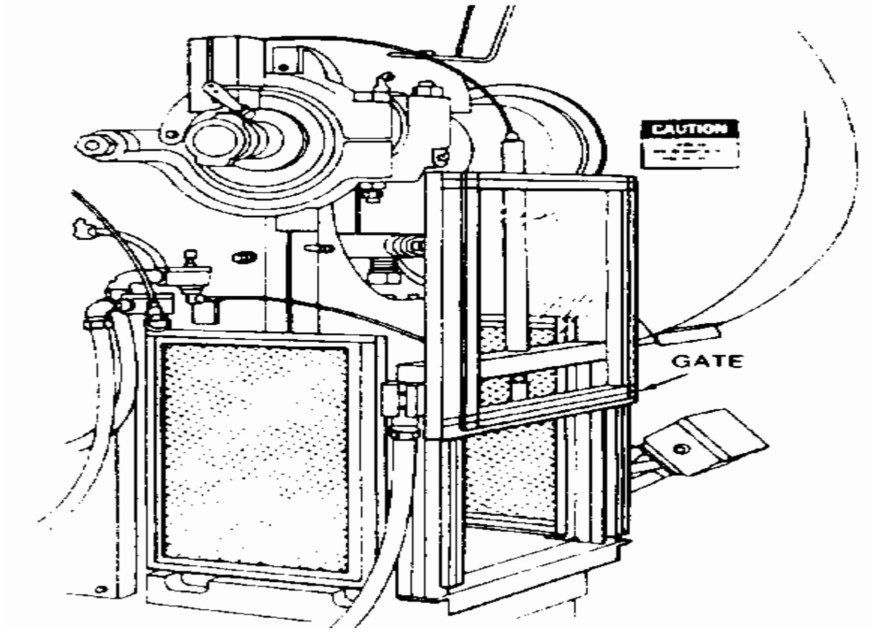
- **Gates**

- **Location/Distance**



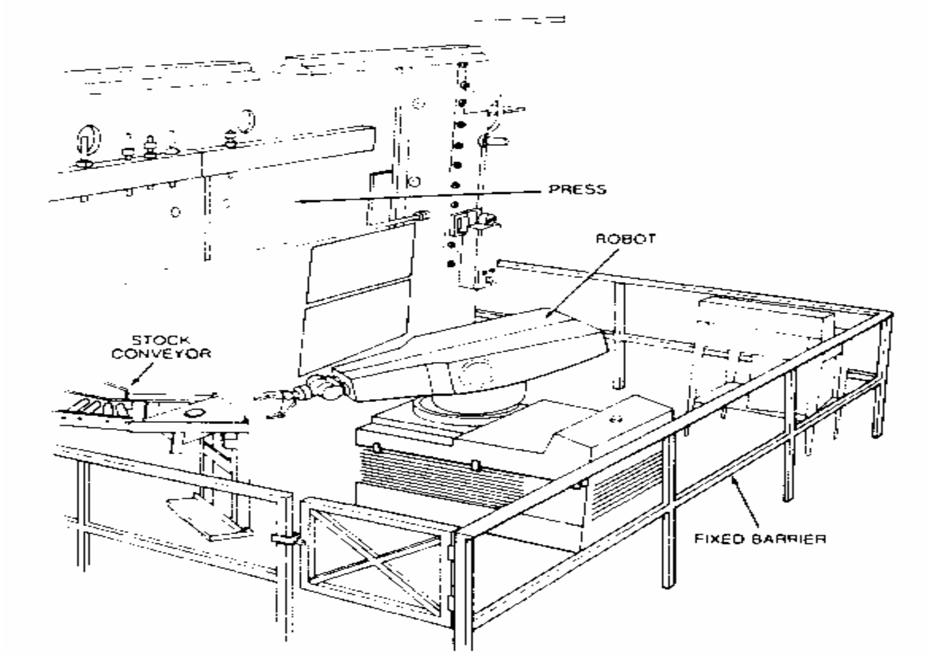
**Horizontal Injection Molding Machine
With Gate Guards**

This shows an example of a gate guard that has been interlocked. If the door were to be opened, the machine would stop based on the interlock switch located behind the door. On molding machines you must also insure that the ejection points are guarded. Many parts on these machines fall out below the die and you must insure that the operator cannot reach up into the die through that opening.



Power Press With Gate Guards

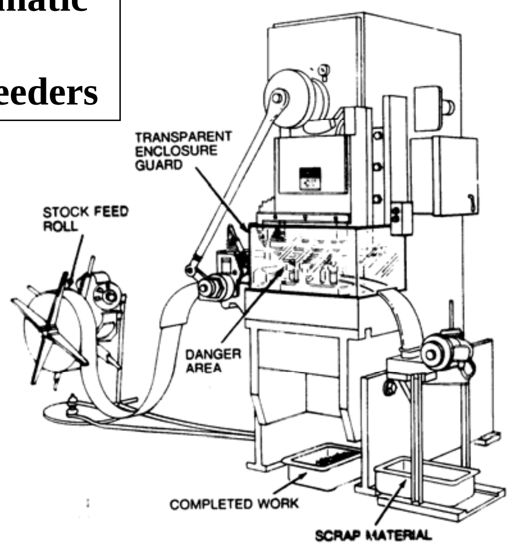
There are two types of gate guards for power presses, Type A and Type B. Type A, when the machine is activated, the gate guard will come down, the die will close and then open. When the die opens the gate guard will then come up. Type B functions the same except when the die opens, the gate guard opens. The concern with Type B is if the press malfunctions and cycles a second time, the point of operation is not guarded. So most people that use gate guards use a Type A.



Robot With Fixed Barrier Guards

In this case, the guard rail is acting as the barrier but is not necessarily a good method. Many employers will use pressure sensitive mats inside the guard rail area to insure that no one is in that area while the machine is operating. They may also interlock gates to stop operations of the machines when the gates are opened.

Power Press With Automatic Feed Guarding feeders



Although this press has the point of operation guarded adequately, there is a need to insure that the feeders and scrap handlers are properly guarded as well. The arm for the feeder must be guarded as well as the raw stock on the spool. The same would hold true for the scrap handler. Any point of operation for these devices that presents nip points or pinch points must be guarded.

Student Handouts

Machine Guarding

Subpart O MACHINE GUARDING

- 1910.211 Definitions
- 1910.212 General Requirements for all Machines.
- 1910.213 Woodworking Machinery

Subpart O

- 1910.215 Abrasive Wheel Machinery
- 1910.216 Mills and Calendars
- 1910.217 Mechanical Power Presses
- 1910.218 Forging Machinery
- 1910.219 Mechanical Power-Transmission

Basics of Machine Safeguarding

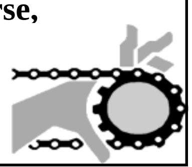
- A good rule to remember is: Any machine part , function, or process which may cause injury must be safeguarded.
- And a guard should not allow someone to reach over, under, around or through.

Mike Marr
Safety Consultant

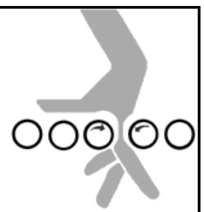
Machine Guarding

Basics Areas of Safeguarding

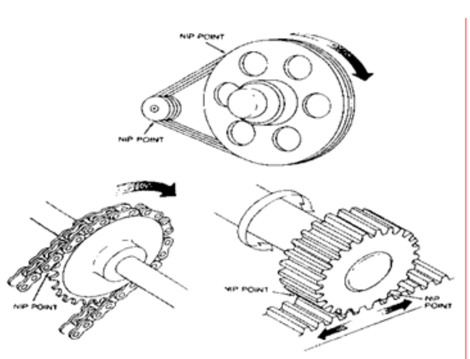
- The point of operation
- Power transmission apparatus
- Other moving parts (reciprocating, transverse, or rotating)



Motions



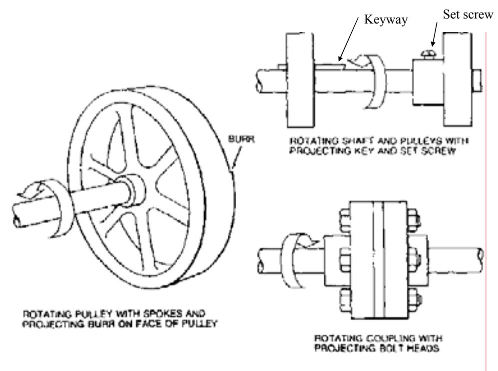
- Motions
  1) Rotating (including in-running nip points)
  2) Reciprocating
  3) Transverse



Nip Points

Mike Marr
Safety Consultant

Machine Guarding



Rotating Hazards

Safeguarding

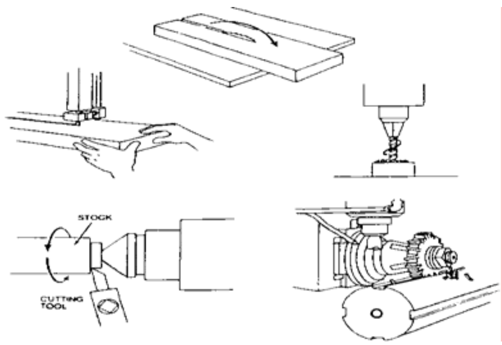
- **Guards--- Prevents access to the danger areas.**
- **Devices---Controls access to the Point of Operation.**

Actions

- **Cutting**
- **Punching**
- **Shearing**
- **Bending**

Mike Marr
Safety Consultant

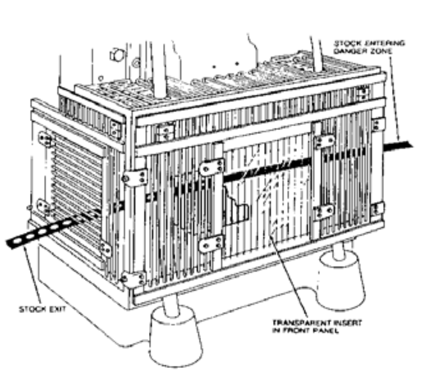
Machine Guarding



Different Actions

Guards

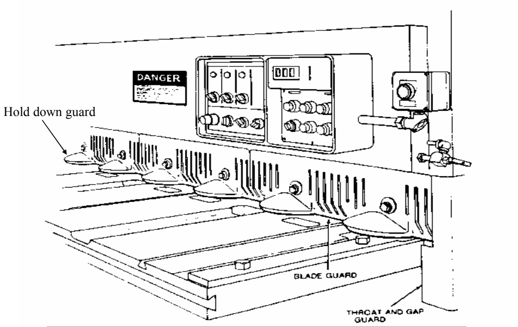
- Fixed
- Interlocked
- Adjustable
- Self-adjusting



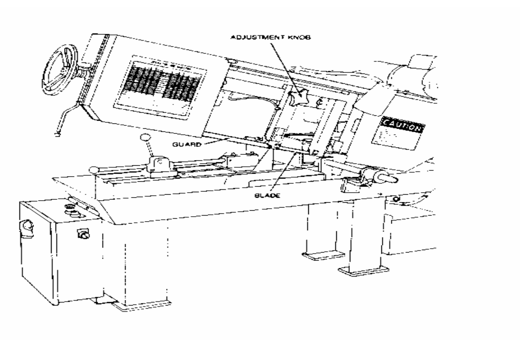
Fixed Guard On A Power Press

Mike Marr
Safety Consultant

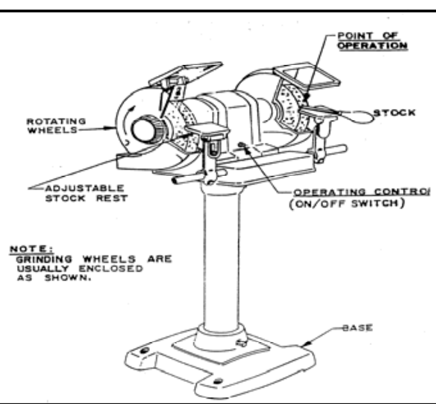
Machine Guarding



Fixed Guard on a Power Squaring Shear



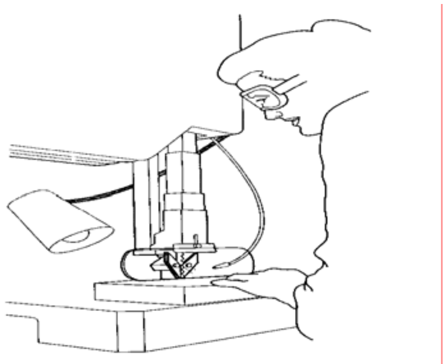
Adjustable Guard On Horizontal Bandsaw



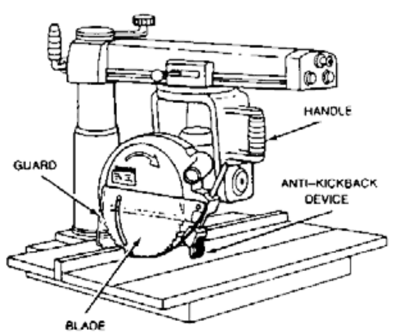
Adjustable Guard On Pedestal Grinder

Mike Marr
Safety Consultant

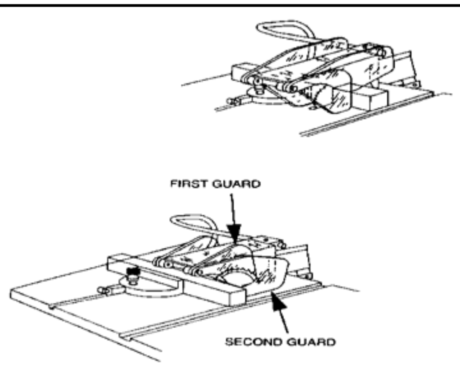
Machine Guarding



Adjustable Guard On Bandsaw



Self-Adjusting Guard On Radial Arm Saw



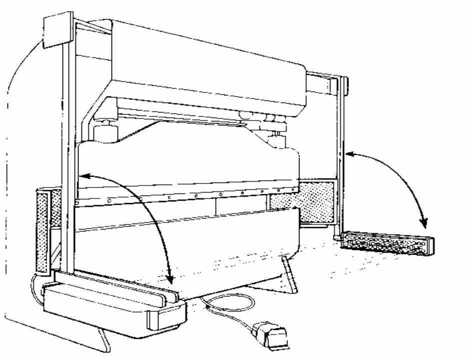
Self-Adjusting Guard Table Saw

Mike Marr
Safety Consultant

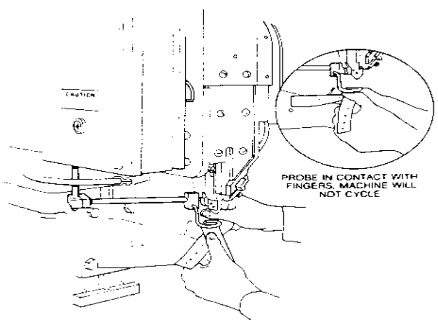
Machine Guarding

Devices

- **Presence Sensing**
  1) **Photo-electrical**
  2) **Electromechanical**
- **Pullback**
- **Restraint**



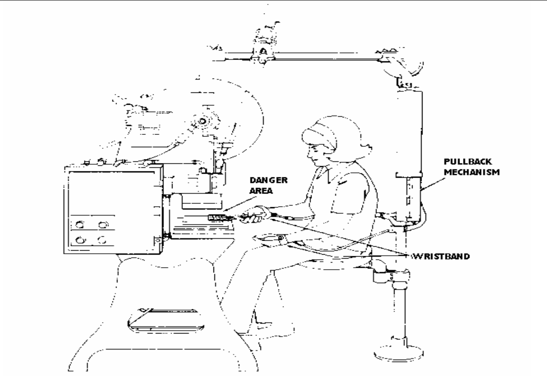
Photoelectric Presence Sensing Device On Press Brake



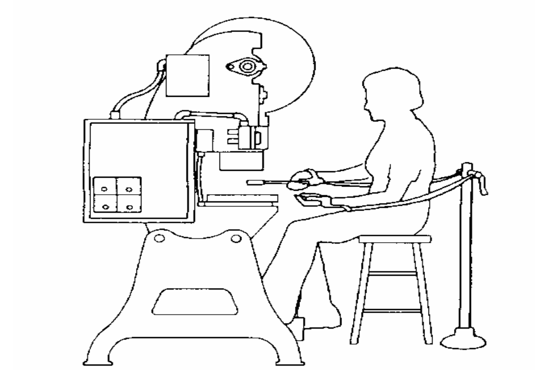
Electromechanical Sensing Device On An Eye-letter

Mike Marr
Safety Consultant

Machine Guarding



Pullback Device On A Power Press



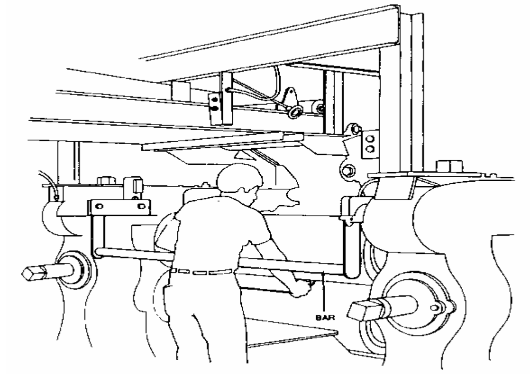
Restraint Device On A Power Press

Devices

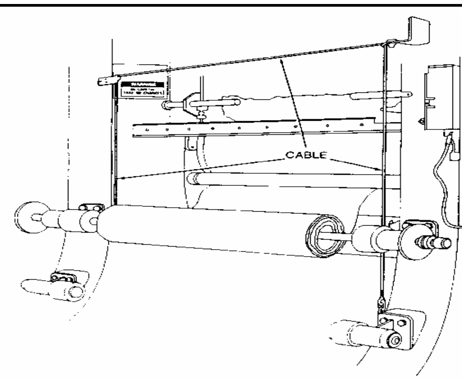
- Safety Controls
  - (a) Pressure-sensitive body bar
  - (b) Safety tripwire cable
- Two-hand control
- Two-hand trip

Mike Marr
Safety Consultant

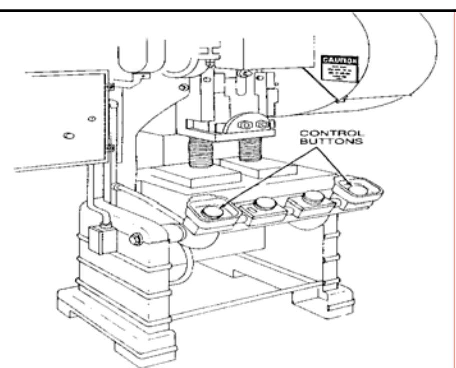
Machine Guarding



Pressure-Sensitive Body Bar On Rubber Mill



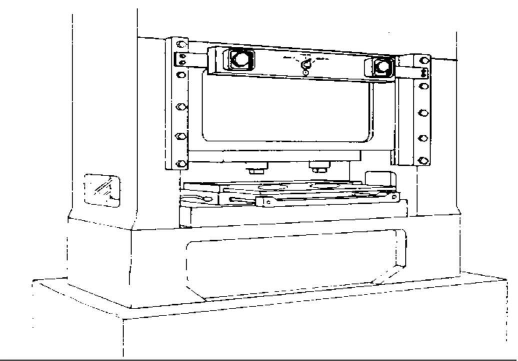
Safety Tripwire Cable On A Calendar



Two-Hand Control Buttons On A Part-Revolution Clutch Power Press

Mike Marr
Safety Consultant

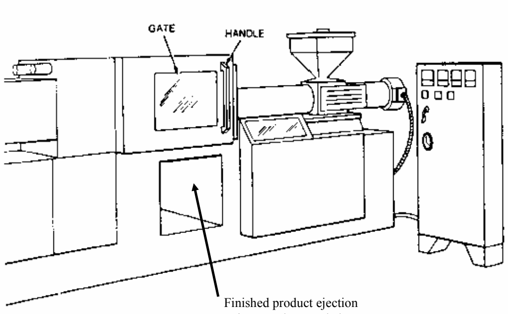
Machine Guarding



Two-Hand Trip Buttons On A Full-Revolution Clutch Power Press

Devices

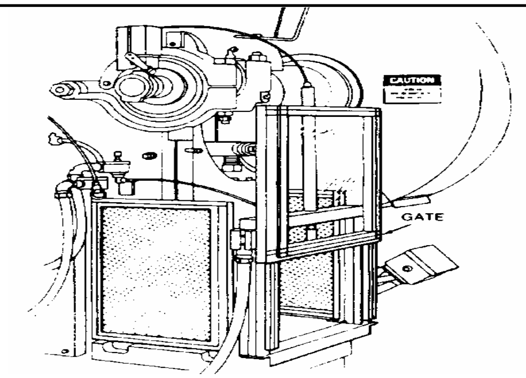
- **Gates**
- **Location/Distance**



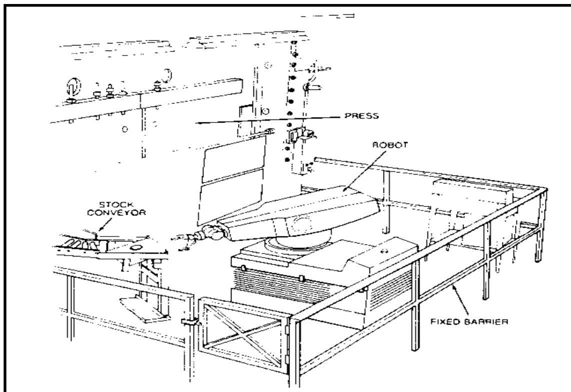
Horizontal Injection Molding Machine With Gate Guards

Mike Marr
Safety Consultant

Machine Guarding

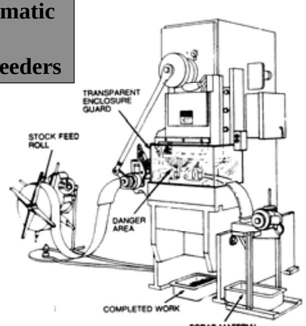


Power Press With Gate Guards



Robot With Fixed Barrier Guards

Power Press
With Automatic
Feed
Guarding feeders



Mike Marr
Safety Consultant

Machines and Machine Guarding
Self-Audit Checklist

Building ______________________________ Room __________ Supervisor ______________________ Date _________

Audit Performed by _____________________________

	Y	N	NA	COMMENTS
A. General Requirements for Machines and Machine Guarding				
1. Guards prevent worker's hands, arms, or other body parts from making contact with moving parts				
2. Guards firmly secured and not easily removable				
3. Guards permit safe, comfortable, and relatively easy operation of the machine				
4. Machine controls within easy reach of the operator				
5. Procedures established to ensure machine is shut down before guard is removed				
B. Guarding of Mechanical Hazards				
1. Point-of-operation guards provided and in place				
2. Gears, sprockets, pulleys, and flywheels guarded				
3. Belts and chain drives guarded				
4. Exposed set screws, key ways, collars, and the like guarded				
5. Guards provide for any other hazardous moving part of the machine				

Key to Machine Guarding Checklist

A. General Requirements for Machines and Machine Guarding

1. Guards should be designed to prevent contact with any machine part, function, or process that could cause an injury.

2. Guards should be made of durable material that will withstand the conditions of normal use and should not be able to be easily removed or tampered with.

3. Machine guard design should allow normal operations to occur without creating any additional hazards.

4. Self explanatory

5. If possible, machine design should allow for routine lubrication and adjustment without removal of safeguards. When safeguards must be removed, safe procedures must be developed to insure that the machine has been shut down. A lockout/tagout program may be necessary.

B. Guarding of Machine Hazards

1. Point-of-operation is the point where work is performed on the material, such as cutting, shaping, boring, or forming of stock. Point-of-operation guarding is complicated by the number and complexity of machines and by the different uses of individual machines. Additional information and assistance is available through EHS.

2. Rotating parts (even smooth, slowly rotating shafts) can grip clothing or, through mere skin contact, force a hand or arm into a dangerous position. Guard should be designed to allow no contact with rotating parts. Additional information and assistance is available through EHS.

3. Belts and chain drives create in-running nip point hazards where the belt or chain contacts the pulley or sprocket. Guards should be designed to allow no contact. Contact EHS for additional information or assistance.

4. The normal hazards associated with rotating parts increase with projections such as set screws, key ways, etc., and must be guarded to prevent contact. Contact EHS for additional information or assistance.

5. Reciprocating and transverse motions of machine parts are examples of other hazards which require guarding. Contact EHS for additional information or assistance.

	Y	N	NA	COMMENTS
C. Evaluation of Non-mechanical Hazards				
1. Noise measurements taken, where necessary				
2. Substances used in machine operations evaluated				
3. Electrical cords or connectors in good repair				
4. Personal protective equipment available, where necessary				
5. Operator dressed safely for the job				
D. Training				
1. Workers trained in the recognition of machine hazards and the importance of using safeguards				
2. Lockout/tagout training provide, where necessary				
3. Electrical Safety-Related Workpractices training provided, where necessary				
4. Personal protective equipment training provided, where necessary				

Key to Machine Guarding Checklist

C. Evaluation of Nonmechanical Hazards

1. Some machines are capable of producing noise levels which require hearing protection. Contact EHS for additional information or assistance in measuring machine noise levels.

2. Cutting fluids, coolants, and any other substance used in machine operations should be evaluated before use. The substance's Material Safety Data Sheet (MSDS), container label, or other product information can be helpful in determining if additional precautions will be necessary

3. Replace frayed, exposed, or deteriorated wiring.

4. A hazard evaluation of the tasks that machine operators perform will help in determining if personal protective equipment is necessary. Sample hazard evaluation forms are available through EHS.

5. Loose-fitting clothing and jewelry should not be worn by machine operators. Long hair can also become entangled in rotating parts.

D. Training

1. General training is available through EHS.

2. Training is required for all workers authorized to apply lockout/tagout devices. Training is also required for workers who are affected by the lockout/tagout activities of authorized workers. General training is available through EHS.

3. Workers who are exposed to energized electrical circuits operating at 50 volts or more must receive training based upon their assigned tasks and level of expertise. General training is available through EHS.

4. Workers must receive adequate training on Personal Protective Equipment selection and use. Documentation of the training must be maintained. Sample forms and general training are available through EHS.