

American National Standard

**Safety Specifications for Mills and
Calenders in the Rubber Industry**



**American National Standards Institute
11 West 42nd Street
New York, New York
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**American National Standard
Safety Specifications for Mills and
Calenders in the Rubber Industry**



**Secretariat
Rubber Manufacturers Association**

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American National Standard

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Foreword (This foreword is not part of American National Standard B28.1-2017)

This standard is intended to present minimum criteria necessary for the safety of workers at the point of operation. It is not intended to represent the best conditions obtainable by modern engineering practices.

The project on Safety Code for Mills and Calenders in the Rubber Industry was initiated in 1924 by the Rubber Section of the National Safety Council. The sponsors were the National Safety Council and the International Association of Industrial Accident Boards and Commissions. The code prepared by that committee was approved in March 1927 as a Recommended American Practice by the American Engineering Standards Committee. The code was printed by the United States Department of Labor, Bureau of Labor Statistics, and was circulated as Bulletin No. 447.

In 1940 a new committee was formed under the same sponsorship to revise the code under the procedure of the American Standards Association, Incorporated (now the American National Standards Institute). The war forced this work to wait until 1946 when the Chairman, Mr. Ernest W. Beck, appointed a subcommittee to begin work on the revision. In 1948 the International Association of Industrial Accident Boards and Commissions resigned from all safety code activities and the National Safety Council was designated sole sponsor. In June 1949 the code was approved by its sponsor. The code was later reaffirmed in 1959, revised in 1967, and reaffirmed in 1972.

Following reaffirmation in 1972, no further action was taken on the standard. As a result, in 1982 the B28.1 standard was administratively withdrawn by ANSI as is their practice when no action is taken on a standard in a 10-year period.

Despite the fact that the standard was withdrawn, the standard continued to be extensively used by those in the rubber and plastics industry. The guidelines contained in the standard were having a positive effect with respect to accident prevention within the affected industries.

In late 1993 the Rubber Manufacturers Association's (RMA) Occupational Safety and Health Committee led by chairman Robert B. Walker, along with the other committee members from the RMA, agreed to sponsor and reactivate B28.1. According to ANSI guidelines, this would have to be done as if it were a new standard. Since the new standard process had to be undertaken, the committee decided for the sake of continuous improvement to make minor revisions to the prior standard which would include additional guarding techniques for consideration that could further assist in the prevention of mill and calender accidents.

In February 1995, RMA had to recanvass due to comments received, which revised the scope to the rubber industry only. The contents of the standard did not change - only the title had changed. Unfortunately, the ANSI Standards Board denied the approval of the standard on the basis of canvass list balance. Subsequently, the approval process started over again in January 1998. This effort led to final approval by ANSI BSR in 2000. In March 2017, RMA and ANSI reaffirmed the ANSI B28.1 standard.

This standard was developed using the Canvass method.

Suggestions for improvement of this standard are welcome. They should be sent to the Rubber Manufacturers Association, Attn: Jesse Levine, 1400 K Street, NW, Suite 900, Washington, DC 20005.

American National Standard Safety Specifications for Mills and Calenders in the Rubber Industry

1 Scope and Purpose

1.1 Scope

This standard covers the safety guarding of mills and calenders in the rubber industry at the point of operation. Such items of installation and maintenance as are necessary for safe operation are also included.

1.2 Purpose

This standard is intended to provide for the safety of life, limb, and property.

1.3 Exceptions

Exceptions to the literal requirements may be granted by the authority having jurisdiction, provided that equal protection is evident.

1.4 Exclusions

Laboratory equipment varies so much from manufacturing equipment in size, speed, and height that it is specifically excluded from the detail requirements of this standard, but equivalent protection must be provided by alternative means.

2 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI/AIHA Z9.2-2007, Fundamentals Governing the Design and Operation of Local Exhaust Systems¹⁾

ANSI/ASME B15.1-1996, Safety Standard for Mechanical Power Press Transmission Apparatus 1)

ANSI/IESNA RP-7-01, Lighting Industrial Facilities¹⁾

NFPA 70-2008, National Electrical Code 1)

3 Definitions

3.1 bite: The nip point between any two in-running rolls.

3.2 calender: A machine equipped with two or more metal rolls revolving in opposite directions and used for continuously sheeting or plying up rubber compounds and for frictioning or coating materials with rubber compounds.

¹⁾ For electronic copies of some standards, visit ANSI's Electronic Standards Store (ESS) at www.ansi.org. For printed versions of all these standards, contact Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, (800) 854-7179.

3.3 mill: 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 compounds.

3.4 shall: The word shall is to be understood as mandatory.

3.5 should: The word should is to be understood as advisory.

4 Requirements

4.1 New Installations

After the date upon which this standard becomes effective, all new installations shall conform to it.

4.2 Existing Installations

All existing plant installations or equipment prior to the effective date of this standard should be brought into compliance with the requirements, to the extent that may be practicable and justifiable. However, upon major modification or relocation of existing installations or equipment, they shall be brought into compliance with the requirements of this standard.

4.3 Auxiliary Equipment

Mechanical and electrical equipment and auxiliaries shall be installed in accordance with applicable standards (see Clause 2).

4.4 Mill Roll Heights

Mill installations shall be installed so that the top of the operating rolls is at least 50 inches (127 cm) 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.

5 Mill Safety Controls

5.1 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:

5.1.1 Pressure-Sensitive Body Bars

Installed at front and back of each mill approximately 40 inches (102 cm) vertically above the working level and 20 inches (50.8 cm) horizontally from the crown face of the roll. (See figure A.8.) These bars shall operate readily by pressure of the mill operator's body. Pressure-sensitive body bars should be installed on new equipment.

5.1.2 Safety Trip Rod

Installed in the front and in the back of each mill and located within 2 inches (5.08 cm) of a vertical plane tangent to the front and rear rolls. The top rods shall not be more than 72 inches (182.88 cm) above the level on which the operator stands. The trip rods shall be accessible and shall operate readily whether the rods are pushed or pulled.

5.1.3 Safety Trip Wire Cable or Wire Center Cord

Installed in the front and in the back of each mill and located within 2 inches (5.08 cm) of a vertical plane tangent to the front and rear rolls. The cables shall not be more than 72 inches (182.88 cm) above the

level on which the operator stands. The trip wire cable or wire center cord shall operate readily whether cable or cord is pushed or pulled.

5.2 Fixed Guards

A fixed bar across the front and one across the back of the mill approximately 40 inches (102 cm) vertically above the working level and 20 inches (50.8 cm) horizontally from the crown face of the roll should be used. A safety trip method as described under 5.1 shall be used with a fixed bar.

5.3 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.

6 Calender Safety Controls

6.1 Safety Trip Control

A safety trip control shall be provided in front and back of each calender. 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:

6.1.1 Safety Trip Rod, Cable, or Wire Center Cord

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. In addition, on both sides of the calender and near each end of the face of the roll, a cable or wire center cord connected to the safety trip. These lines should be not more than 12 inches (30.48 cm) from the faces of the respective rolls and not less than 2 inches (5.08 cm) from the calender frame. They should be anchored to the frame not more than 6 inches (15.24 cm) from the floor or operator's platform. They shall operate readily when pushed or pulled.

6.1.2 Pressure-Sensitive Body Bar

Installed approximately 40 inches (102 cm) vertically above the working level and 34 inches (86.36 cm) horizontally from the in-running nip point. The bar shall operate readily by pressure of the mill operator's body. When in-running rolls are positioned below the bar whereby the operator must duck under the bar, then the safety trip control described under 6.1.1 shall be used by itself or in addition to a pressure-sensitive body bar. The pressure needed is to be 40 lbs. (18 kg) or less.

7 Protection by Location

7.1 Where a mill is so installed that persons cannot reach through, over, under, or around any element or elements 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 clause 5 shall not apply.

7.2 Where a calender is so installed that persons cannot reach through, over, under, or around any element or elements 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 clause 6 shall not apply.

8 Trip and Emergency Switches

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

9 Stopping Limits

9.1 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.

9.2 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 (centimeters) 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 (centimeters per minute).

EXCEPTION: Where acceptable alternate safeguards are provided as described in section 7.1, stopping requirements may be waived.

9.3 Stopping Limits for Calenders

All calenders, irrespective of size of the rolls or their configuration, shall be stopped within a distance, as measured in inches or centimeters 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 (centimeters per minute).

EXCEPTION: Where speeds above 250 feet per minute (7620 centimeters per minute) as measured on the surface of the drive roll are used, stopping distances of more than 1-3/4 percent are permissible when approved by the authority having jurisdiction. Such stopping distances shall be subject to engineering determination.

10 Alarm

Where an exposure is created by the operation, and the operators are not within sight or hearing of other employees, a suitable alarm device shall be provided so that assistance will be available in case of accidents.

Annex A (informative)

Application and Principles

A.1 General

A.1.1 Introduction

This annex is intended to aid in applying the standard to actual mill and calender installations and operations. It includes a discussion of the basic principles of mill and calender safety and illustrations of various safety devices.

As stated in the Foreword, only the minimum criteria necessary for the safety of workers are presented in this standard. However, under actual operating conditions, considerable engineering ingenuity will sometimes be required to meet these criteria, particularly insofar as the location of the safety stopping devices on mills is concerned. This is due primarily to the widespread use today of automatic feed and take-away conveyors and blending rolls which occupy considerable space above the mills. In many other instances, however, it is both possible and practical to achieve a measure of safety far greater than called for in this standard. This annex has been prepared to aid in solving some of these problems and to encourage, through illustrations of installations in actual use, engineering experimentation towards the development of better means of protecting mills and calenders.

A.1.2 Principles

The operation of mills and calenders is not necessarily hazardous, and, actually, as experience has shown, can be relatively safe if the basic principles of accident prevention – engineering, education, and enforcement – are faithfully applied.

A.2 Basic Principles

A.2.1 Engineering

The safety of any given mill or calender installation depends far more than is generally realized on the design of the equipment and the job methods selected. The importance of carefully correlating the design of the equipment to the job methods cannot be emphasized too strongly if maximum safety is to be achieved. The methods must be planned step-by-step in advance with the element of safety constantly in mind, and then the equipment engineered to fit these methods.

Certain fundamental factors necessary to the safety of mill and calender operators must be considered in designing the equipment. Included in these are: stock feeding and removal, blending equipment, working space requirements, braking requirements, type and location of safety stopping switches and actuating devices, lighting, ventilation, and emergency release provisions.

A.2.1.1 Stock Feeding

Feeding devices designed to keep the operators away from the bite of the in-running rolls should be provided wherever possible. This can be both practicable and practical for almost every type of mill and calendar operation if sufficient thought is given to the design. The choice of the type of feed will depend on the type of stock, the quantity to be processed, the type of operation to be performed, and the type of equipment. Feeding devices now in general use include but are not limited to gravity drop, gravity roller conveyor, belt conveyor (fixed and oscillating), and pull roller conveyors.

A.2.1.2 Stock Removal

The removal of stock from mills and calenders can be accomplished largely by means of belt conveyors. The location and design of such equipment are usually dependent upon both the form of the stock as it comes from the mill or calender and the next operation to be performed on it. Such operations as continuous strip removal, batching off, removing cracked pieces, and sheeting readily lend themselves to mechanical handling. Stock removal conveyors for mills are usually located above and in front of the front mill rolls. On some types of operations (cracker and slabber mills), however, the conveyors are located under the mill rolls.

A.2.1.3 Blending Equipment

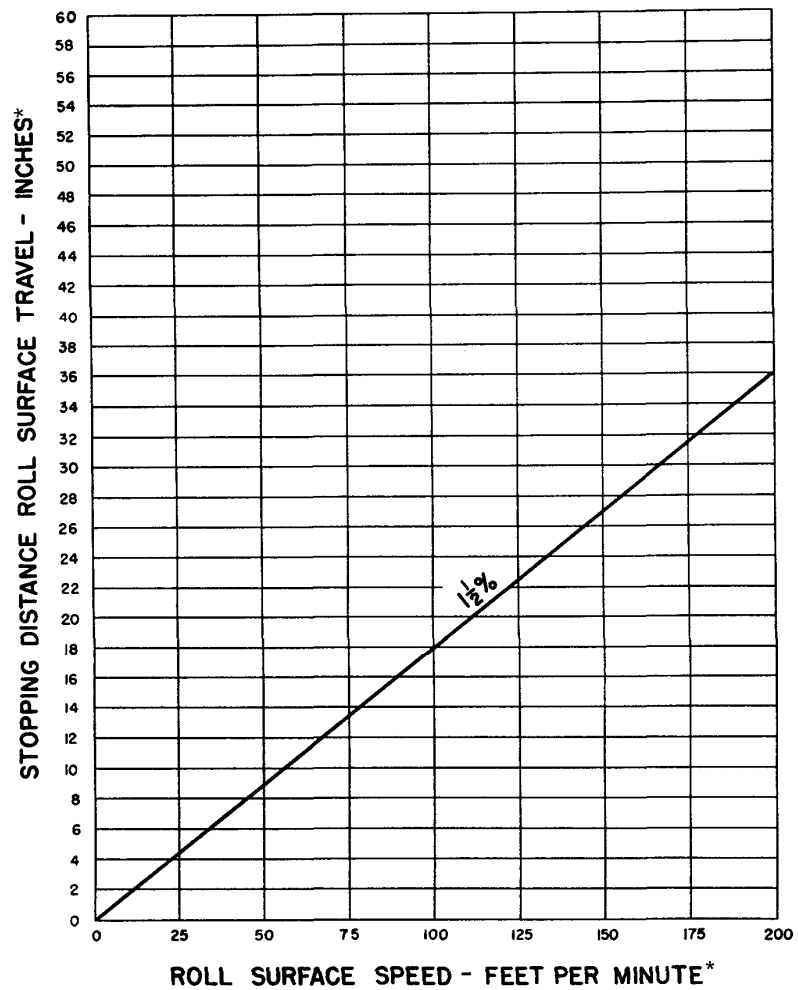
Much hand work, and consequently, exposure to accidents, can be eliminated on mill blending and mixing operations by the use of automatic overhead blending rolls. If individually driven, these rolls should be interlocked with the mill-stopping switches so that actuation of the mill safety-stopping devices will also stop these rolls.

A.2.1.4 Working Space Requirements

The manner in which stock is fed to, and removed from, the mill or calender will largely determine the working space required around the equipment for safe and efficient operation. Hand-feed operations necessarily need more floor space than conveyor-feed operations because of stock storage space requirements. On conveyor-fed operations, however, care must be exercised in locating the conveyors so that operators have sufficient headroom and do not have to work in awkward positions. This factor must also be considered in positioning the stock guide rolls for overhead mixing and blending equipment. A frequently overlooked fact is that clear space is needed behind mills so that operators can safely remove stock which has traveled around the rear roll.

A.2.1.5 Braking Equipment

To meet the maximum stopping distances as specified in the standard (see Section 9 and Figures A.1 and A.2), all mills and calenders require braking equipment. The types available include dynamic, regenerative, magnetic, plugging, and mechanical. Electrical braking equipment is the most commonly used and in general provides the most trouble-free service under the rugged conditions of use.

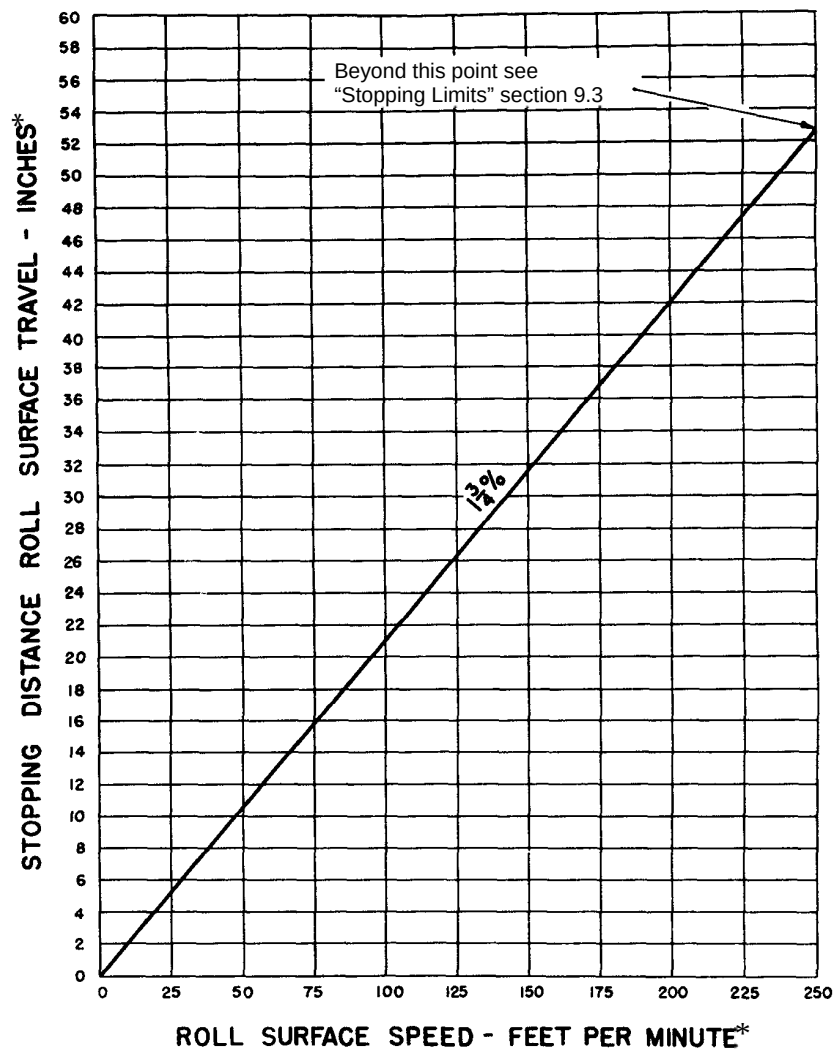


*See tables below for metric conversions.

Stopping distance roll surface travel – centimeters			
Stopping distance in inches	Stopping distance in centimeters	Stopping distance in inches	Stopping distance in centimeters
2	5.08	32	81.28
4	10.16	34	86.36
6	15.24	36	91.44
8	20.32	38	96.52
10	25.40	40	101.60
12	30.48	42	106.68
14	35.56	44	111.76
16	40.64	48	121.92
18	45.72	50	127.00
20	50.80	52	132.08
22	55.88	54	137.16
24	60.96	56	142.24
26	66.04	58	147.32
28	71.12	60	152.40
30	76.20		

Roll surface speed	
Feet per minute	Centimeters per minute
25	762.0
50	1524.0
75	2286.0
100	3048.0
125	3810.0
150	4572.0
175	5334.0
200	6096.0
225	6858.0
250	7620.0

Figure A.1 - Maximum Allowable Mill Stopping Distances for Various Roll Speeds



*See tables below for metric conversions.

Stopping distance roll surface travel – centimeters			
Stopping distance in inches	Stopping distance in centimeters	Stopping distance in inches	Stopping distance in centimeters
2	5.08	32	81.28
4	10.16	34	86.36
6	15.24	36	91.44
8	20.32	38	96.52
10	25.40	40	101.60
12	30.48	42	106.68
14	35.56	44	111.76
16	40.64	48	121.92
18	45.72	50	127.00
20	50.80	52	132.08
22	55.88	54	137.16
24	60.96	56	142.24
26	66.04	58	147.32
28	71.12	60	152.40
30	76.20		

Roll surface speed	
Feet per minute	Centimeters per minute
25	762.0
50	1524.0
75	2286.0
100	3048.0
125	3810.0
150	4572.0
175	5334.0
200	6096.0
225	6858.0
250	7620.0

Figure A.2 - Maximum Allowable Calender Stopping Distances for Various Roll Speeds

A.2.1.6 Safety-Switch Specifications

Good braking equipment is of little value if the switch to operate it is not reliable. For this reason, great care should be exercised in selecting safety switches for mills and calenders. The following specifications are offered as a guide to selecting a dependable switch:

- (1) A safety switch should be of two-pole, snap action, manual reset, extra heavy construction, with positive action.
- (2) The switch contacts should be closed during normal operation and be arranged to isolate both sides of the starting and holding circuit upon tripping.
- (3) As far as possible, the design of the switch should be such that any failure of the switch or operating mechanism will result in opening the contacts.
- (4) The switch enclosure should be of heavy construction with a threaded hub for conduit connection.
- (5) The switch should require a set amount of tension applied by the cable; this sets the switch to the active mode. This precludes the mill from being operated without the cable and validates the condition of the switch.

A.2.1.7 Safety Switch Actuating Device

The design of the safety-switch actuating device for a mill or calender is an extremely important step and one which should be given careful engineering study. Each individual mill or calender should be considered separately and the actuating device tailor-made to suit the operations to be performed on that particular piece of equipment. The methods of stock feeding and removal, and whether or not encumbrances such as hoppers, troughs, blending rolls, stripping rolls, and ventilation hoods are present, will all influence the final design of the safety-switch actuating device and must be given consideration.

The location and design of the safety-switch actuating device described in the standard (clauses 5 and 6) provide the minimum requirements necessary for the safety of the operators. It should be clearly understood that it is neither the intent nor the purpose of the standard to limit either the degree of protection provided or the type and location of the actuation device used to that described in the standard. Actually, under specific operating conditions, ways and means can usually be found to install actuating devices that provide greater protection than that called for in the standard. In many cases on both mills and calenders, the safety-switch actuating devices can be so located as to provide a barrier between the "bite" and the operator so that it is impossible for the operator to reach the "bite" without tripping the safety switch. In other instances, actuating devices that are extensions of, or in addition to, that described in the standard, in the form of knee- or foot-operated devices, can be used effectively.

A.2.1.8 Lighting

Good lighting is essential to the safety of mill and calender operators. Artificial illumination should be provided in accordance with the American National Standard Practice for Industrial Lighting, ANSI/IES RP7-1990, or the latest revision thereof. Lighting installations should be planned with care to avoid shadows and glare.

A.2.1.9 Ventilation

Certain rubber stocks in use today produce smoke and fumes when milled or calendered. Therefore, in the design of mill or calender installations (including stock feeding devices), this factor should be considered, and adequate exhaust ventilation provided where necessary in accordance with the principles outlined in the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2- 2007, or the latest revision thereof. Such ventilation equipment usually takes the form of a ventilated hood or enclosure located over the mill or calender.

A.2.1.10 Emergency Release Provisions

In designing the equipment, provisions must be made for easily and quickly extricating employees who may become caught in the in-running bites of mill or calender rolls. The means of extrication should be developed on the principle of roll separation, except when the stock or rolls are very hot, in which case the machine should be reversed at once to minimize burning.

In most instances, roll separation of calenders can be accomplished through the use of the normal roll-spacing mechanism. In some cases, however, where the maximum separation of the rolls through normal means would not be great enough for release purposes, special equipment such as air-operated pull-out spacers may have to be provided.

Little difficulty has been encountered in separating the rolls of mills equipped with pull-back devices. In the case of mills which are not so equipped, special means must be provided. Among the methods in successful use are air hammers equipped with wedge-shaped tools and hydraulic jacks.

Emergency release provisions/drills should be periodically scheduled at intervals no greater than monthly; quarterly for mills and calenders with pressure-sensitive body bars.

A.2.1.11 Maintenance

Good maintenance, particularly of the preventive type, is a vitally important phase of mill and calendar safety. Braking equipment, safety switches, and actuating devices should be inspected and tested on a regular, periodic schedule. Stopping distances should be measured and recorded on a weekly basis so that a degradation of the effectiveness of the braking equipment can be readily noted and corrected before the point is reached at which the maximum allowable stopping limit is exceeded. Figure A.3 illustrates one form which has proved to be very useful in recording the results of such inspections and tests.

Other items which require periodic attention are: stock guides, guards, roll adjustment screws (lubrication), lights, and ventilation.

WEEKLY INSPECTION OF SAFETY STOPS ON MILLS AND CALENDERS

NOTE: ONE COPY OF THIS REPORT COVERING THE COMPLETE TESTS FOR THE LAST WEEK IN EACH MONTH SHOULD BE SENT TO THE SUPERVISOR OF SAFETY.

PLANT _____ LOCATION _____ FOR WEEK ENDING _____ 20_____

DATE TESTED	MILL LINE NO.	CALENDER NO.	ROLL DESIGNATION	SURFACE SPEED OF ROLL (FT PER MIN OR CM PER MIN)	REQUIRED STOPPING DISTANCE IN INCHES OR CENTIMETERS	ACTUAL STOPPING DISTANCE IN INCHES OR CENTIMETERS	ACTION TAKEN (MILLS AND CALENDERS WHICH FAIL TO STOP WITHIN THE REQUIRED DISTANCE SHOULD BE SHUT DOWN AT ONCE AND REPAIRED BEFORE USING.)

STOPPING LIMITS OF MILLS																			
Roll speed in feet per minute	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Roll speed in centimeters per minute	610	914	1219	1524	1829	2134	2438	2743	3080	3352.8	3657.6	3962.4	4267.2	4572.0	4876.8	5181.6	5486.4	5791.2	6096.0
Limit of travel in inches	4	5	7	9	11	13	14	16	18	20	22	23.4	25.2	27.0	28.8	30.6	32.4	34.2	36.0
Limit of travel in centimeters	9.144	13.716	18.288		27.432	32.004	36.576	41.148		50.292	54.864	59.436	64.008	68.580	73.152	77.724	82.296	86.8	91.440
NOTE "A": STOPPING DISTANCES ARE 1 ½% OF ROLL SPEED																			

STOPPING LIMITS OF CALENDERS																			
Roll Speed in feet per minute	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250
Roll speed in centimeters per minute	2133.6	2438.4	2743.2	3048.0	3352.8	3657.6	3962.4	4267.2	4572	4876.8	5181.6	5486.4	5791.2	6096.0	6400.8	6705.6	7010.4	7315.2	7620.0
Limit of Travel in Inches	14.7	16.8	18.9	21.0	23.1	25.2	27.3	29.4	31.5	33.6	35.7	37.8	39.9	42	44.1	46.2	48.3	50.4	52.5
Limit of Travel in Centimeters	37.338	42.672	48.006	53.340	58.674	64.008	69.342	74.676	80.01	85.344	90.678	96.012	101.346	106.68	112.014	117.348	122.682	128.016	133.35
NOTE "A": STOPPING DISTANCES ARE 1 ¾ % OF ROLL SPEED																			
NOTE "B": WHERE SPEEDS ABOVE 250 FT (7620 CM) PER MINUTE ARE USED STOPPING DISTANCES OF MORE THAN 1 ¾ % ARE PERMISSIBLE WHEN APPROVED BY THE AUTHORITY HAVING JURISDICTION. SUCH STOPPING DISTANCES SHALL BE SUBJECT TO ENGINEERING DETERMINATION																			

GENERAL NOTES:

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 (centimeters) of surface travel of the roll from the instant the emergency stopping device is actuated.

See American National Standard Safety Specifications for Mills and Calenders in the Rubber Industry (ANSI B28.1-2009).

TESTED BY: _____

Figure A.3 – Mill and Calender Safety Stopping Equipment Inspection Form

A.2.2 Education

In perhaps no other type of work in the rubber industry is the need for training as a means of preventing accidents so great as in milling and calendering. The amount and effectiveness of the mechanical protection which can be provided for these operations is definitely limited by the type and form of the material used and the work performed on it. For this reason, a thorough, well-planned training program affords the most practical and effective weapon against mill and calender accidents.

Experience has shown that supervisors of mill and calender operations as well as the employees who work on this equipment should be given special training in the safe operation of this equipment.

A.2.3 Enforcement

If freedom from accidents is to be achieved in mill and calender work, no latitude from established safe operating methods can be permitted. For this reason there must be continual, close, and uncompromising supervision of each operation to insure against the use of unsafe practices. Effective enforcement measures must be established and these applied impartially and consistently when necessary. Enforcement should not be confused with training, however. It is a necessary supplement to a training program but is not a substitute for operator training.

A.3 Arrangements of Mill Safety Controls

A.3.1 Safety Controls

The type of safety controls that it is possible to install on a production mill depends largely on the degree to which the mill is encumbered with stock handling equipment. In general, there are two types of control, the barrier or automatic tripping device and the manual or nonautomatic device. The barrier type provides the greatest amount of protection but can usually be installed only on unencumbered mills. The manual type is the more versatile and can be used on all mills.

A.3.1.1 Pressure-Sensitive Body Bars (See 5.1.1)

On many mills that are not encumbered with stock-handling equipment it is possible to install a safety switch actuating device which can activate with pressure towards the mill and in some situations away from the mill (double-action pressure-sensitive body bar) and is also a barrier which prevents the operator from reaching the bite of the rolls without first tripping the device and stopping the mill.

This arrangement is very desirable (the operator does not have to make a conscious decision to reach or kick, rather, the safety trip is automatic) and its application is not nearly as limited as might generally be believed. It has been successfully used on cracker mills, mixing mills, warming mills, and refining mills. Because of its position it forces the operators to work lower on the face of the front roll than they normally do, which in itself helps prevent accidents. A rigid bar is generally better for this type of device than wire cable. Figures A.4, A.5, A.6, and A.7 illustrate the pressure-sensitive body bar. (See Figure A.8 for installation instruction.)

A.3.1.2 Safety Trip Rod (See 5.1.2)

Unlike the pressure-sensitive body bar, the safety trip rod must be actuated deliberately by the operator. Figure A.9 illustrates this safety device.

A.3.1.3 Safety Trip Wire Cable (See 5.1.3)

Wire cable usually lends itself to installation on mills that are encumbered with overhead stock blending rolls, feed and take-away conveyors, chutes, and hoppers. It is possible, through careful engineering, to locate the safety-switch actuating device so that it is readily accessible to the operator from all normal working positions. In order to achieve the maximum protection it is usually necessary to install baffle plates to keep the stock from striking the cable and unnecessarily stopping the mill. Figure A.10 illustrates this type of application.

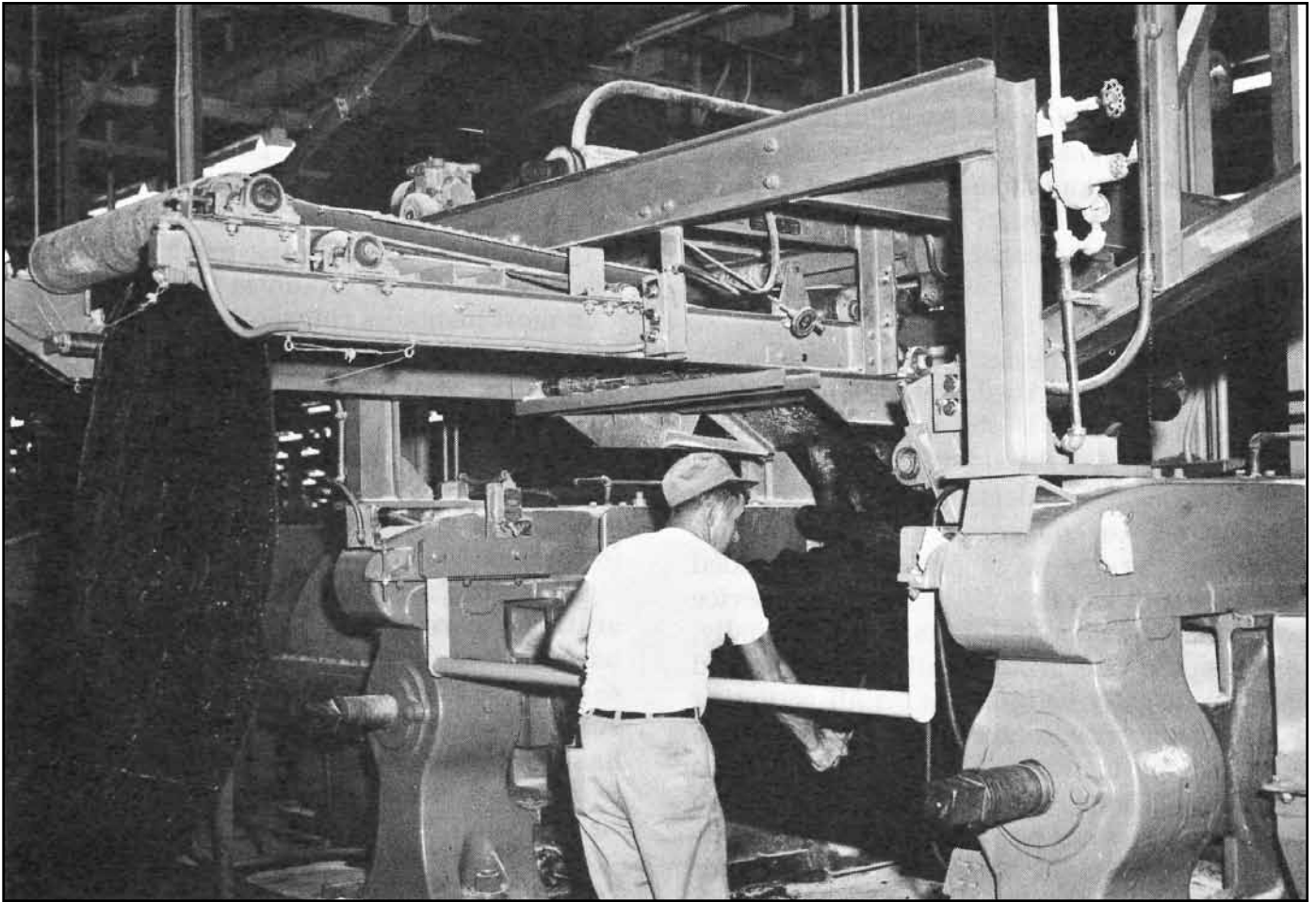


Figure A.4 - Location of Pressure-Sensitive Body Bar on Front of Mill

The view shows how operator must work in relation to the body bar. A pressure equal to approximately 40 pounds (88.184 kg) toward the bite stops the mill, affording excellent protection.

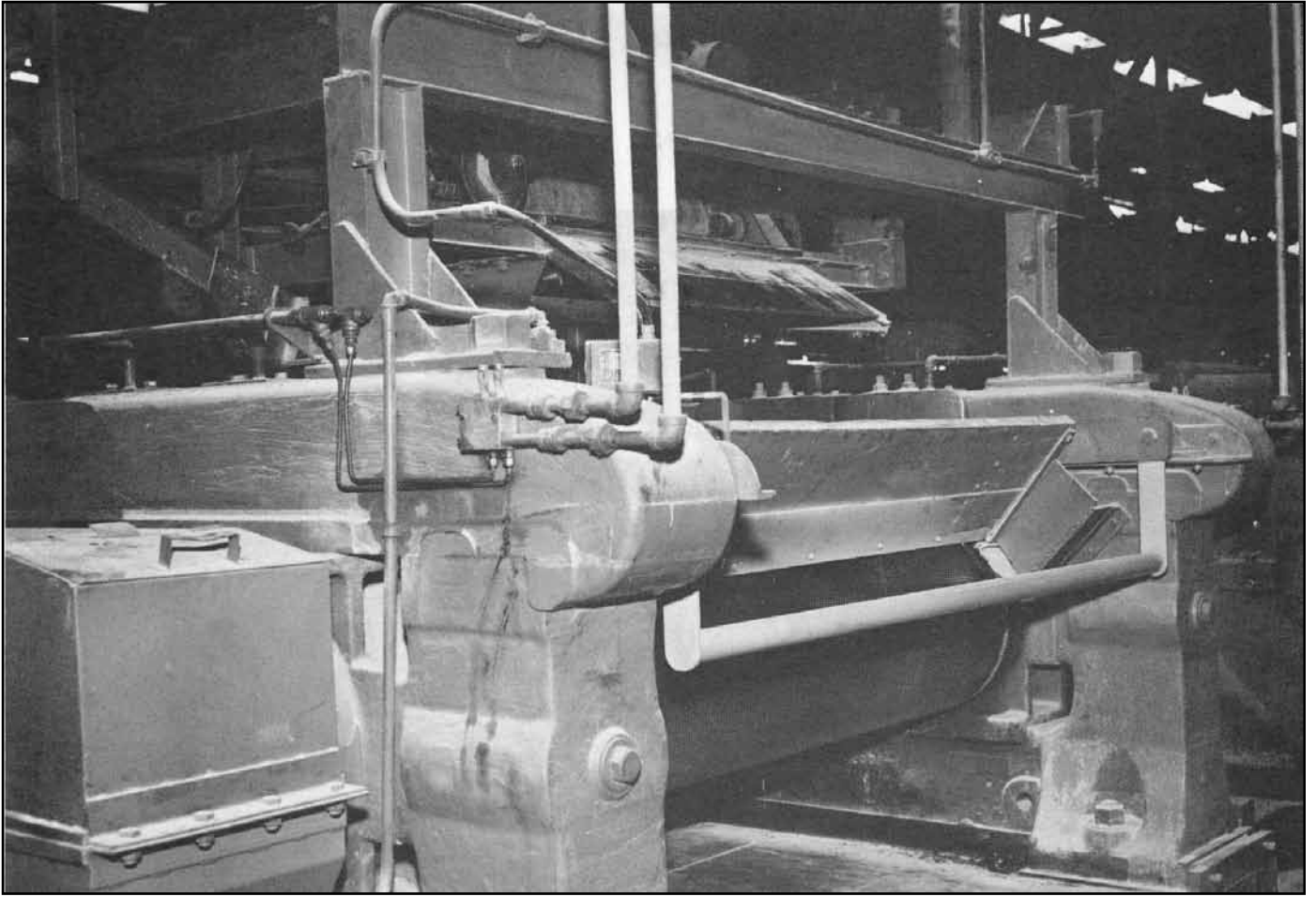


Figure A.5 - Location of Pressure-Sensitive Body Bar on Rear of Mill

Rear view of same mill as in Figure A.4, showing installation of pressure-sensitive body bar on back of mill to give maximum protection to complete mill.

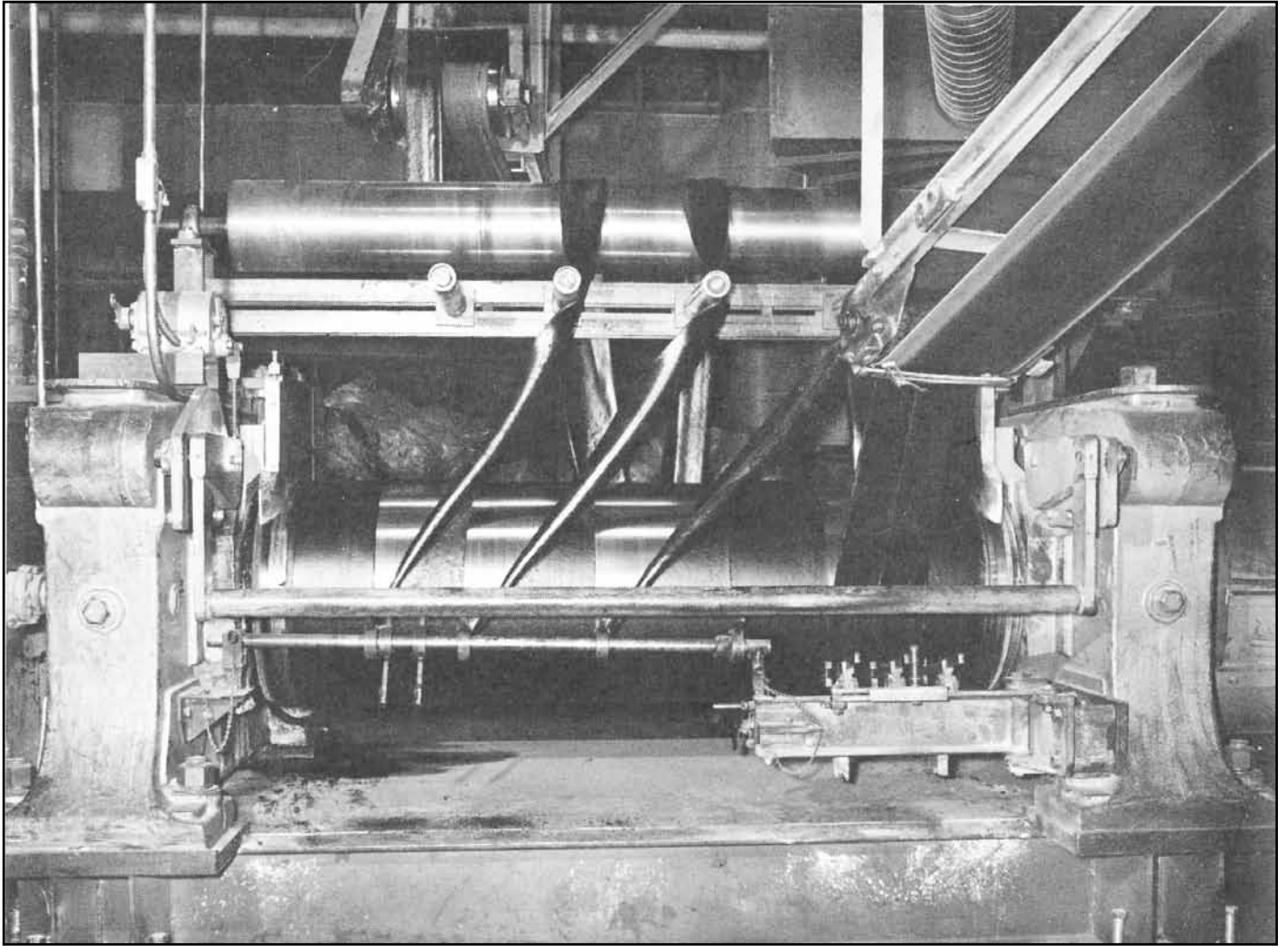
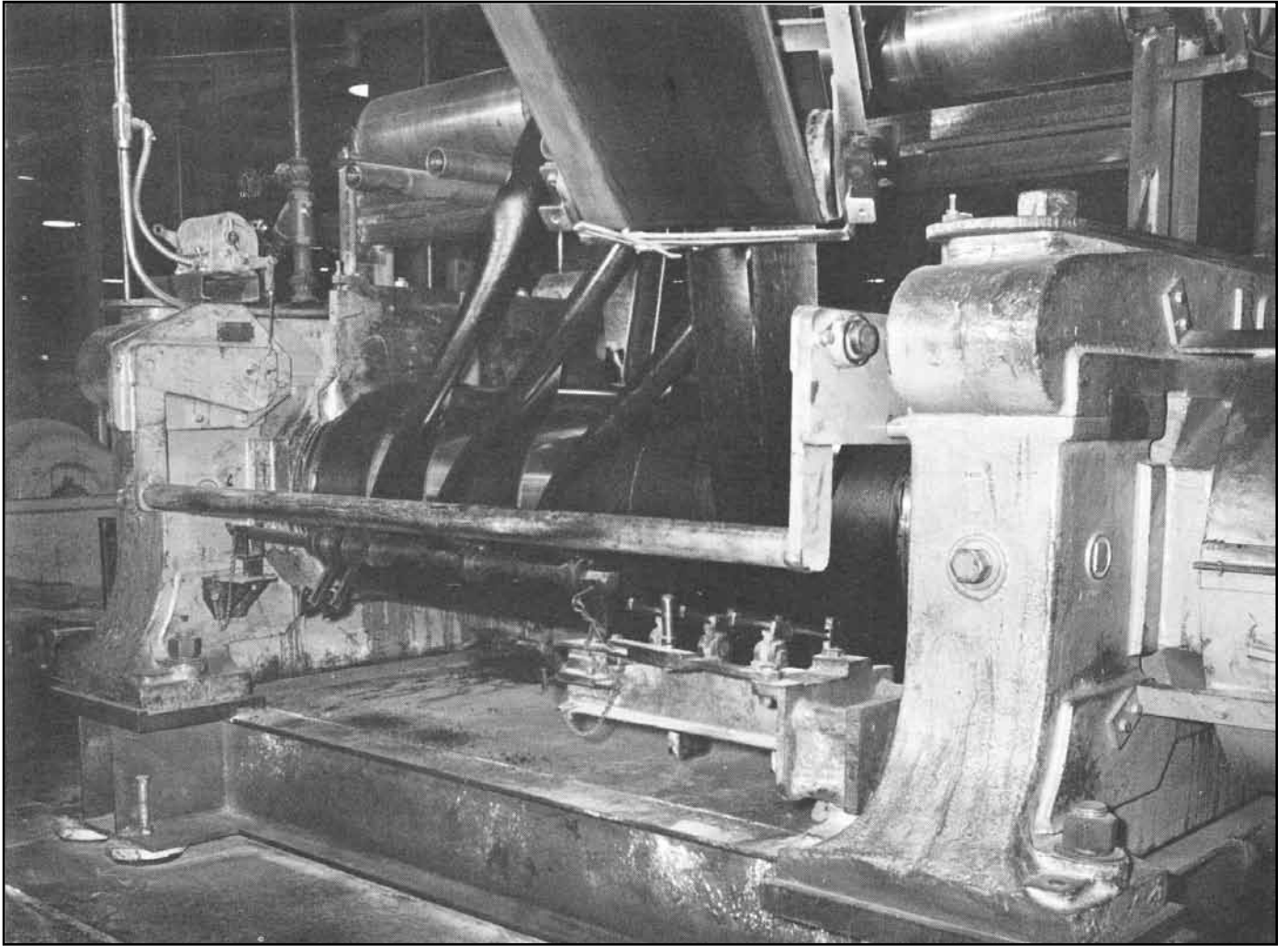


Figure A.6 - Location of Pressure-Sensitive Body Bar on a Mill with Overhead Equipment



**Figure A.7 - Angle View Showing Location of Pressure-Sensitive
Body Bar in Relation to Mill Frame**

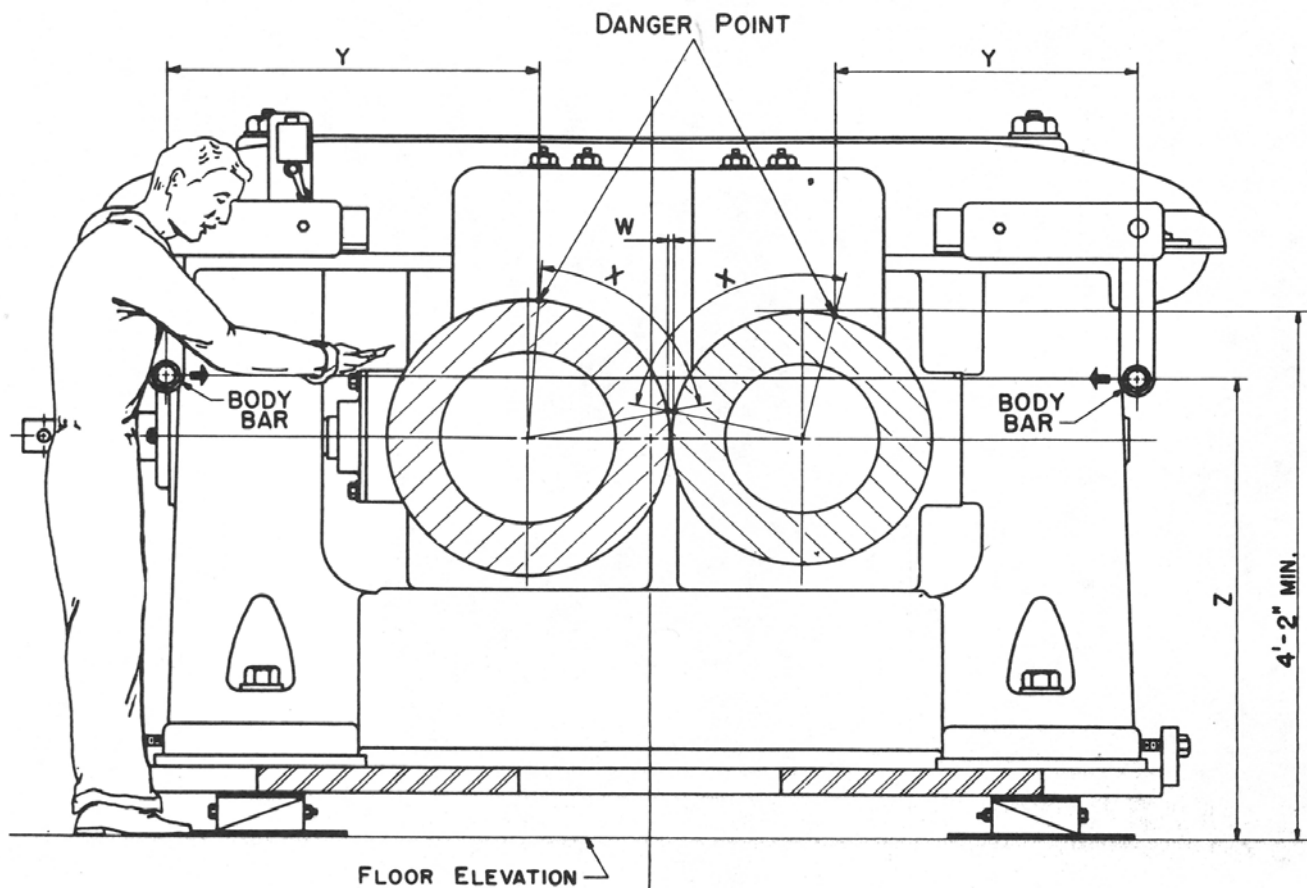


Figure A.8 - Installation of Pressure-Sensitive Body Bar

This illustration shows relative position of a man to the pressure-sensitive body bar and the working roll. The body bar is positioned so that the man cannot reach the danger point on the face of the roll without tripping the safety switch.

The danger point is determined as follows:

W represents the thickness of a man's fingers

X represents the maximum allowable stopping distance.

*Y and Z dimensions are such that the man cannot reach the danger point.
(minimum of 20 inches (50.8 cm) and 40 inches (101.6 cm), respectively).*

A force equal to approximately 40 lbs (88.184 kg) (in the direction of the arrow) is required to actuate the safety switch.

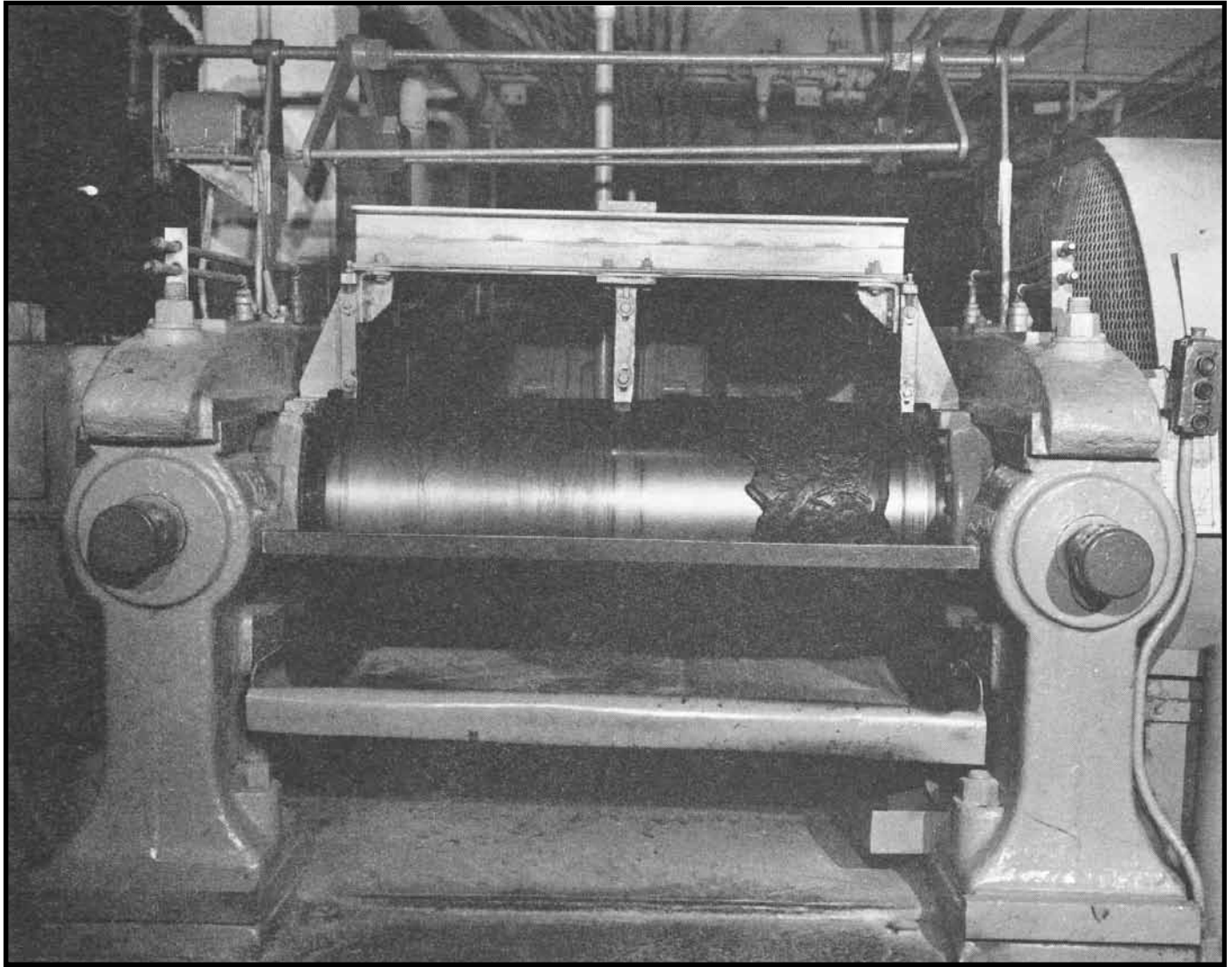


Figure A.9 - Safety Trip Rod

View showing position of safety trip rod and how operator must reach up to hit safety rod in the event he starts moving toward the bite.

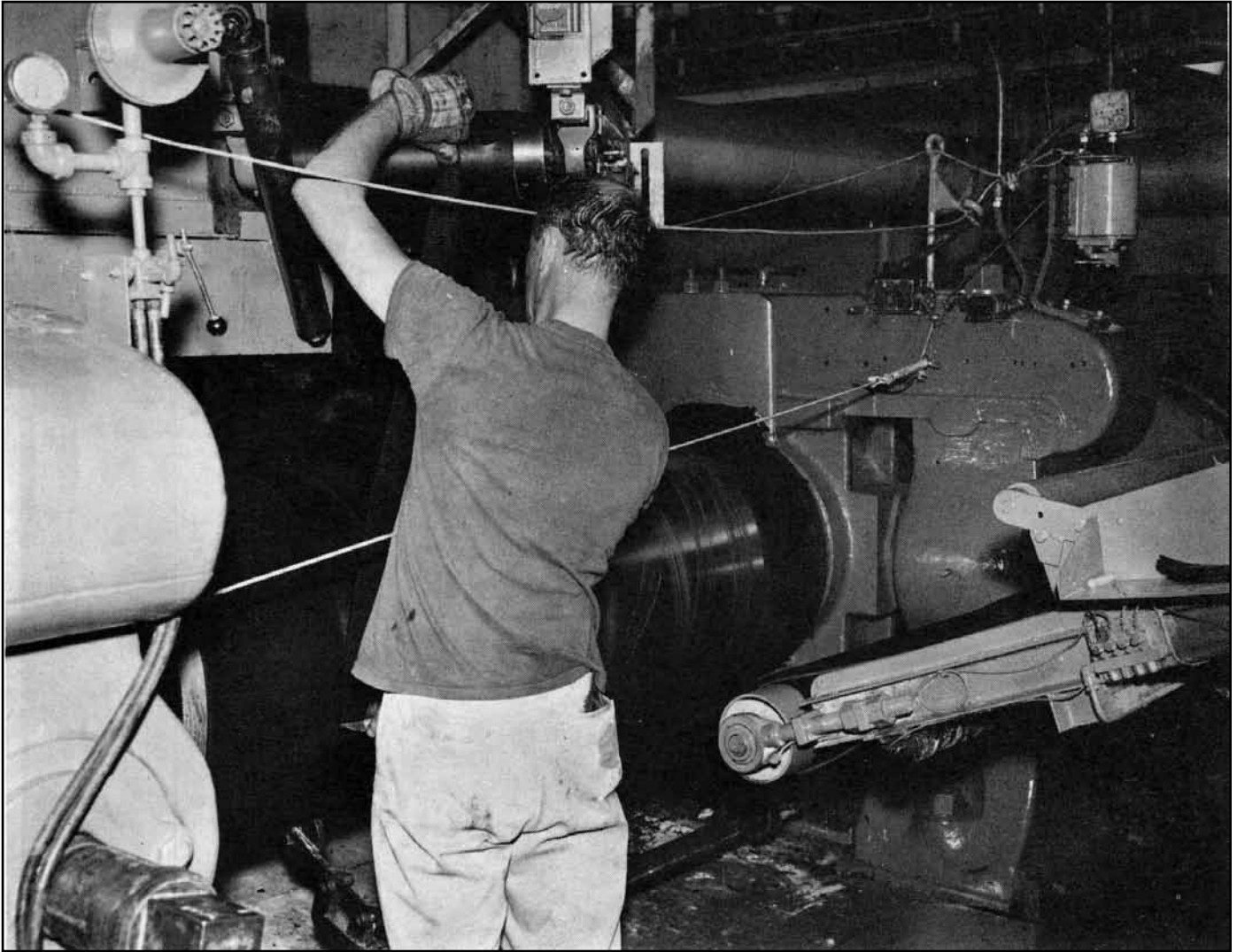


Figure A.10 - Safety Trip Wire Cable

View showing how a wire cable can be installed on a heavily encumbered mill and still afford maximum protection to the operator.

A.3.1.4 Mill Guard Bars

Rigidly mounted or hinged bars located across the face of the mill rolls both in front and in back of the mill offer a means of keeping the operators from working too close to the mill. Fixed bars can usually be installed on all types of mills and are particularly valuable for cracker and mixing mills as they provide the operators with a convenient resting place for pans of compounds or large pieces of stock.

In installing such bars, care should be taken to make certain that they are located as stated in the standard so that they do not constitute a hazard in themselves. (See Figures A.11 and A.12.)

A safety trip method as described under 5.1 must be used with a fixed bar.

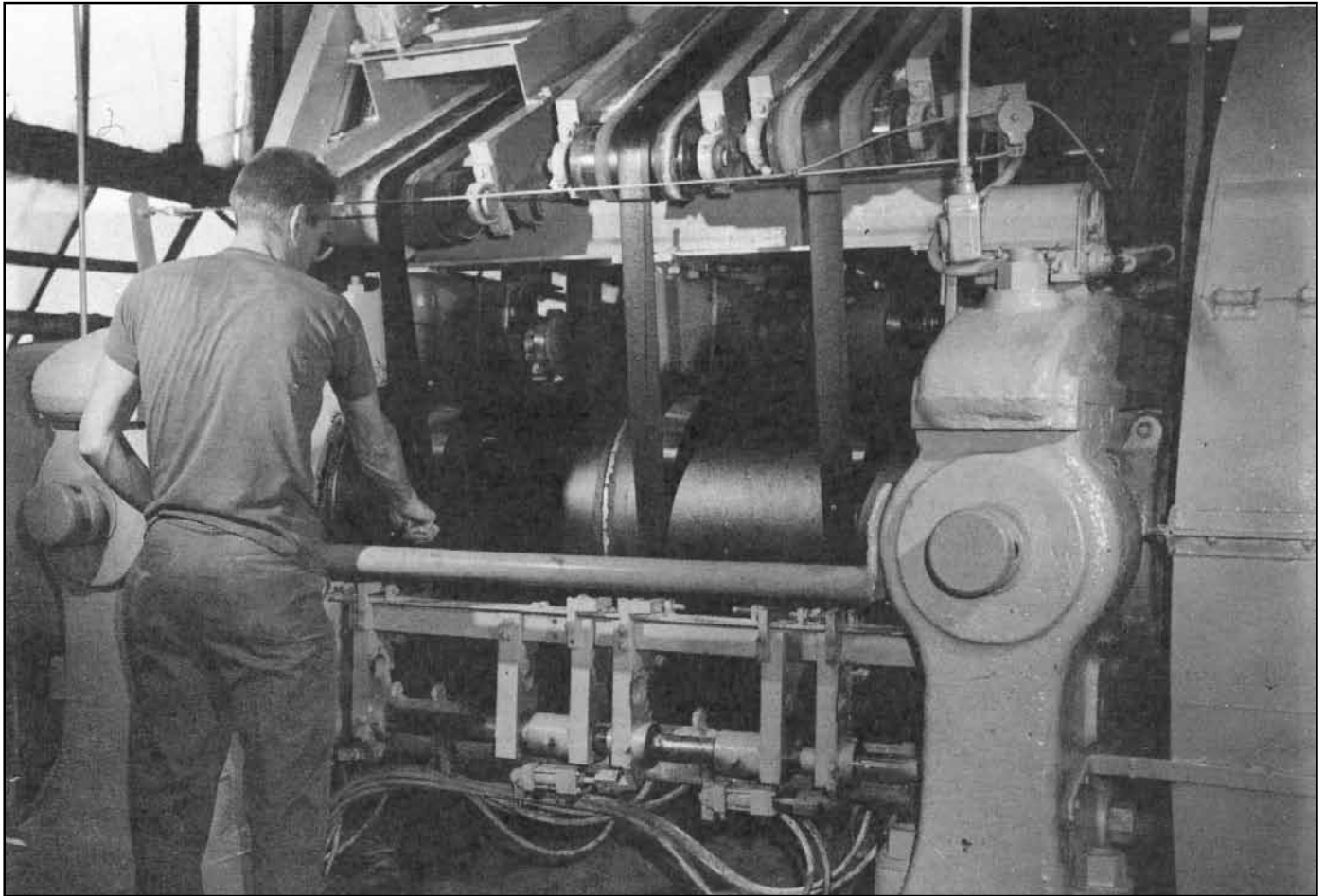


Figure A.11 - Fixed Guard Bar for Mills

View of a fixed guard bar across the front of a mill, showing how it serves to keep operator away from the bite.



Figure A.12 - Moveable Guard Bar for Mills

View of moveable guard bar across the front of a cracker mill. This bar is hinged at both sides of the mill frame so that it will raise should the operator get caught between the bar and the mill roll. Note stock guide plate A fits closely against the surface at end of mill roll.

A.3.1.5 Protection by Location

See 7.1 and 7.2

A.3.1.6 Pressure Sensitive Mats or Light Curtains

Under certain conditions, pressure sensitive mats or light curtains may be a viable guarding option. Like pressure-sensitive body bars, these devices provide automatic protection since the operator does not have to make a conscious decision to reach or kick at something.

A.3.2 Laboratory Mills

The inherent hazard of small laboratory-size mills is greater than that of production mills because the roll diameter is so small that the operator's hands are never far away from the bite when working stock. For this reason, a barrier-type safety-cradle actuating device is recommended for all such mills. Fortunately, the batch size run on a laboratory mill is usually small so that such a device can be used without interfering with the operation of the equipment. Figures A.13 and A.14 show a very effective device that has been successfully used on many laboratory mills. Figure A.15 shows a laboratory mill equipped with knee-operated tripping device in addition to a safety trip cable.

A.4 Arrangements of Calender Safety Controls

The problem of protecting calenders is considerably different from that of protecting mills. The accident exposure is greater for most calenders because of the increased number of bites and because the rolls are in a vertical plane, making the bites more accessible. The point where stock is fed into the calender is extremely difficult to guard. However, the hazard can be greatly reduced by employing feed conveyors, preferably of the oscillating type, which prevents the need for the operator's hands to be near this bite. Stock tables located just below the stock feed rolls and placed close to the face of the rolls also help reduce this exposure.

A.4.1 Safety Cables

Safety trip cables, when installed as directed in section 6 of the standard, afford the best general protection for most calenders. Figure A.16 illustrates the easy accessibility of such cables from all normal working points.

A.4.2 Pressure-Sensitive Bar

A pressure-sensitive bar may be used alone for calender arrangements where the in-running rolls do not require the operator to work underneath the bar. Otherwise, a pressure-sensitive bar shall be used in conjunction with safety cables.

A.4.3 Fixed Fabric Bite Guards

At the in-running bites where fabric is fed into calenders, it is usually possible to provide guards which will prevent the operator's hands from reaching the bites. These guards or barriers can be designed in many different forms to suit the type of operations performed. One form is shown in Figure A.17.

A.4.4 Moveable-Type Barriers for Calenders

Figure A.18 shows a moveable-type barrier, which is interlocked to the calender speed so that it must be in the down position before the calender can exceed a given speed.

A.4.5 Interlocked Fabric Bite Barriers

Hinged, double-action, electrically interlocked barrier bars located at fabric feed bites provide excellent protection against accidents at these points.

These barriers, which usually consist of one or more bars, must be carefully positioned so that the operator cannot reach the bite without first tripping the barrier and stopping the calender. To be effective the bars must actuate the safety switch if moved either up or down. See Figures A.19 and A.20.

A.4.6 Pressure-Sensitive Mats or Light Curtains

Under certain conditions, pressure-sensitive mats or light curtains may be a viable guarding option. Like pressure-sensitive body bars, these devices provide automatic protection since the operator does not have to make a conscious decision to reach or kick at something.

**Figure A.13 - Barrier Safety Cradle
for Laboratory Mills**

Barrier-type safety cradle installed on a 6-inch (15.24-cm) laboratory mill. View shows cradle detail, switch housing mounting, and illustrates method of feeding. Note that operator's hand is kept well above the bite by the cradle. Also note safety trip cable above passing around fixed pulley.

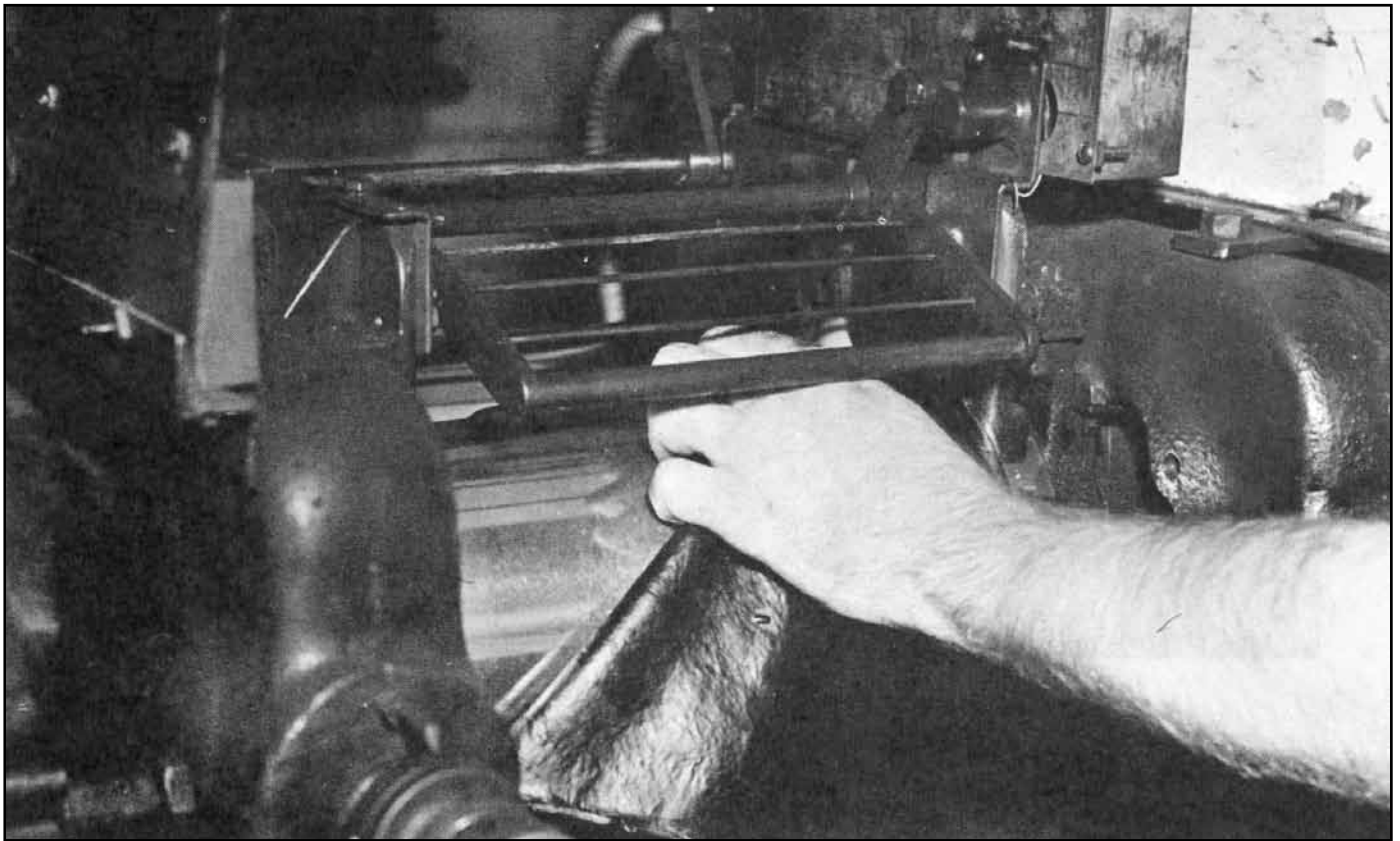
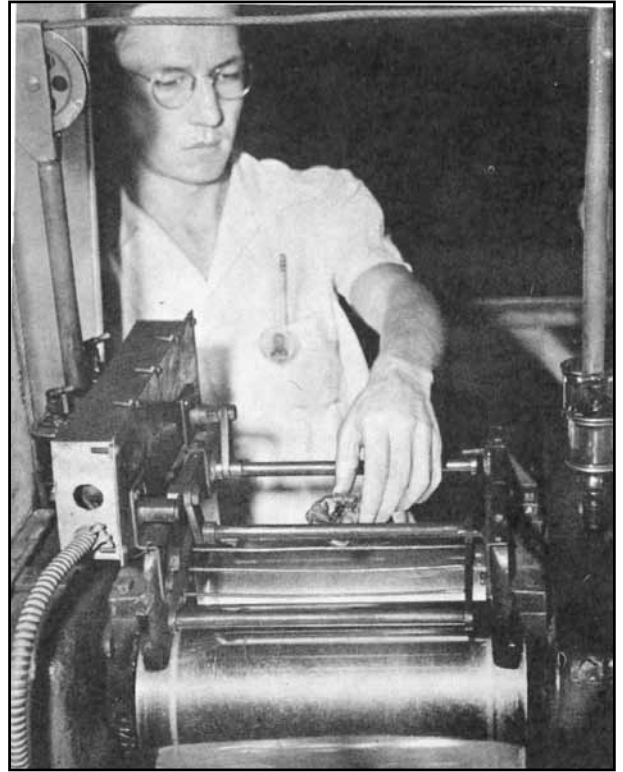


Figure A.14 - Close-Up of Barrier Safety Cradle

Another view of barrier cradle showing that operator's hand cannot fit under cradle bar without tripping cradle and stopping mill.

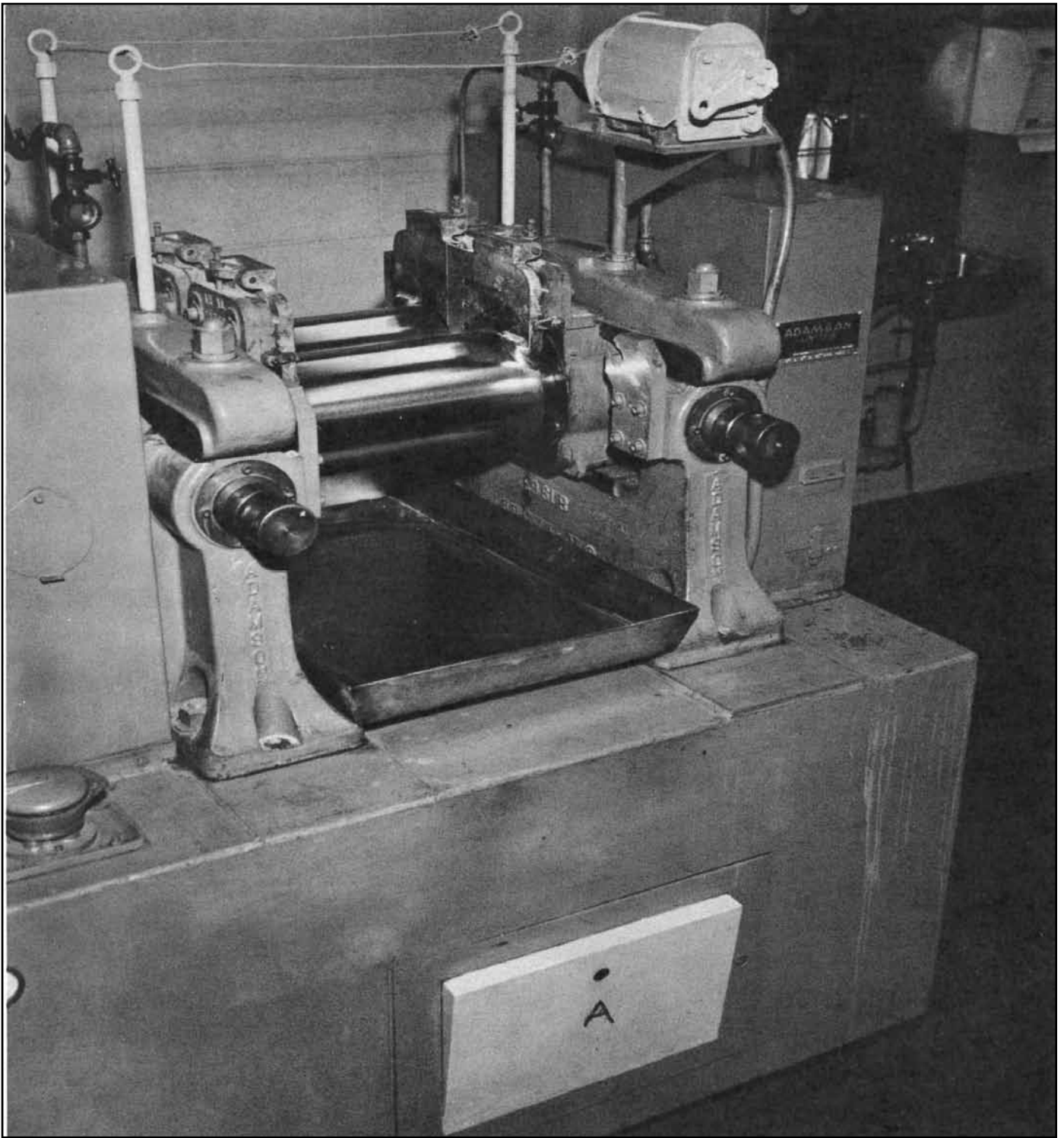


Figure A.15 - Knee-Operated Barrier Safety Plate

View of laboratory mill equipped with a knee-operated safety plate, A. Pressure against the plate will trip a switch and stop the mill. Note that mill is also equipped with a safety cable.

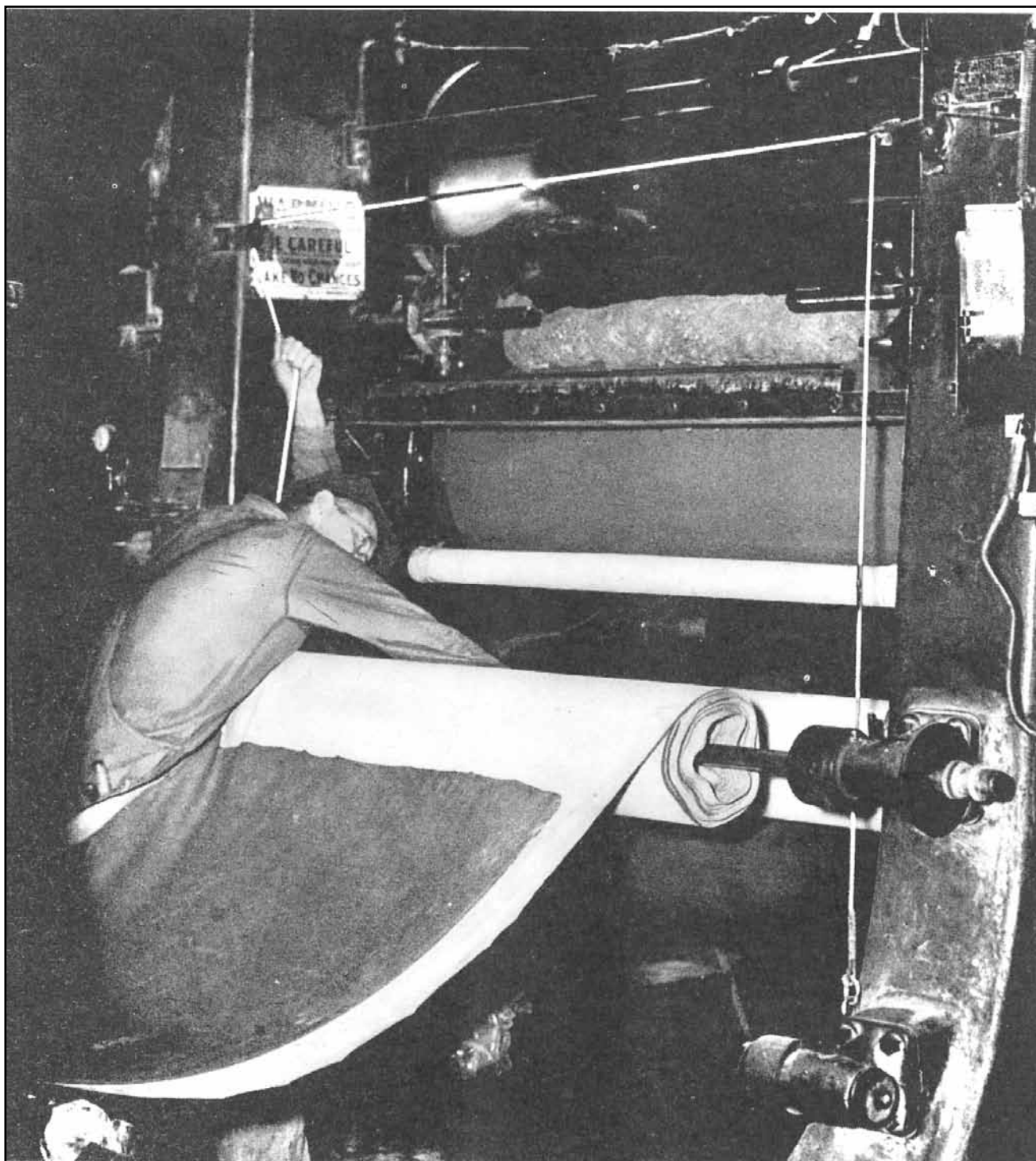


Figure A.16 - Safety Cables on Calenders

View of stock feed side of a three-roll calender showing the location of safety cables. Note use of fixed pulleys and that cables are supported out from the frame of the calender so that operator will be able to grasp them easily.

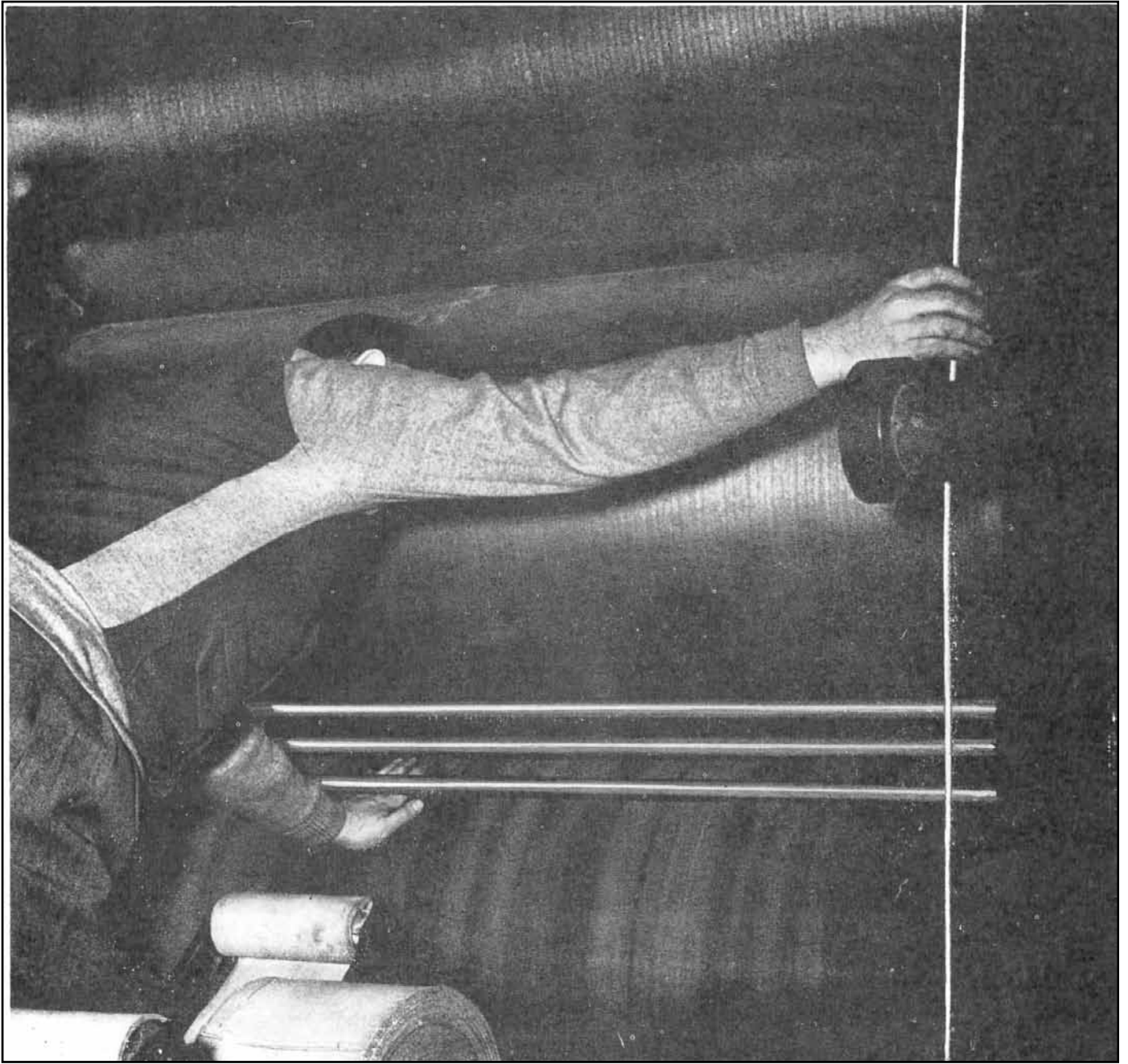


Figure A.17 - Fixed Finger Bars for Calenders

Illustration of the effectiveness of finger bars in preventing operators hands from reaching the bite. This calender is equipped with a three-bar barrier at the in-running roll bite. Note location of safety cable at calender housing for ease of tripping.

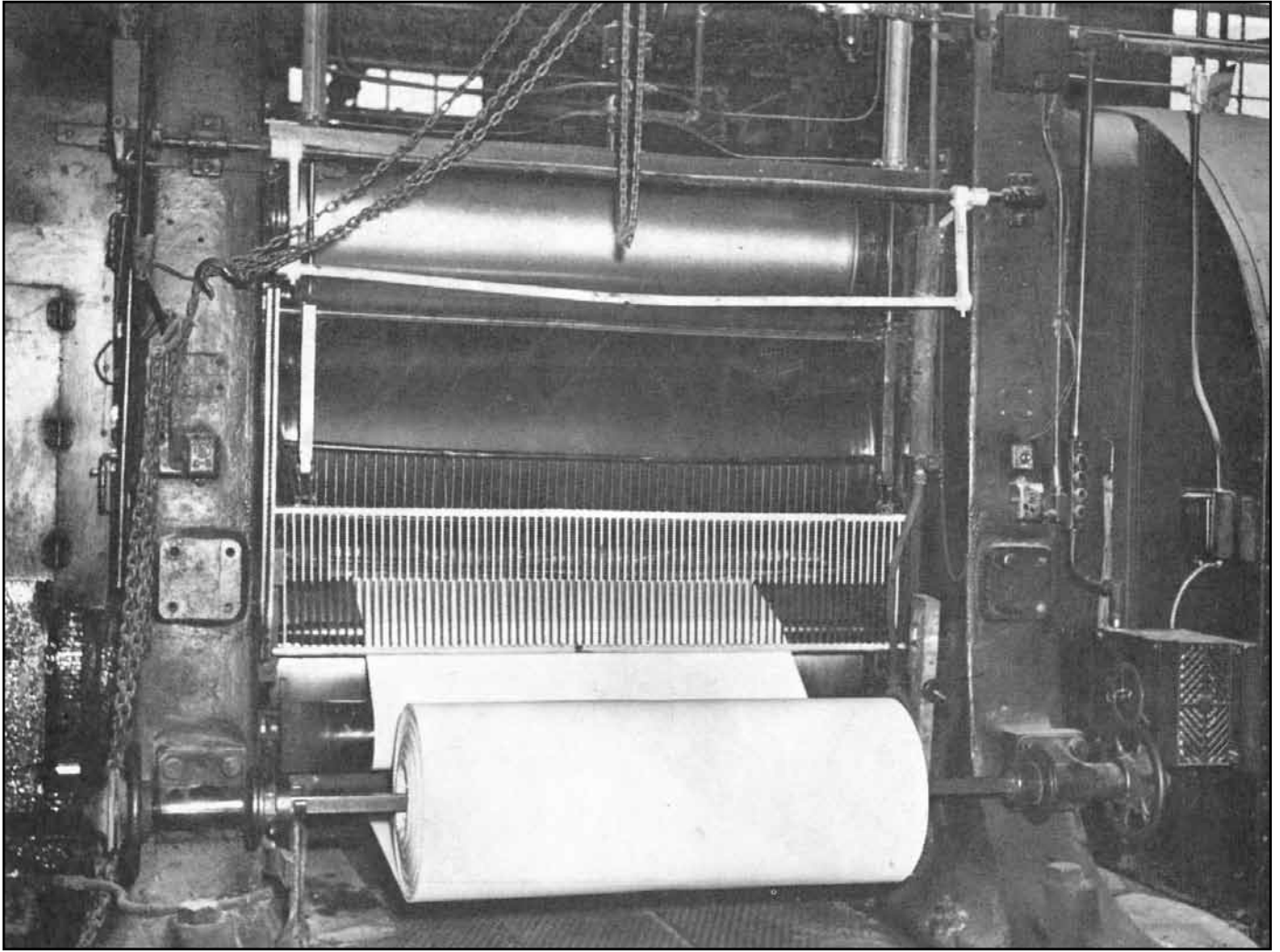


Figure A.18 - Moveable-Type Barriers for Calenders

View showing barriers in down position protecting fabric feed bite. Barrier is in up position when calender is stopped and then automatically moves to down position when calender reaches a certain speed.

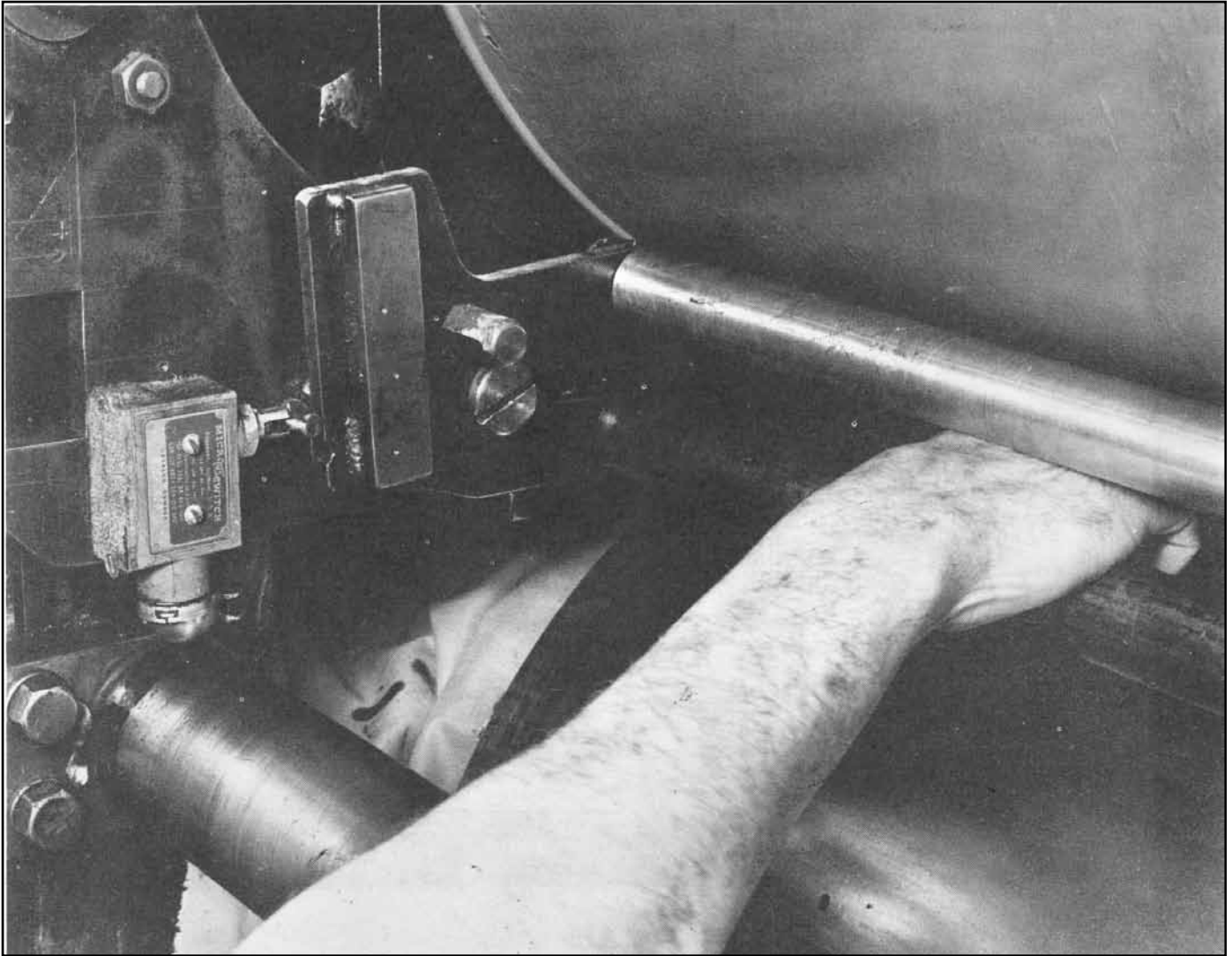
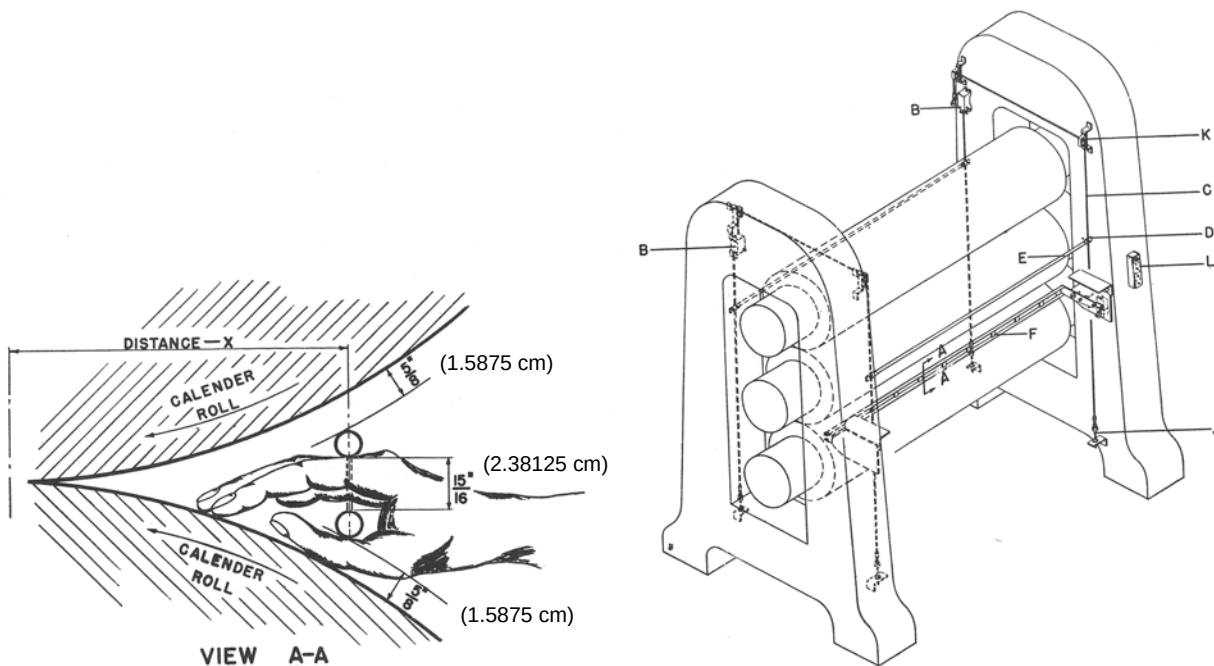


Figure A.19 - Interlocked Fabric Bite Barriers

View shows how operator's hand will move barrier rolls before reaching calender bite. This movement of barrier rolls actuates safety switch, stopping calender.



View A-A in this drawing illustrates the recommended location of the interlocked safety bar at the fabric feed bites of calenders. The dimensions shown are the maximum allowable for safe operation. Distance X will vary in accordance with the roll diameter, but must always be great enough to insure that no part of the operator's hand can reach the bite without tripping the bar.

The full calendar view shows the safety bar in position at the fabric feed bite and also illustrates the recommended location for safety trip cables which are required in addition to the interlocked bite bar. The letters in this drawing indicate the following items:

- B – Safety trip cable switch*
- C – Vertical safety trip cable*
- D - Adjustable clamp for horizontal safety trip bar*
- E – Horizontal safety trip bar*
- F – Double-action electrically interlocked bite bar*
- J – Safety trip cable screw eye tension adjustment*
- K – Safety trip cable guide pulley*
- L – Calender control switch*

Figure A.20 - Location of Double-Action Interlocked Safety Bar at Fabric Bites of Calenders

Acknowledgments of Illustrations

The American National Standards Institute wishes to thank the following organizations for supplying illustrations for this annex:

Pirelli Tire Corporation, Figures A.6 and A.7.

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Goodyear Tire & Rubber Company, Figures A.4, A.5, and A.10.

Office of Rubber Reserve, Figures A.13 and A.14.

Uniroyal Goodrich Tire Co., Figures A.12, A.16, A.17, A.18, A.19, and A.20.