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SAFETY CODE SERIES

**SAFETY CODE FOR MECHANICAL
POWER-TRANSMISSION APPARATUS**

FIRST REVISION

**RULES FOR GUARDING PRIME MOVERS, INTER-
MEDIATE EQUIPMENT, AND DRIVEN MACHINES**

SPONSOR ORGANIZATIONS
NATIONAL BUREAU OF CASUALTY AND SURETY UNDERWRITERS
INTERNATIONAL ASSOCIATION OF INDUSTRIAL ACCIDENT BOARDS AND COMMISSIONS
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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FOR MECHANICAL POWER-TRANSMISSION APPARATUS

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BULLETIN OF THE U. S. BUREAU OF LABOR STATISTICS

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WASHINGTON

JUNE, 1928

SAFETY CODE FOR MECHANICAL POWER-TRANSMISSION APPARATUS

INTRODUCTION

SCOPE

This code applies to all moving parts of equipment used in the mechanical transmission of power, including prime movers, intermediate equipment, and driven machines, excluding point of operation.

The safeguarding of all connecting rods, cranks, flywheels, shafting, spindles, pulleys, belts, link belts, chains, ropes and rope drives, gears, sprockets, friction drives, cams, couplings, clutches, counterweights, revolving or reciprocating parts, up to but not including point of operation, also all bolts, keys, set screws, oil cups, or similar projections are included and shall be in accordance with the provisions of the Mechanical Power-Transmission Apparatus Code.

NOTE.—For exemptions see section on "Interpretations and exceptions."

INTERPRETATIONS AND EXCEPTIONS

The purpose of this code is to provide reasonable safety for life, limb, and health. It is intended to serve as a guide to State and municipal authorities and may be adopted by them in whole or in part. This safety code is also in a form to be adopted by industrial concerns.

The code should be liberally construed and applied by enforcing authorities to secure these results; and, in case of practical difficulty or unnecessary hardship, exceptions from the literal requirements may be granted as long as equivalent protection is secured. Where specific devices or methods are mentioned in this code, other devices or methods which will secure equally good results may be used, subject to the approval of the enforcing authority.

Flat belts 1 inch or less in width and round belts $\frac{1}{2}$ inch or less in diameter running at any speed and flat belts in association with flat or crowned pulleys when 2 inches or less in width which are free from metal lacings or fasteners and running not more than 250 feet per minute are exempted. This exemption does not include spoke or other hazards of pulleys which shall be guarded.

Vertical and inclined belts (rules 221 and 222) if not more than $2\frac{1}{2}$ inches wide and running at a speed of less than 1,000 feet per minute and if free from metal lacings or fastenings may be guarded with a "nip-point belt and pulley guard." (See "Definitions"—Nip point belt and pulley guard.)

For the textile industry, because of the presence of the excessive deposits of lint, which constitutes a serious fire hazard, the sides and face sections only of nip-point belt and pulley guards will be required, provided the guard shall extend at least 6 inches beyond the rim of the pulley on the inrunning and offrunning sides of the belt and at least 2 inches away from the rim and face of the pulley in all other directions.

These regulations cover the principal features with which power-transmission safeguards shall comply. The mere technical fulfillment of these requirements does not assure the approval of the guard if examination shows lack of practicability and/or durability.

The supervising authority may require guards not called for in these standards, if, in the opinion of such authority, a sufficient hazard exists to warrant such action.

NEW AND OLD INSTALLATIONS

After the date on which this code becomes effective all new construction and installations shall conform to its rules. Equipment installed prior to that date need not, however, be modified to conform to its rules unless definite provision is made in the enacting law.

MANDATORY AND ADVISORY REQUIREMENTS

The word "shall," where used, is to be understood as mandatory and the word "should" as advisory.

DEFINITIONS

Belt pole.—A "belt pole," sometimes called a "belt shipper" or "shipper pole," is a device used in shifting belts on and off pulleys on line or countershaft where there are no loose pulleys.

Belt shifter.—A belt shifter is a device for mechanically shifting belts from tight to loose pulleys or vice versa, or for shifting belts on cones of speed pulleys.

Exposed to contact.—The term "exposed to contact" shall be interpreted as meaning that the location of an object is such that a person is liable to come into contact with it and be injured.

Flywheels.—The term "flywheel" is to include flywheels, balance wheels, and pulleys mounted and revolving on crank shaft of engine or other shafting.

Gears.—A set or train of gears comprises two or more intermeshing gears.

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

Nip point belt and pulley guard.—A "nip point belt and pulley guard" is a device which incloses the pulley and is provided with rounded or rolled edge slots through which the belt passes. (See "Interpretations and exceptions" for textile industry.)

Point of operation.—The term "point of operation" shall be understood to mean 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.

Prime movers.—The term “prime movers” as used in this code is to include steam, gas, oil, and air engines, motors, steam, and hydraulic turbines.

Securely fastened.—The term “securely fastened” shall mean that the safety device or object referred to shall be so secured in place that it can not be moved under normal or reasonably foreseen conditions or circumstances.

Sheaves.—Sheaves shall be considered as grooved pulleys and shall be so classified unless used as flywheels.

Sprockets.—A set of sprockets comprises two or more sprockets carrying one or more chains.

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PART I.—PRIME MOVERS

Section 10.—PRIME-MOVER GUARDS

Rule 100. Flywheels.

Flywheels located so that any part is 6 feet or less above floor or platform shall be guarded in one of the following ways:

(a) With an inclosure of sheet, perforated, or expanded metal or woven wire. For standards see Part IV, sections 40 and 41.

(b) With guard rails placed not less than 15 inches nor more than 20 inches from rim. When flywheel extends into pit or is within 12 inches of floor, a standard toe board shall also be provided. For standards see Part IV, rule 424.

(c) When the upper rim of flywheel protrudes through a working floor, it shall be entirely inclosed or surrounded by a guard rail and toe board.

(d) For flywheels with smooth rims 5 feet or less in diameter, where the preceding methods can not 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 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. See standard for disk guard Part IV, section 41.

NOTE.—This does not apply to flywheels with solid web centers.

(e) 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.

Rule 101.—Crank and connecting rods.

Cranks and connecting rods, when exposed to contact, shall be guarded in accordance with Part IV, sections 40 and 41, or by a guard rail as described in Part IV, rule 424.

Rule 102.—Tail rods or extension piston rods.

Tail rods or extension piston rods shall be guarded in accordance with Part IV, sections 40 and 42, or by a guard rail on sides and end, with a clearance of not less than 15 inches when rod is fully extended.

Rule 103.—Governor balls.

Governor balls 6 feet or less from the floor or other working level, when exposed to contact, shall be provided with an inclosure extending to the top of the governor balls when at their highest position. The material used in the construction of this inclosure shall conform to Part IV, sections 40 and 42.

PART II.—MECHANICAL POWER-TRANSMISSION EQUIPMENT

Section 20.—SHAFTING

Rule 200. Installation.

(a) Each continuous line of shafting shall be secured in position against excessive endwise movement.

(b) Inclined and vertical shafts, particularly inclined idler shafts, shall be securely held in position against endwise thrust.

Rule 201. Guarding horizontal shafting.

(a) All exposed parts of horizontal shafting 6 feet or less from floor working platform, excepting runways used exclusively for oiling, or running adjustments, shall be protected by a stationary casing inclosing shafting completely or by a trough inclosing sides and top or sides and bottom of shafting as location requires.

(b) Wherever shafting extends over a driveway it should be protected as stated above unless it is located 15 feet or more above driveway.

(c) Shafting under bench machines shall be inclosed 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 6 inches of the underside of table, or if shafting is located near floor within 6 inches of floor. In every case the sides of trough shall extend at least 2 inches below or above the shafting as the case may be.

NOTE.—For requirements regarding materials and construction see Part IV, sections 40 and 42.

Rule 202. Guarding vertical and inclined shafting.

Vertical and inclined shafting 6 feet or less from floor or working platform, excepting maintenance runways, shall be inclosed with a stationary casing in accordance with requirements of Part IV, sections 40 and 42.

Rule 203. Projecting shaft ends.

(a) 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.

(b) Unused keyways shall be filled up or covered.

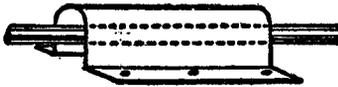
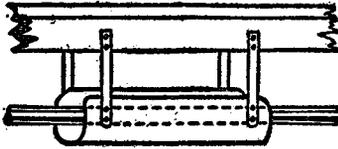
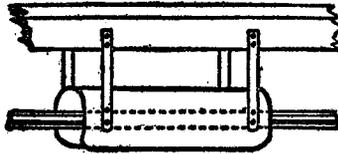
Rule 204. Power-transmission apparatus located in basements.

All mechanical power-transmission apparatus located in basements, towers, and rooms used exclusively for power transmission equipment shall be guarded in accordance with these standards, except that the requirements for safeguarding belts, pulleys, and shafting may be waived when the following conditions are met:

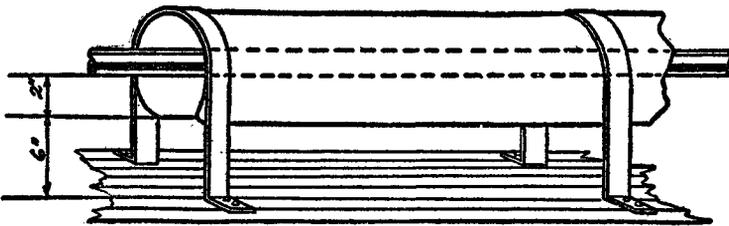
1. The basement, tower, or room occupied by transmission equipment shall be locked against unauthorized entrance.

2. The vertical clearance in passageways between the floor and power-transmission beams, ceiling or any other objects, should not be less than 5 feet 6 inches.

TROUGH GUARDS FOR SHAFTING



SHAFTING LOCATED UNDER BENCH MACHINES



3. The intensity of illumination shall conform to the standard Code for Lighting of Factories, Mills, and other Work Places.

4. The footing shall be dry, firm, and level.

5. The route followed by the oiler shall be protected in such manner as to prevent accident.

NOTE.—The exemption granted by this rule shall not apply to single isolated hazards which can be guarded without hardship in the usual prescribed manner.

Section 21.—PULLEYS

Rule 210. Guarding.

Pulleys any parts of which are 6 feet or less from the floor or working platform shall be guarded in accordance with the standards specified under Part IV, sections 40 and 42. Pulleys serving as balance wheels (e. g., punch presses) on which the point of contact between belt and pulley is more than 6 feet from the floor or platform may be guarded with a disk covering the spokes. See Part IV, section 41.

Rule 211. Location of pulleys.

(a) 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.

(b) Where there are overhanging pulleys on line, jack, or counter-shafts with no bearing between the pulley and the outer end of the shaft, a guide to prevent the belt from running off the pulley should be provided.

(c) For requirements for guarding pulleys located in basements, towers, and rooms where no employees are regularly stationed, see Part II, section 20, rule 204.

Rule 212. Broken pulleys.

Pulleys with cracks, or pieces broken out of rims shall not be used.

Rule 213. Pulley speeds.

Pulleys operating at rim speed in excess of 4,000 feet per minute shall be especially designed for the purpose and carefully balanced for the speed at which they are to operate.

Rule 214. Belt guides.

Belt guides should not be installed except as provided in rule 211 (a) and (b).

Rule 215. Composition and wood pulleys.

Composition or laminated wood pulleys shall not be installed where they are continually subjected to the action of moisture.

Rule 216. Pulleys exposed to corrosion.

Pulleys used where conditions are such as to produce active corrosion should be of corrosion resisting material.

Rule 217. Pulleys out of service.

Pulleys permanently out of service should not be allowed to remain on shafting which is in use.

Section 22.—BELT, ROPE, AND CHAIN DRIVES**Rule 220. Horizontal belts and ropes.**

(a) Where both runs of horizontal belts are 6 feet or less from the floor level, the guard shall extend to at least 15 inches above the belt or to a standard height (see table following rule 420) except that where both runs of a horizontal belt are 42 inches or less from the floor, the belt shall be fully inclosed in accordance with Part IV, sections 40 and 42.

NOTE.—In power plants or power-development rooms a guard rail may be used in lieu of the above.

(b) Overhead horizontal belts, with lower part 7 feet or less from the floor or platform, shall be guarded on sides and bottom in accordance with Part IV, section 42, rule 422.

(c) Horizontal overhead belts more than 7 feet above floor or platform shall be guarded for their entire length under the following conditions:

1. If located over passageways or work places and traveling 1,800 feet or more per minute, and
2. If center to center distance between pulleys is 10 feet or more, and
3. If belt is 8 inches or more in width.

NOTE.—For details of guard construction and for sizes of material see Part IV, section 42, rule 422, and table following rule 423, also Discussion, Part VI.

For exception in case of flat belts 1 inch or less in width, or round belts $\frac{1}{2}$ inch or less in diameter, see "Interpretations and exceptions."

(d) 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—

1. Completely barred by a guard rail or other barrier in accordance with Part IV, sections 40 and 42; or

2. 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 power plants only the lower run of the belt need be guarded.

(e) Overhead chain and link belt drives, where the chain exceeds 2 inches in width, are governed by the same rules as overhead horizontal belts and shall be guarded in the same manner as belts.

NOTE.—All guards to be constructed in accordance with Part IV, section 42, rule 423.

(f) American or continuous system rope drives so located that the condition of the rope (particularly the splice) can not be constantly and conveniently observed shall be equipped with a "telltale" device (preferably electric-bell type) that will give warning when rope begins to fray.

For guarding of overhead rope drives, see Part IV, section 42, rule 423.

Rule 221. Vertical and inclined belts.

(a) Vertical and inclined belts shall be inclosed by a guard conforming to standards in Part IV, sections 40 and 42.

(b) All guards for inclined belts shall be arranged in such a manner that a minimum clearance of 6 feet 6 inches is maintained between belt and floor at any point outside of guard.

NOTE.—For exceptions in the case of narrow belts and slow moving belts see “Interpretations and exceptions.”

Rule 222. Vertical belts.

Vertical belts running over a lower pulley more than 6 feet above floor or platform shall be guarded at the bottom in the same manner as horizontal overhead belts, if conditions are such as stated in Rule 220 (c), 1 and 3.

NOTE.—For exceptions in the case of narrow belts and slow-moving belts see “Interpretations and exceptions.”

Rule 223. Cone-pulley belts.

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.

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. (See rule 313.)

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.

Rule 224. Belt tighteners.

(a) 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.

NOTE.—See Discussion, Part VI.

(b) Where suspended counterweights are used and not guarded by location, they shall be so encased as to prevent accident.

Section 23.—GEARS, SPROCKETS, AND CHAINS

Rule 230. Gears.

Gears shall be guarded in accordance with one of the following specifications:

- (a) A complete inclosure.
- (b) A standard guard as described in section 42 at least 6 feet high extending 6 inches above the mesh point of the gears.
- (c) 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 6 feet from the floor a disk guard or a complete inclosure to the height of 6 feet shall be required.

NOTE.—Rule 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. See part VI, par. 5.

Rule 231. Sprockets and chains.

All sprocket wheels and chains shall be inclosed unless more than 7 feet above the floor or platform.

NOTE.—This does not apply to manually operated sprockets.

Rule 232. Openings for oiling.

When frequent oiling must be done, openings with hinged or sliding self-closing covers shall be provided.

Section 24.—FRICTION DRIVES**Rule 240. Guarding.**

(a) The driving point of all friction drives when exposed to contact shall be guarded.

(b) All arm or spoke friction drives and all web friction drives with holes in the web shall be entirely inclosed.

(c) All projecting bolts on friction drives where exposed to contact shall be guarded.

Section 25.—KEYS, SET SCREWS, AND OTHER PROJECTIONS**Rule 250. Elimination or guarding.**

All projecting keys, set screws and other projections in revolving parts shall be removed or made flush or guarded by metal cover. This does not apply to keys or set screws within gear or sprocket casings or other inclosures, nor to keys, set screws or oil cups in hubs of pulleys less than 20 inches in diameter where they are within the plane of the rim of the pulley.

It is recommended, however, that no projecting set screws or oil cups be used in any revolving pulley or part of machinery, even though they are within the limits stated in the above paragraph.

Section 26.—COLLARS AND COUPLINGS**Rule 260. 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.

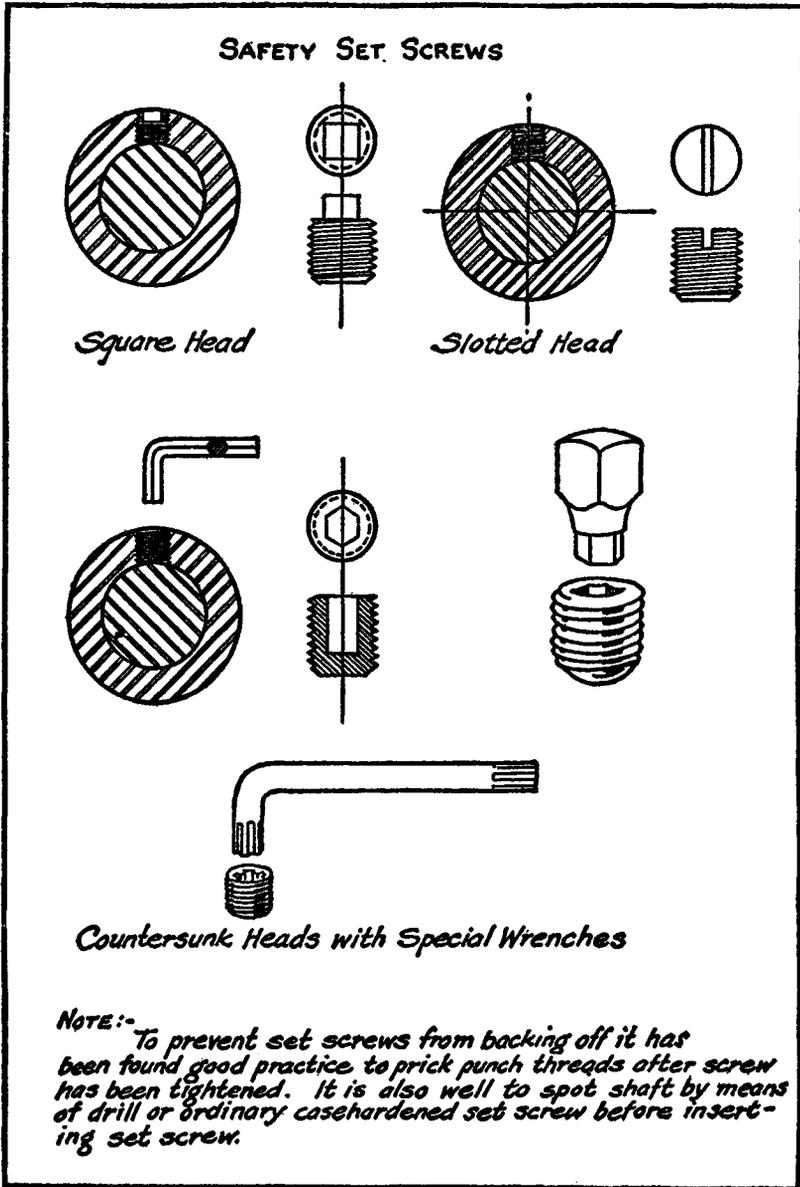
Rule 261. Couplings.

(a) Shaft couplings shall be so constructed as to present no hazard from bolts, nuts, set screws, or revolving surfaces.

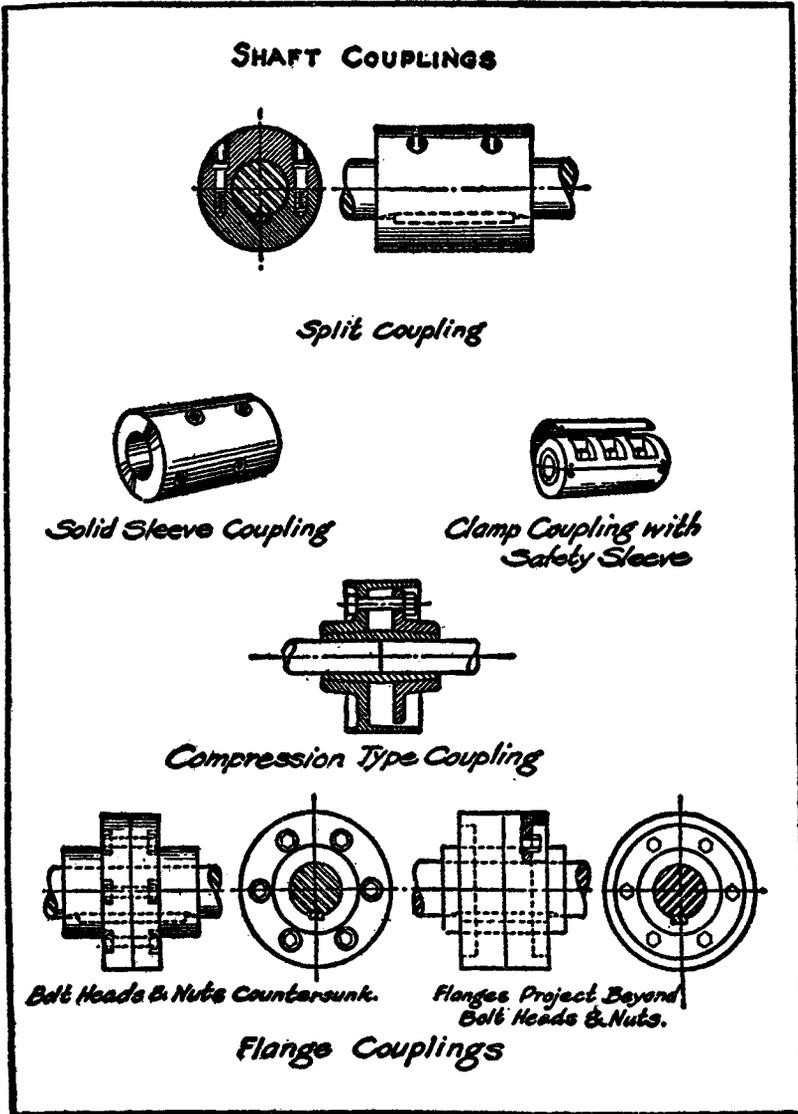
Bolts, nuts, and set screws will, however, be permitted where they are covered with safety sleeves or where they are used parallel with the shafting and are countersunk or else do not extend beyond the flange of the coupling.

NOTE.—While the use of a rib or clamp type coupling is not recommended they will be acceptable if the ends of the fastenings be well within the periphery of the body of the coupling and the ends of all bolts are flush with or below the crown of the nut. All outside surfaces are to be turned or ground and outside edges carefully rounded.

(b) The shifting part of jaw clutches and the shifting or mechanism part of friction clutch couplings should be attached to the driven shaft, i. e., the shaft that will be idle when clutch is disengaged.



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Section 27.—BEARINGS AND FACILITIES FOR OILING**Rule 270. Bearings.**

- (a) Self-lubricating bearings are recommended.
- (b) All drip cups and pans shall be securely fastened.

Rule 271. Ladders.

Wherever portable ladders are used in oiling, repairing, or adjusting power-transmission machinery, these ladders shall be equipped with safety hooks or antislip device at bottom.

NOTE.—For standard construction of ladders see “Safety Code for Ladders.”

Rule 272. Oilers' runways and platforms

Shall conform to the “Safety Code for Floor and Wall Openings, Railings, and Toe Boards.”

PART III.—STARTING AND STOPPING DEVICES

Section 30.—CLUTCHES, CUT-OFF COUPLINGS, AND CLUTCH PULLEYS

Rule 300. Guarding.

(a) Clutches, cut-off couplings, or clutch pulleys having projecting parts, where such clutches are located 7 feet or less above the floor or working platform, shall be inclosed by a stationary guard constructed in accordance with these standards (the U type guard is permissible, see rule 412).

NOTE 1.—Where clutches, cut-off couplings, or clutch pulleys are so situated within a machine or otherwise guarded by location, the application of this rule is within the discretion of the enforcing authority.

NOTE 2.—In engine rooms a guard rail, preferably with toe board, will be permitted instead of the above, provided this room is occupied only by engine-room attendants.

NOTE 3.—The use of a bearing support immediately adjacent to a friction clutch or cut-off coupling being recognized engineering practice, only self-lubricating bearings requiring attention at infrequent intervals shall be used in such locations.

Section 31.—BELT SHIFTERS, CLUTCHES, SHIPPERS, POLES, PERCHES, AND FASTENERS

Rule 310. Belt shifters.

(a) Tight and loose pulleys on all new installations made subsequent to the date of the adoption of this code shall be equipped with a permanent belt shifter provided with mechanical means to prevent belt from creeping from loose to tight pulley.

NOTE.—It is recommended that old installations be changed to conform to this rule.

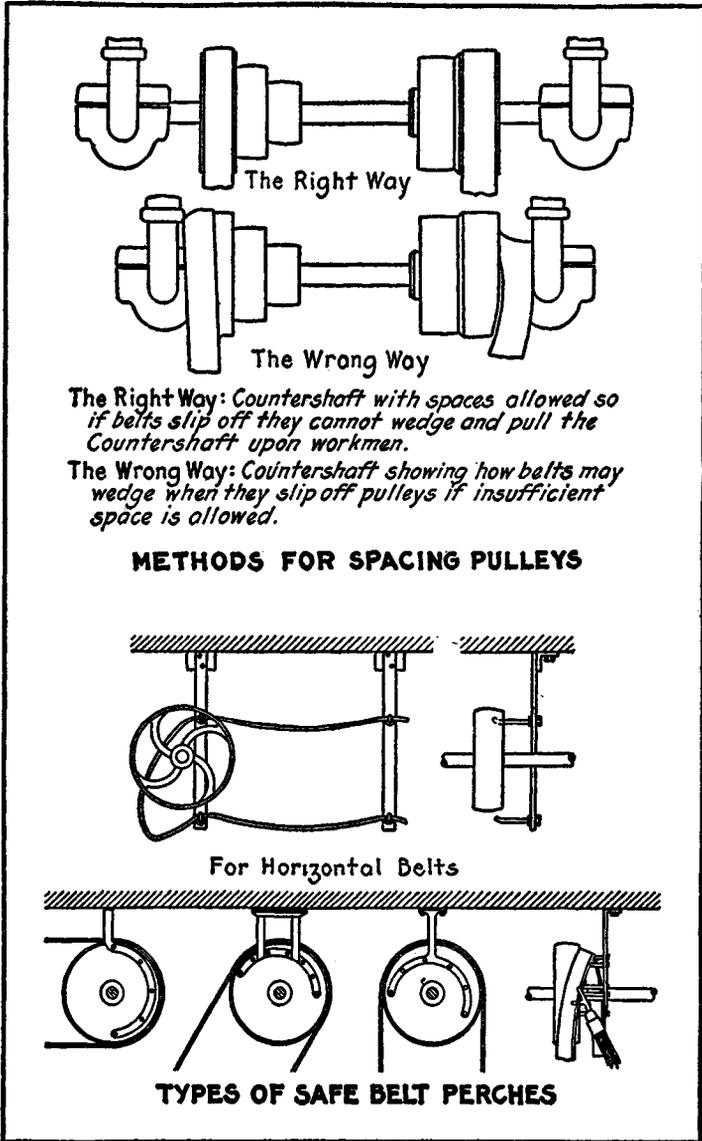
(b) Belt shifter and clutch handles shall be rounded and be located as far as possible from danger of accidental contact, but within easy reach of the operator. Where belt shifters are not directly located over a machine or bench, the handles shall be cut off 6 feet 6 inches above floor level.

(c) All belt and clutch shifters of the same type in each shop should move in the same direction to stop machines, i. e., either all *right* or all *left*.

NOTE.—This does not apply to friction clutch on countershaft carrying two clutch pulleys with open and crossed belts, respectively. In this case the shifter handle has three positions and the machine is at a standstill when clutch handle is in the neutral or center position.

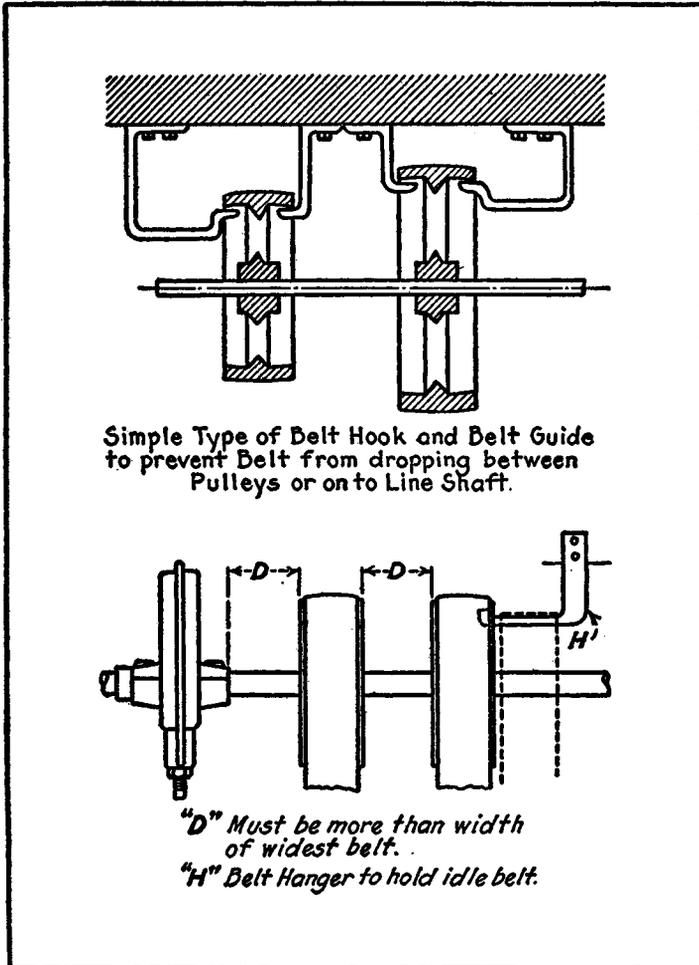
Rule 311. Belt shippers and shipper poles.

The use of belt poles as substitutes for mechanical shifters is not recommended. Where necessity compels their use they shall be of sufficient size to enable workmen to grasp them securely. (A 2-inch diameter or 1½ by 2-inch cross-section is suggested.) Poles shall be smooth and preferably of straight grain hardwood, such as ash or hickory. The edges of rectangular poles should be rounded. Poles should extend from the top of the pulley to within about 40 inches of floor or working platform.



Rule 312. 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. Perches should be substantially made and so designed that the shipping of belts to and from them can be safely accomplished.

**Rule 313. Belt fasteners.**

Belts which of necessity must be shifted by hand and belts within 6 feet of the floor or working platform which are not guarded in accordance with the intent of this code shall not be fastened with metal in any case nor with any other fastening which by construction or wear will constitute an accident hazard.

PART IV.—GUARD STANDARDS

Section 40.—STANDARD GUARDS—GENERAL REQUIREMENTS

Rule 400. Materials.

(a) Standard conditions will be secured by the use of the following materials: Expanded metal, perforated or solid sheet metal, or wire mesh on a frame of angle iron or iron pipe securely fastened to floor or to frame of machine. See section 42, rule 420.

(b) All metal should be free from burrs and sharp edges.

(c) Wire mesh should be of the type in which the wires are securely fastened at every cross point either by welding, soldering, or galvanizing, except in case of diamond or square wire mesh made of No. 14 gauge wire, $\frac{3}{4}$ -inch mesh or heavier.

NOTE.—For method of fastening diamond or square wire mesh made of crimped wire into frames see rule 402 (3).

Rule 401. Design of guards.

(a) Where it is necessary to change belts, make adjustments, or for the admission of oil or grease, guards should preferably be provided with hinged sections or be made removable.

(b) Guards should be designed so as not to interfere with the usual machine operations, but give the maximum protection to the operator.

Rule 402. Method of manufacture.

(a) Expanded metal, sheet or perforated metal, and wire mesh shall be securely fastened to frame by one of the following methods:

(1) With rivets or bolts spaced not more than 5 inches center to center. In case of expanded metal or wire mesh, metal strips or clips shall be used to form a washer for rivets or bolts.

(2) By welding to frame every 4 inches.

(3) By weaving through channel or angle frame, or if No. 14 gauge $\frac{3}{4}$ -inch mesh or heavier is used by bending entirely around rod frames.

(4) Where openings in pipe railing are to be filled in with expanded metal, wire mesh, or sheet metal, the filler material shall be made into panels with rolled edges or bound with V or U edging of No. 24 gauge or heavier sheet metal fastened to the panels with bolts or rivets spaced not more than 5 inches center to center. The bound panels shall be fastened to the railing by sheet-metal clips spaced not more than 5 inches center to center.

NOTE.—Diamond or square mesh made of crimped wire fastened into channels, angle or round-iron frames, may also be used as a filler in guards.

Size of mesh shall correspond to table given under rule 420.

(b) Where the design of guards requires filler material of greater area than 12 square feet, additional frame members shall be provided to maintain panel area within this limit.

(c) All joints of framework shall be made equivalent in strength to the material of the frame.

Section 41.—DISK, SHIELD, AND “U” GUARDS

Rule 410. Disk guards.

(a) A disk guard shall consist of a sheet-metal disk not less than No. 22 gauge fastened by U bolts or rivets to spokes of pulleys, fly-wheels or gears. Where possibility of contact with sharp edges of the

disk exists, the edge shall be rolled or wired. In all cases the nuts shall be provided with lock nuts which shall be placed on the unexposed side of the wheel.

Rule 411. Shield guards.

(a) A shield guard shall consist of a frame filled with wire mesh, expanded, perforated, or solid sheet metal.

(b) If area of shield does not exceed 6 square feet the wire mesh or expanded metal may be fastened in a framework of $\frac{3}{8}$ -inch solid rod, $\frac{3}{4}$ by $\frac{3}{4}$ by $\frac{1}{8}$ -inch angle iron or metal construction of equivalent strength.

Metal shields may have edges entirely rolled around a $\frac{3}{8}$ -inch solid iron rod.

NOTE.—All material of shield guard shall meet the requirements of section 42, rule 420.

Rule 412. U guards.

U guards shall be constructed of materials specified in table, section 42, rule 420. Edges shall be smooth and if size of guard requires, these edges shall be reinforced by rolling, wiring, or by binding with angle or flat iron.

Section 42.—APPROVED MATERIALS

Rule 420. Minimum requirements.

The materials and dimensions specified in this rule shall apply to all guards except horizontal overhead belts, rope, cable, or chain guards more than 7 feet above floor, or platform. (For the latter see table following rule 423.)

(a) Table of standard materials and dimensions

Material	Clearance from moving parts at all points	Largest mesh or opening allowable	Minimum gauge (U. S. standard) or thickness	Minimum height of guard from floor or platform level
				<i>Feet</i>
Woven wire.....	{ Under 4 inches.....	$\frac{1}{2}$ inch.....	No. 16.....	6
	{ 4 to 15 inches.....	2 inches.....	No. 12.....	5
Expanded metal.....	{ Under 4 inches.....	$\frac{1}{2}$ inch.....	No. 18.....	6
	{ 4 to 15 inches.....	2 inches.....	No. 13.....	5
Perforated metal.....	{ Under 4 inches.....	$\frac{1}{2}$ inch.....	No. 20.....	6
	{ 4 to 15 inches.....	2 inches.....	No. 14.....	5
Sheet metal.....	{ Under 4 inches.....	No. 22.....	6
	{ 4 to 15 inches.....	No. 22.....	5
Wood or metal strip crossed.....	Under 4 inches.....	$\frac{1}{2}$ inch.....	Wood $\frac{3}{4}$ inch. Metal No. 16.....	6
	4 to 15 inches.....	2 inches.....	Wood $\frac{3}{4}$ inch. Metal No. 16.....	5
Wood or metal strip not crossed.....	Under 4 inches.....	$\frac{1}{2}$ inch width.....	Wood $\frac{3}{4}$ inch. Metal No. 16.....	6
	4 to 15 inches.....	1 inch width.....	Wood $\frac{3}{4}$ inch. Metal No. 16.....	5
Standard rail.....	{ Minimum 15 inches... Maximum 20 inches...}	See standard for railings (rule 424)		

NOTE.—For flat belts 1 inch or less in width and round belts $\frac{1}{2}$ inch or less in diameter see "Scope."

(b) Framework.

(1) Minimum dimensions of materials for the framework of all guards except as noted in paragraph 3 shall be angle iron 1 by 1 by $\frac{1}{8}$ inch, metal pipe of $\frac{3}{4}$ inch inside diameter or metal construction of equivalent strength.

All guards shall be rigidly braced every 3 feet or fractional part of their height to some fixed part of machinery or building.

(2) The framework for all guards fastened to floor or working platform and without other support or bracing shall consist of $1\frac{1}{2}$ by $1\frac{1}{2}$ by $\frac{1}{8}$ -inch angle iron, metal pipe of $1\frac{1}{2}$ inches inside diameter or metal construction of equivalent strength. All rectangular guards shall have at least four upright frame members each of which shall be carried to the floor and be securely fastened thereto.

Cylindrical guards shall have at least three supporting members carried to floor.

(3) Guards 30 inches or less in height and with a total surface area not in excess of 10 square feet may have a framework of $\frac{3}{8}$ inch solid rod, $\frac{3}{4}$ by $\frac{3}{4}$ by $\frac{1}{8}$ inch angle or metal construction of equivalent strength. The filling material shall correspond to the requirements of the table under rule 420.

NOTE.—This rule is made for the purpose of providing a standard for small guards not subject to severe stress for use in locations where guards constructed of framework as specified in the above standards would be cumbersome and unnecessarily expensive.

(c) The specifications given in (a) and (b) are the minimum requirements; where guards are exposed to unusual wear or deterioration, heavier material should be used.

Rule 421. Wood guards.

(a) 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 will not be allowed except by special permission of the supervising authority.

NOTE.—A wood guard unless very carefully constructed is not substantial. Wood guards are a decided fire hazard, especially when they become saturated with oil and when they are located near flammable material.

(b) *Material and construction.*

(1) Wood shall be sound, tough, and free from any loose knots.

(2) Guards shall be made of planed lumber not less than 1 inch rough board measure and edges and corners rounded off.

(3) Wood guards shall be securely fastened together with wood screws, hardwood dowel pins, bolts, or rivets.

(4) While no definite dimensions are given under this heading for framework or filler materials, wood guards shall be equal in strength and rigidity to metal guards specified in rule 420 (a), (b), and (c).

(5) For construction of standard wood railing see section 42, rule 424.

Rule 422. Guards for horizontal overhead belts.

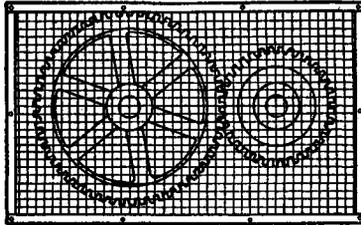
(a) Guards for horizontal overhead belts shall run the entire length of the belt and follow the line of the pulley to the ceiling or be carried to the nearest wall, thus inclosing the belt effectively. Where belts are so located as to make it impracticable to carry the guard to wall or ceiling, construction or guard shall be such as to inclose completely the top and bottom runs of belt and the face of pulleys. See rule 220 (b) and (c).

(b) The guard and all its supporting members shall be securely fastened to wall or ceiling by gimlet-point lag screws or through bolts. In case of masonry construction, expansion bolts shall be used. The use of bolts placed horizontally through floor beams or ceiling rafters is recommended.

(c) Suitable reinforcement shall be provided for the ceiling rafters or overhead floor beams, where such is necessary, to sustain safely

GUARD CONSTRUCTION

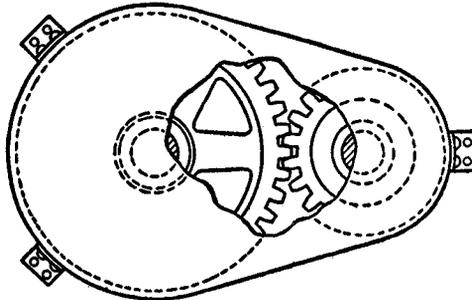
Front



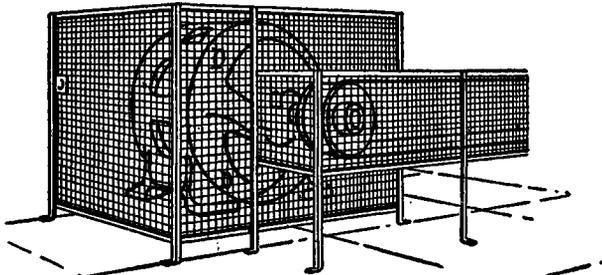
Side



GEAR GUARD WITH WIRE CLOTH FILLER

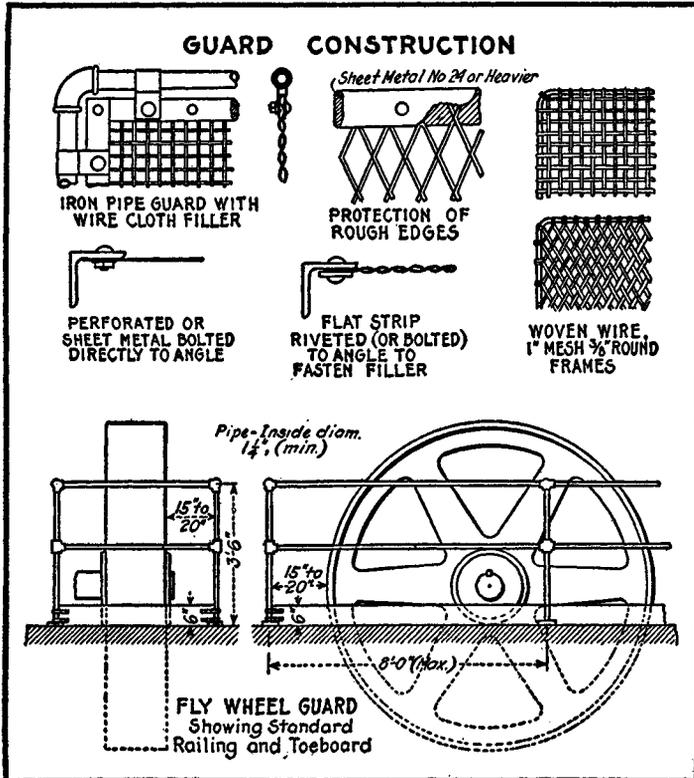


GEAR GUARD OF SHEET METAL



MOTOR AND LOW BELT ENCASED

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 round-head 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 6 inches on each side. Overhead rope drive and block and roller-chain-drive guards shall be not less than 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 20-inch centers or under shall be not less than $\frac{1}{4}$ inch from the nearest moving chain part and on drives of over 20-inch centers a minimum of $\frac{1}{2}$ inch from the nearest moving chain part.

(d) The table following rule 423 gives sizes of materials to be used and general construction of guards for belts 10 inches or more in width. No material for overhead belt guards should be smaller than that specified in this table for belts 10 to 14 inches wide, even if the belt is less than 10 inches in width. However, No. 20 gauge sheet metal may be used as a filler on guards for belts less than 10 inches wide. Expanded metal, because of the sharp edges, should not be used as a filler in horizontal belt guards.

(e) For clearance between guards and belts, ropes, or chains of various center to center dimensions between the shafts see bottom of table following rule 423.

Rule 423. Guards for horizontal overhead rope and chain drives.

Overhead-rope and chain-drive guard construction shall conform to the rules for overhead-belt guard construction of similar width, except that the filler material shall be of the solid type as shown in the table unless the fire hazard demands the use of open construction. A side guard member of the same solid filling material should be carried up in a vertical position 2 inches above the level of the lower run of the rope or chain drive and 2 inches within the periphery of the pulleys which the guard incloses, thus forming a trough. These side filler members should be reinforced on the edges with $1\frac{1}{2}$ by $\frac{1}{4}$ inch flat steel, riveted to the filling material at not greater than 8-inch centers; the reinforcing strip should be fastened or bolted to all guard supporting members with at least one $\frac{3}{8}$ -inch rivet or bolt at each intersection, and the ends should be secured to the ceiling with lag screws or bolts. The filling material shall be fastened to the framework of the guard and the filler supports by $\frac{3}{16}$ -inch rivets spaced on 4-inch centers. The width of the multiple drive shall be determined by measuring the distance from the outside of the first to the outside of the last rope or chain in the group accommodated by the pulley.

Rule 424. Guard rails and toe boards.

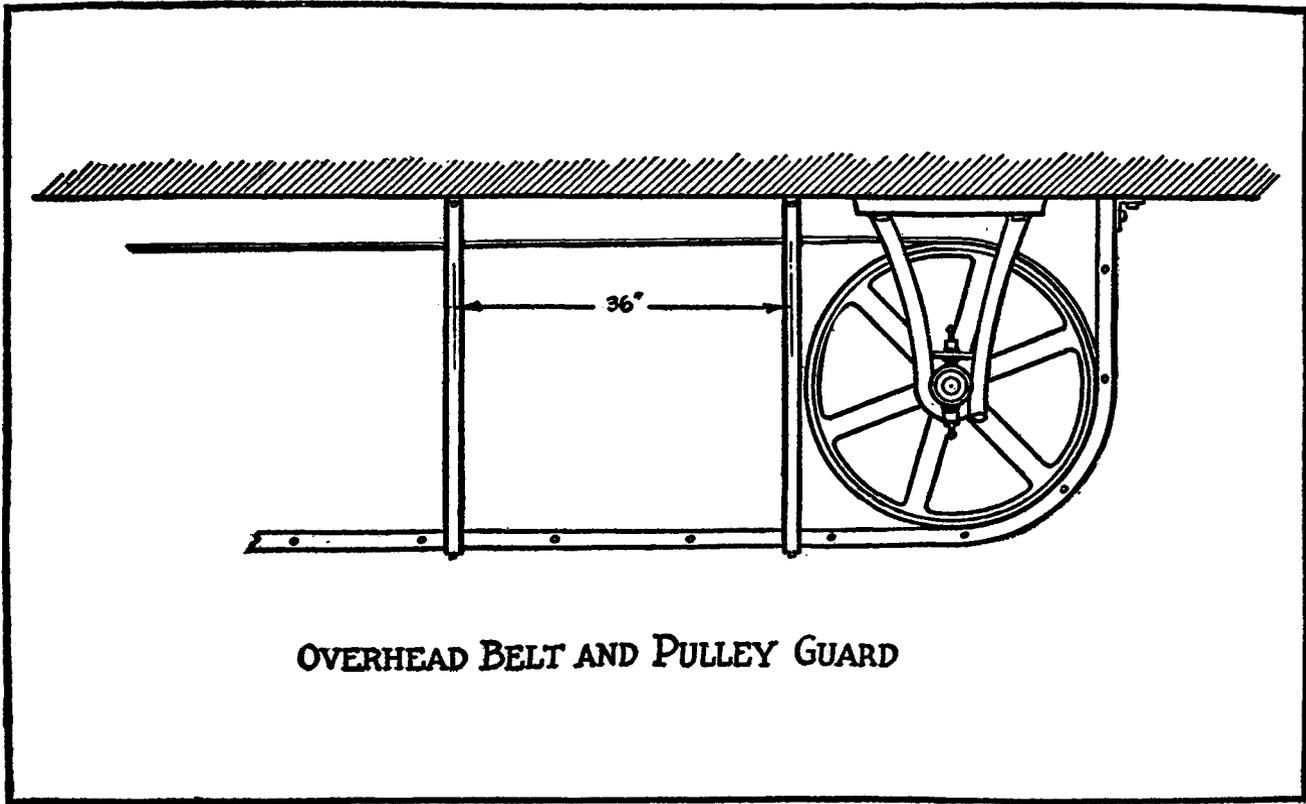
(a) Guard rail shall be 42 inches in height, with mid rail between top rail and floor.

(b) Posts shall be not more than 8 feet apart; they are to be permanent and substantial, smooth, and free from protruding nails, bolts, and splinters. If made of pipe, it shall be $1\frac{1}{4}$ inches inside diameter, or larger. If made of metal shapes or bars their section shall be equal in strength to that of $1\frac{1}{2}$ by $1\frac{1}{2}$ by $\frac{3}{16}$ -inch angle iron. If made of wood, the posts shall be 2 by 4 inches or larger. The upper rail shall be 2 by 4 inches, or two 1 by 4 strips, one at the top and one at the side of posts. The mid rail may be 1 by 4 inches or more. The rails (metal shapes, metal bars, or wood), should be on that side of the posts which gives the best protection and support. Where panels are fitted with expanded metal or wire mesh as noted in table, 420 (a), the middle rails may be omitted.

(c) Toe boards shall be 4 inches or more in height, of wood, metal, or of metal grill not exceeding 1 inch mesh. Toe boards at flywheel pits should preferably be placed as close to edge of the pit as possible.

Horizontal overhead belts, ropes, and chains 7 feet or more above floor or platform

Guard.	WIDTH.			Material.
	Over 10" to 14" inclusive.	Over 14" to 24" inclusive.	Over 24".	
MEMBERS				
Framework.....	1½" x 1½" x ¼"	2" x 2" x ¼"	3" x 3" x ⅝"	Angle iron.
Filler (belt guards).....	1½" x ⅞"	2" x ⅞"	2" x ⅞"	Flat iron.
Filler and vertical side member.....	No. 20 A. W. G.	No. 18 A. W. G.	No. 18 A. W. G.	Solid sheet metal.
Filler supports.....	2" x ⅞" flat iron	2" x ⅞" flat iron	2½" x 2½" x ¼" angle.	Flat and angle.
Guard supports.....	2" x ⅞"	2" x ⅞"	2½" x ⅞"	Flat iron.
FASTENINGS.				
Filler supports to framework.....	(2) ¼"	(2) ⅜"	(3) ½"	Rivets.
Filler flats to supports (belt guards).....	(1) ⅞"	(1) ⅞"	(2) ⅞"	Flush rivets.
Filler to frame and supports (rope and chain guards).....	⅞" rivets spaced.....	8" centers on sides and 4" centers on bottom.		
Guard supports to framework.....	(2) ⅝"	(2) ⅞"	(2) ⅝"	Rivets or bolts.
Guard and supports to overhead ceiling.....	¼" x 3½" lag screws or ½" bolts.	⅝" x 4" lag screws or ⅝" bolts.	¾" x 6" lag screws or ¾" bolts.	Lag screws or bolts.
DETAILS—SPACING, ETC.				
Width of guards.....	One-quarter wider than belt, rope, or chain drive.			
Spacing between filler supports.....	20" C. to C.....	16" C. to C.....	16" C. to C.....	
Spacing between filler flats (belt guards).....	2" apart.....	2½" apart.....	3" apart.....	
Spacing between guard supports.....	36" C. to C.....	36" C. to C.....	36" C. to C.....	
OTHER BELT GUARD FILLING PERMITTED.				
Sheet metal fastened as in rope and chain guards.....	No. 20 A. W. G.....	No. 18 A. W. G.....	No. 18 A. W. G.....	Solid or perforated.
Woven wire, 2" mesh.....	No. 12 A. W. G.....	No. 10 A. W. G.....	No. 8 A. W. G.....	
CLEARANCE FROM OUTSIDE OF BELT, ROPE, OR CHAIN DRIVE TO GUARD.				
Distance center to center of shafts.....	Up to 15' inclusive.....	Over 15' to 25' inclusive.....	Over 25' to 40' inclusive.....	Over 40'.
Clearance from belt, rope, or chain to guard.....	6".....	10".....	15".....	20".....



OVERHEAD BELT AND PULLEY GUARD

PART V.—OPERATING RULES.

Section 50.—CARE OF EQUIPMENT.

Rule 500. General.

All power-transmission equipment shall be inspected at intervals not exceeding 60 days and be kept in good working condition at all times.

Rule 501. Shafting.

(a) Shafting shall be kept in alignment, free from rust, and excess oil or grease.

(b) Where explosives, explosive dusts, flammable vapors, or flammable liquids exist, the hazard of static sparks from shafting shall be carefully considered.

NOTE.—Static electricity may be removed by means of a spring copper brush in contact with the shafting. This brush must be well grounded through No. 12 insulated copper wire. Other effective methods may be used.

Rule 502. Bearings.

Bearings shall be kept in alignment and properly adjusted.

Rule 503. 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.

Rule 504. Pulleys.

(a) Pulleys shall be kept in proper alignment to prevent belts from running off.

(b) Both driving and driven pulleys carrying a nonshifting belt should have crowned faces.

(c) Cast-iron pulleys should be tested frequently with a hammer to disclose cracks in rim or spokes. It should be borne in mind that the sound is usually much different if the belt is or is not on the pulley.

(d) Split pulleys should be inspected to ascertain if all bolts holding together the sections of the pulley are tight.

Rule 505. Care of belts.

(a) Quarter-twist belts when installed without an idler can be used on drives running in one direction only. They will run off a pulley when direction of motion is reversed.

(b) Inspection shall be made of belts, lacings, and fasteners and such equipment kept in good repair.

(c) Where possible, dressing should not be applied when belt or rope is in motion; but, if this is necessary, it should be applied where belts or rope leave pulley, not where they approach. The same precautions apply to lubricating chains.

(d) The hazard of static electricity from belts shall be carefully considered where explosives, explosive dusts, flammable vapors, or flammable liquids exist.

NOTE.—Static electricity may be removed from belts by means of metallic flexible-tooth combs the same width as the belts. One comb should be placed within 10 inches of the line of contact where the belt leaves each pulley or flywheel. These combs should be in contact with and placed transversely to the belt and also be well grounded with No. 12 insulated copper wire. The teeth of the comb should point in the direction of the belt motion. Other effective methods may be used.

Rule 506. Belts on overhead pulleys.

A belt pole should be used to throw off or put on belts.

In unshipping a belt it should always be thrown off the driving pulley, not the driven.

It is advisable to have one experienced man to take care of overhead belts and put them on and take them off pulleys.

Belts should not be allowed to ride on shafting but should be held from same either by loop or belt perch. (See rule 312.)

Rule 507. Lubrication.

The regular oilers shall wear tight-fitting clothing and should use cans with long spouts to keep their hands out of danger.

Machinery shall be oiled when not in motion, wherever possible.

PART VI.—DISCUSSION.

1. *Broken pulleys.*—Under section 21, rule 212 states that pulleys with small pieces broken out of rim shall not be used. The rough edges formed by pieces broken out of pulley rim offer a decided accident hazard in case anyone should come in contact with the rough edge of the pulley rim. Considerable unnecessary wear on the belt is also caused.

2. *Belt tighteners.*—Under section 22, rule 223 states that belt tighteners of the suspended type shall be arranged in such a way as to prevent falling on any person below, should the belt break or throw tightener. This can be accomplished by securely fastening cables or chains of sufficient strength to the tightener and to the roof, or some substantial object above, to prevent it from falling far enough to strike a person.

3. *Power control.*—Among the methods used for power control may be mentioned motor switches, friction clutches, belt shifters, and engine stops. The means for controlling power should be positive and should be so arranged as to permit of operation from a point not more than 100 feet from any machine driven from the source of power in question. If the stations can be arranged to be within 50 feet of any machine, it is highly advisable. There will be cases, as for example in the steel industry, where a greater distance from the machine becomes necessary.

It is advisable to mark the stop station with a mark easily distinguishable—green bands on posts and green circles on walls are recommended, together with a sign "Stop station" or "Emergency stop." A light of characteristic color should be added in shops where night work is carried on.

All electrical safety devices should operate by the opening of a *normally closed circuit*. Any failure of the current or device will thus be indicated by the stopping of the prime mover. It is advisable to test such devices daily by shutting off the power at noon or night by such means.

4. *Power-transmission equipment.*—Rule 204 states certain conditions under which the guarding of power-transmission equipment may be modified. This rule was inserted as frequently in paper or saw mills, woodworking plants, etc., transmission equipment is located in basements, lofts, or transmission towers not used for any other purpose, and it would be a hardship to require the complete guarding of this apparatus.

5. *Hand-operated gears.*—The note under rule 230 states that hand-operated gears need not be equipped with guards. Quite frequently, however, such gears are operated by a short lever or crank, and when the operator braces himself against the frame of the machine he is likely to come in contact with the gears. It is always good practice to look into this matter carefully, and wherever there is the slightest chance of injury it is well to provide guards.

6. *Horizontal overhead belts.*—Rule 220 (c) covers guarding of horizontal overhead belts more than 7 feet above floor or platform. It is a difficult proposition to decide which overhead belts need guarding and which can be left exposed. These belts, under certain operating conditions, offer a decided accident hazard in case they break. Any belt transmitting power is subjected to a certain stress which increases with the load and the speed. In case this belt breaks this force is reduced somewhat, due to the fact that the driving power is eliminated. The belt is impelled only by its momentum, but this is usually sufficient to give it a decided whipping force strong enough to cause considerable damage. This question of overhead belts located more than 7 feet above floor or working platform is well worth investigating as the cost of one serious accident might suffice to pay for quite a number of guards.

PART VII.—REFERENCES

The Safety Codes printed in the list below are those dealing with subjects other than Mechanical Power-Transmission Apparatus but related in some way to this Code. These Codes, when completed and approved will be known as "American Standard" or "Tentative American Standard" Codes and may be obtained from the American Engineering Standards Committee, 29 West Thirty-ninth Street, New York.

APPROVED AND PUBLISHED

Abrasive Wheels, Safety Code for the Use, Care and Protection of.
Aeronautics, Safety Code for.
Automobile Brakes and Brake Testing, Safety Code for.
Building Exits Code.
Electrical Equipment in Coal Mines, Safety Rules for Installing and Using.
Electrical Code, National.
Electrical Safety Code, National.
Elevators and Escalators, Safety Code for.
Explosives, Permissible, Specifications for the Testing and Use of.
Forging and Hot Metal Stamping, Safety Code for.
Foundries, Safety Code for the Protection of Industrial Workers in.
Gas Safety Code.
Heads and Eyes of Industrial Workers, Safety Code for the Protection of.
Ladders, Safety Code for.
Laundry Machinery and Operations, Safety Code for.
Lighting Factories, Mills, and Other Work Places, Code of.
Lighting of School Buildings, Code for.
Logging and Sawmill Machinery, Safety Code for.
Paper and Pulp Mills, Safety Code for.
Power presses and Foot and Hand Presses, Safety Code for.
Woodworking Plants, Safety Code for.

CODES IN PROCESS OF DEVELOPMENT

Compressed Air Machinery, Safety Code for.
Construction Work, Safety Code for.
Conveyors and Conveying Machinery, Safety Code for.
Cranes, Derricks, and Hoists, Safety Code for.
Electrical Fire and Safety Code.
Exhaust Systems, Safety Code for.
Explosives, Safety Code for.
Floor and Wall Openings, Railings, and Toe Boards, Safety Code for.
Lamps, Electric Mine, Permissible Portable.
Lightning, Code on Protection Against.
Locomotives, Storage Battery, for Use in Gaseous Mines.
Plate and Sheet Metal Working, Safety Code for.
Power Control, Mechanical, Safety Code for.
Refrigeration, Mechanical, Safety Code for.
Sanitation, Industrial, Safety Code for.
Tanneries, Safety Code for.
Textiles, Safety Code for.
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