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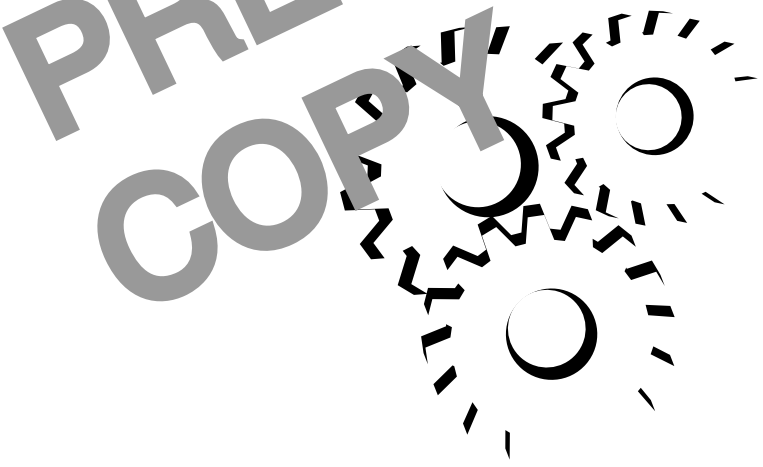
MAINTENANCE OF MECHANICAL DRIVES

Lesson One

Chain Drives



TPC Training Systems

34101

Lesson

1 Chain Drives

TOPICS

Types of Chain Drive
Installing and Aligning Shafts
Mounting the Drive Sprockets
Mounting the Drive Chain
Test Running with No Load
Lubrication Recommendations
Lubrication Methods or Types
Test Running with Full Load
Preventive Maintenance of Chain
Care of Stored Chain
Troubleshooting Chain Drives
Chain Drives and Safety

OBJECTIVES

After studying this Lesson, you should be able to…

- List four types of chain drives.
- Describe the procedure for aligning the driving and driven shafts.
- Distinguish between bored sprockets and bushed sprockets and tell how each is mounted.
- Tell how a drive chain is mounted on the sprockets.
- List four methods of lubrication for chain drives.
- Explain both no-load and full-load test running procedures.
- Describe the causes of fatigue breaks, tensile breaks, rapid chain wear, roller wear, and side plate spreading.

KEY TECHNICAL TERMS

Idler sprocket 1.04 a sprocket mounted on a tightener to control chain tension and eliminate weaving
Bushed sprocket 1.15 a sprocket equipped with a tapered bushing for easier installation and removal
Roller chain 1.18 a continuous series of rollers mounted on pins held between sideplates
Horsepower rating 1.27 capacity of chain based on speed, small sprocket size, and lubrication
Preventive maintenance 1.36 program to prevent breakdowns and keep machinery operating
Troubleshooting 1.50 process of finding and correcting the cause of failure in a machine

Chain drives for manufacturing and processing machinery serve a wide range of your plant's needs. These popular drives function well at low to moderately high speeds, and under very light loads to very heavy ones. Installing and maintaining these drives requires special techniques that other drives do not.

The precision roller chain used in chain drives has many finely machined surfaces and joints that give it unusual flexibility, strength, and service life. To prolong these benefits, this Lesson tells how to install and maintain the chain. Good drive operation requires proper chain installation and adequate lubrication.

In a properly maintained drive, the heavy steel sprockets may outlast three chains. The service life of sprockets can be shortened—and their teeth made useless—if you don't maintain the chain well. This Lesson offers practical suggestions for troubleshooting chain breakage and preventing drive failure.

Types of Chain Drive

1.01 Most new machines purchased for industry come with their motors and drive shafts already in position. Their arrangement has already been established by the manufacturer. Sometimes, however, you may be called on to install a new chain drive—or to modify an existing one. Perhaps you will have to determine the positions of the driving and driven shafts, and how to connect them into the drive train. In cases like these, one of the following basic arrangements should meet your needs.

1.02 **Horizontal chain drive**. In horizontal drives (Fig. 1-1), a line connecting the centers of the shaft ends would be almost horizontal. The top two views show a speed reduction, as indicated by the difference in the sizes of the sprockets. The setup at the bottom is often used where the distance between shaft centers (the center distance) is longer than usual. The arrows indicate the direction of shaft rotation and chain movement.

1.03 If possible, install the chain so that the driving (tight) strand is on top of the sprockets. If the top side is slack, as sometimes happens, it may rub against the lower strand during operation, damaging both the drive and the machine. This is most likely to occur when the center distance is long.

1.04 **Vertical chain drive with idler**. Most chain drives—particularly vertical drives—have some means of adjusting the chain tension to compensate for normal wear. The usual way to do this is to increase the center distance. If a machine has fixed center distances (nonadjustable), an *idler sprocket* should be installed in the drive system, as shown in Fig. 1-2. If you place the idler outside the chain loop (Fig. 1-2A, B, and C), install it nearer

Fig. 1-1. Patterns for horizontal shaft drives

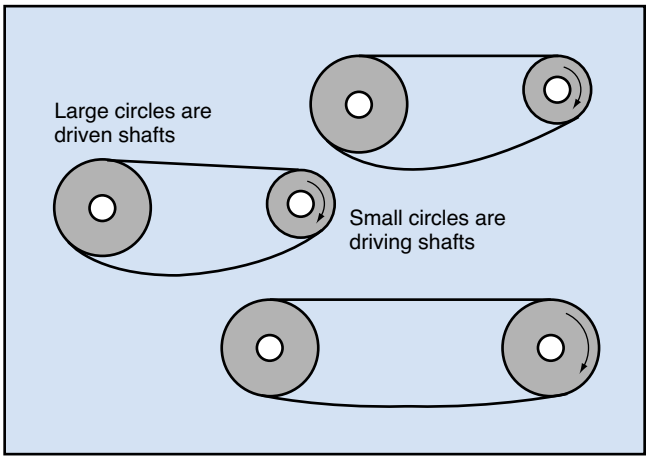


Fig. 1-2. Idler sprockets on either side of chain

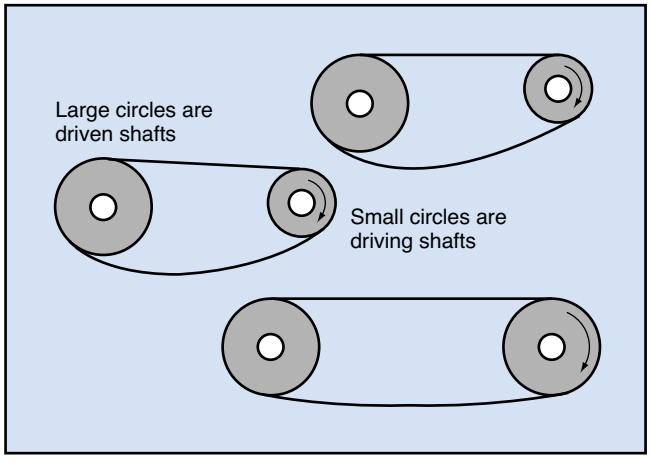


Fig. 1-3. Common types of drive chain tighteners

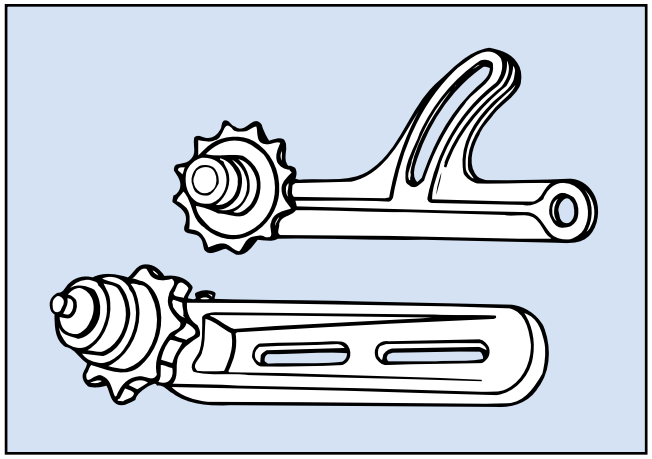
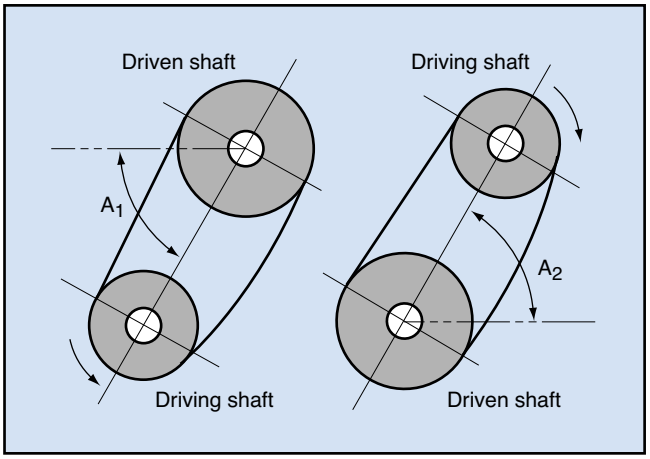


Fig. 1-4. Vertical shaft drives without idlers



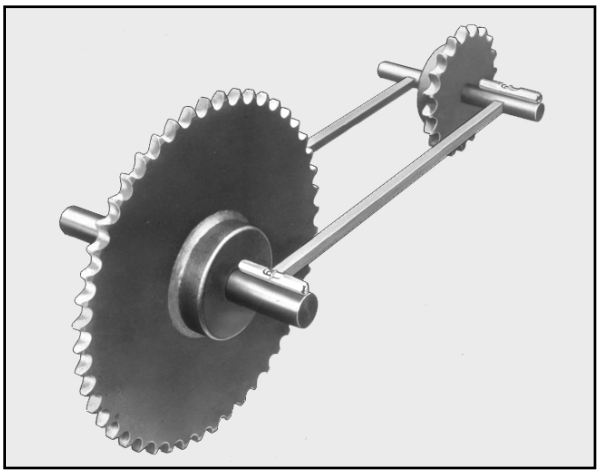
to the small drive sprocket. If you place it inside the loop (Fig. 1-2D), mount it nearer to the large sprocket. At all times, at least three idler sprocket teeth should engage the chain. Adjustable chain tighteners permit you to move the idler farther into the chain as wear occurs.

1.05 The most convenient way to mount an idler sprocket on a drive is to support it on a chain tightener bracket, as shown in Fig. 1-3. The tightener assembly, either spring loaded or manually adjusted, consists of a cast iron bracket, in the bore of which a setscrew anchors a steel shaft for the sprocket. Most chain tighteners are equipped with a lubrication fitting and a pair of steel safety collars for the sprocket.

1.06 **Vertical chain drive without idler**. In vertical drives *without idlers* (Fig. 1-4), install the shafts so that one is not directly above or below the other. Angle A_1 or A_2 should be no more than 60°. At any larger angle, the chain's weight tends to pull it away from the lower sprocket. This greatly reduces the operating life and power transmission efficiency of the chain.

1.07 **Multi-shaft drive**. Multiple-spindle machines, such as looms, have several drive shafts. They are a little harder to maintain than conventional two-shaft drives. The chain installation is basically the same, however, and the shafts and sprockets must be aligned as they are in two-shaft drives.

Fig. 1-5. Checking drive shafts with spirit levels



Installing and Aligning Shafts

1.08 As it wraps around the sprocket teeth, a precision roller chain is flexible in only one plane. It has little capacity to twist or to vary from its lengthwise axis. You must align the chain accurately during installation, and check its alignment periodically during operation.

1.09 For efficient operation, both the driving and driven shafts must be level and they must be parallel with each other. To level the shafts, place a spirit level on them (Fig. 1-5). Use a straightedge against the shaft ends to check the parallelism. You can readily see any misalignment in a parallel plane by sighting along the straightedge.

1.10 If the center distance is too great to use a straightedge, measure the distance between the outside diameters (ODs) of the shafts at several points. If the shafts are parallel, all measurements should be the same. If they are not parallel, move

Fig. 1-6. Place sprockets as near bearing as possible

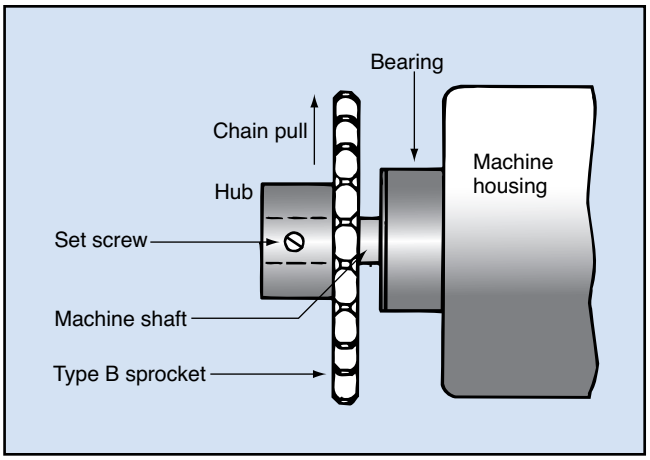
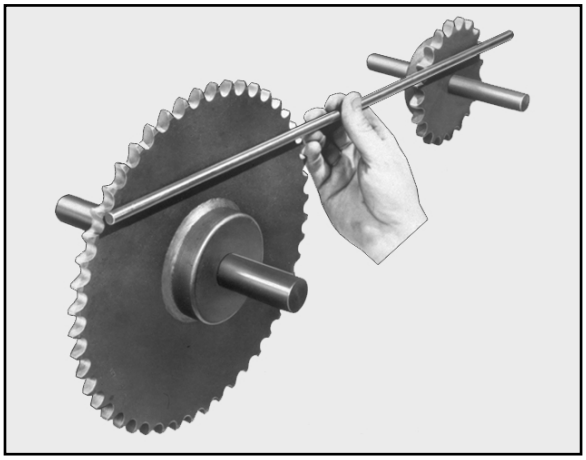


Fig. 1-7. Aligning faces with a steel rod



the shafts into correct alignment by adjusting either one of them. Use shims to position them in a level plane.

Mounting the Drive Sprockets

1.11 Inspect the drive sprockets before mounting them on their shafts. Look for nicked or cracked teeth. Remove or repair nicks and burrs with a fine file. Don't use a sprocket with damaged teeth. Check the bores and keyways of the sprockets; remove any rust, grease, or dirt from the bores.

1.12 Inspect the journal surfaces of the shafts on which the sprockets will be mounted. Remove any rough spots with pumice or emery cloth, and apply a coating of light oil, such as SAE 20. When mounting Type B sprockets (which have only one hub), put the hubless face of the sprocket against the bearing to keep the pull of the chain as close as possible to the bearing. See Fig. 1-6.

1.13 **Bored sprockets**. To mount a conventional bored sprocket (it has no bushing), insert the key in the shaft keyseat and align the sprocket keyway with the key. Using firm, even pressure, push the sprocket onto the shaft. Never pound or hammer the sprocket. The sprocket bore and shaft tolerances normally allow a good commercial fit without using heat or special tools. If your working drawing specifies a really tight fit, ask your supervisor for help.

1.14 After mounting the driving and driven sprockets, check the alignment of their faces. As shown in Fig. 1-7, place a steel rod or straightedge across the faces. If you find any misalignment (which appears as a gap along the edge), shift the sprockets on the shafts so they line up. Then tighten the setscrews in the hubs so they bear firmly on the keys and keep the sprockets in place.

1.15 **Bushed sprockets**. Sprockets for light- or medium-duty chain drives are usually equipped with detachable bushings fitted into their shaft bores, as shown in Fig. 1-8. Several designs of *bushed sprockets* are available. They make it easier and quicker to mount and dismount the sprockets. The sprockets have tapered bores to accommodate the bushings.

1.16 The bushing has a tapered OD to match the sprocket bore and an ID to fit a specific shaft diameter. To mount the sprocket, first insert the bushing into

Fig. 1-8. Sprockets with taper-bore bushings

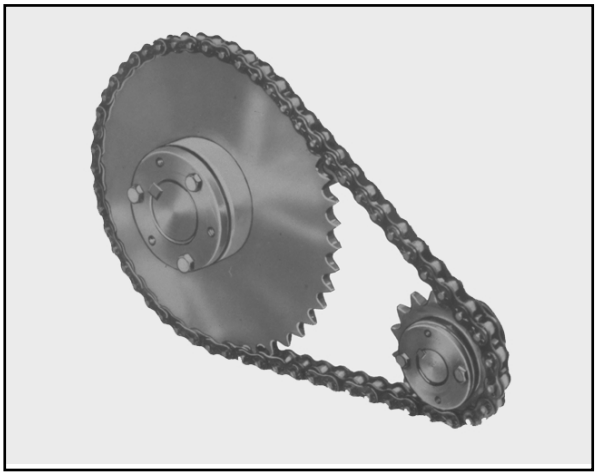


Fig. 1-9. Inserting connecting link in chain ends

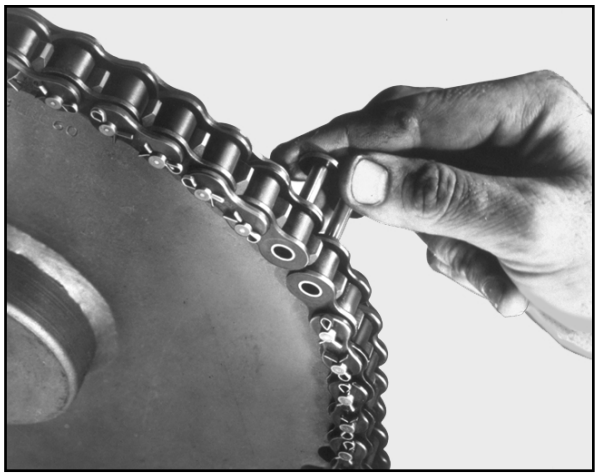
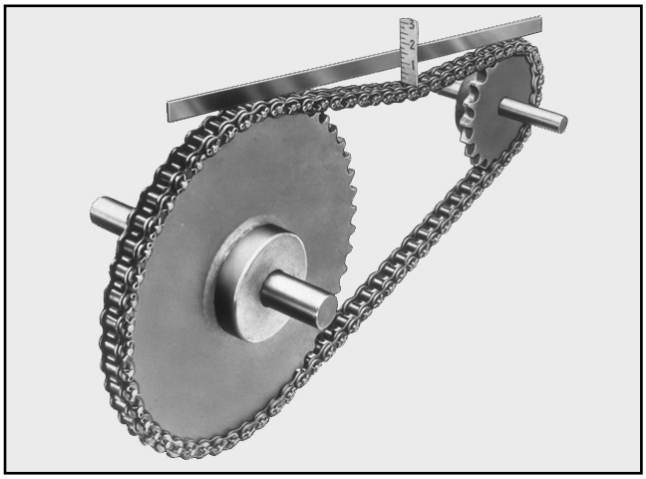


Fig. 1-10. Determining amount of chain sag



the tapered bore. Then place the capscrews (furnished with the sprocket-and-bushing assembly) in the drilled holes in the bushing flange, screwing them into the threaded holes in the hub. (In some sprockets, a second set of threaded holes is used to back the sprocket off the shaft.)

1.17 Because the bushing is split along its entire length, it "gives" and grips the shaft as you tighten the capscrews to draw it into the bore. To install a bushed sprocket, follow the manufacturer's instructions carefully. Align the faces of bushed sprockets with a straightedge—the same as for bored sprockets. Before replacing a bored sprocket with a bushed one, ask your supervisor if the drive will operate properly with a bushed one.

Mounting the Drive Chain

1.18 Chain for chain drives is usually a precision *roller chain*—much like a bicycle chain. It comes in a wide range of sizes. After unpacking the chain, inspect it carefully. If it has cotter keys, make sure no keys are missing. If it was not packaged when you received it, it may be dirty. Dip it in a solvent to remove any dirt or other foreign matter from its joints. Coat it with a light oil.

1.19 Release the chain tightener so you can move the shafts as close together as possible. Then lay the chain over the sprockets, keeping the driving (top) strand as tight as you can. Bring the ends of the chain together on one of the sprockets, and join them by inserting a connecting link (Fig. 1-9). Some people prefer to make the ends meet—and insert the link—in the middle of the lower (slack) strand.

1.20 **Chain tension**. The chain must always be under some tension (pull) to keep it on the sprocket teeth. So the next step is to tighten the chain. Allow the top strand to sag about 2% of the sprocket center distance. For example, if the sprocket center distance is 40 in., the sag should be 0.02×40, or 0.80 in. As shown in Fig. 1-10, use a straightedge and a scale to measure the sag. The idler sprocket should be as close as possible to the smaller of the two sprockets when outside the chain loop. Be sure it is free to move into the strand of chain as required. Table 1-1 lists the approximate amount of sag for sprocket center distances up to 175 in. (14 ft, 7 in.).

Table 1-1. Chain sag in inches, based on 2% of sprocket center distance

Sprocket center distance (in.)	20	30	40	50	60	70
Chain sag (in.)	1/2	5/8	7/8	1	1 1/4	1 1/2
Sprocket center distance(in.)	80	90	100	125	150	175
Chain sag (in.)	1 5/8	1 7/8	2	2 1/2	3	3 1/2

1.21 **Chain casings**. Usually a chain drive needs only a simple protective guard. If it operates in a dirty, dusty area, however, you must protect it with a casing (Fig. 1-

11). For easy installation, the casing is split along its centerline. Be sure to align the shaft seals to fit the casing. They should have a snug fit around the shaft extensions (Fig. 1-11A). Position the lock plates so the flats on them keep the seals from turning with the shafts.

1.22 Install the lower half of the casing first (Fig. 1-11B), making sure that the slack (bottom) strand of chain doesn't rub or drag on the inside of the casing. Also see that the sprocket hubs don't rub against the shaft seals. Then mount the neoprene gaskets and place the top half of the casing over the drive and bolt the halves together (Fig. 1-11C). When the assembly is complete (Fig. 1-11D), remove the oil filler cap. Add oil until you can see from the oil gauge (at the bottom) that you have a "gauge full" of oil.

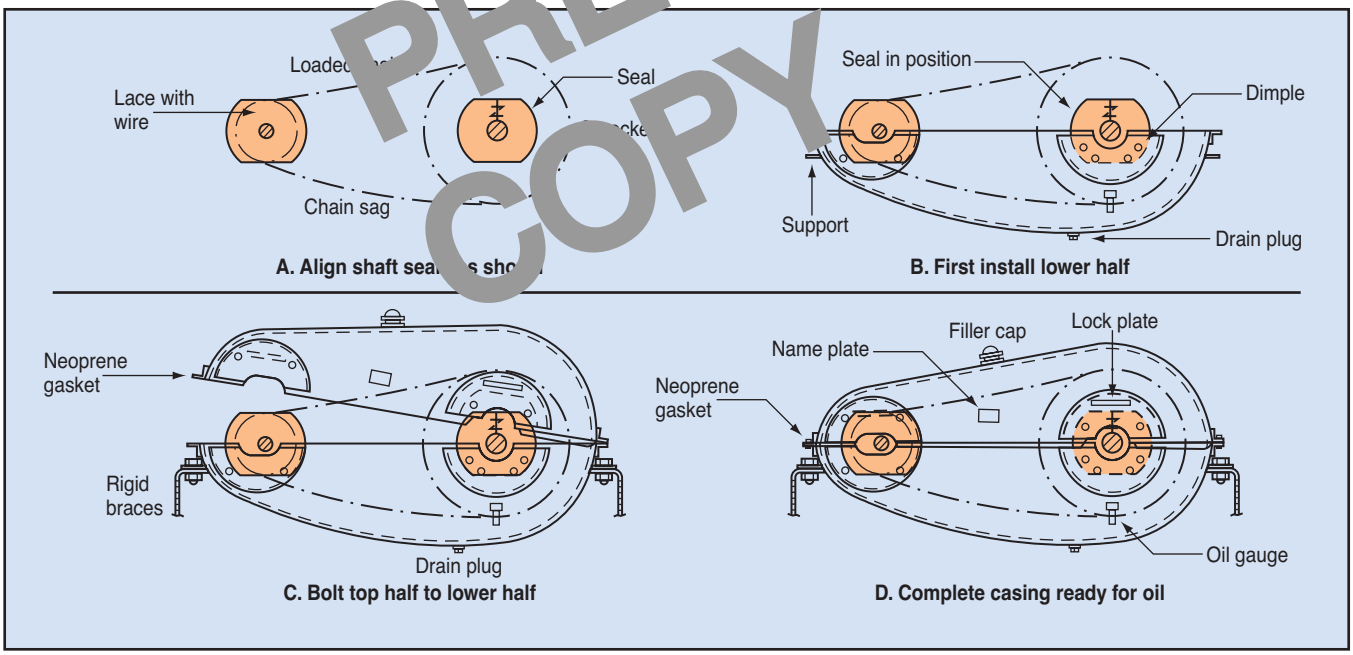
Test Running with No Load

1.23 If possible, test run the chain without any load on it. When running a newly installed chain drive for the first time, run it at a reduced speed for just a few minutes. (You need not even lubricate it, because it has no load.) The test run simply gives you a chance to watch the chain operate.

1.24 Listen for striking or slapping noises that could mean the chain is hitting another machine part. Check that the chain isn't whipping or weaving as it approaches and leaves the sprockets. Stop the drive and look for worn spots on the chain. If the teeth are worn on only one side, check the alignment of the sprockets. If the edges of the chain's side plates show wear, the chain is probably striking the inside of the casing.

The Programmed Exercises on the next page will tell you how well you understand the material you have just read. Before starting the exercises, remove the REVEAL KEY from the back of your Book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

Fig. 1-11. Common form of casing for a chain drive



1-1. In a horizontal chain drive, the driving (tight) strand should be on the _____.	1-1. TOP Ref: 1.03, Fig. 1-1
1-2. The usual way to compensate for chain wear is to increase the shaft _____.	1-2. CENTER DISTANCE Ref: 1.04
1-3. When using an idler sprocket outside the chain loop, place it as close as possible to the drive's _____ sprocket.	1-3. SMALL Ref: 1.04
1-4. An idler sprocket can be moved farther into a chain as wear occurs by an adjustable chain _____.	1-4. TIGHTENER Ref: 1.04, Fig. 1-3
1-5. The driving and driven shafts must be level and perfectly _____ with each other.	1-5. PARALLEL Ref: 1.09
1-6. A sprocket that has no bushing is held in position on its shaft by a(n)_____.	1-6. KEY Ref: 1.13
1-7. Before mounting a drive chain, always check the alignment of the sprockets with a(n)_____.	1-7. STEEL ROD or STRAIGHTEDGE Ref: 1.14, Fig. 1-7
1-8. If the teeth are worn on one side after an initial test run, check the _____ of the sprockets.	1-8. ALIGNMENT Ref: 1.24

Lubrication Recommendations

1.25 The most common cause of drive chain failure is improper or inadequate lubrication. This is because each joint of a chain is actually a bearing under load—and each bearing needs lubrication as it operates over the sprocket teeth. In every installation, therefore, the lubricant must enter each joint to reach the load-carrying surfaces—the ID of the chain bushings and OD of the chain pins. Figure 1-12 shows how the lubricant is drawn into the joints where it is needed. It does little good to lubricate only the rollers and side plates.

1.26 The lubricant for a drive chain is almost always an oil—seldom a grease. Table 1-2 lists the recommended oils for chains that operate in various temperature ranges. These are general recommendations. Precision chain drives are costly. So always be sure you are using the correct type and grade of oil to protect them. If you need help in selecting an oil for an unusual or severe operating condition, consult an oil manufacturer.

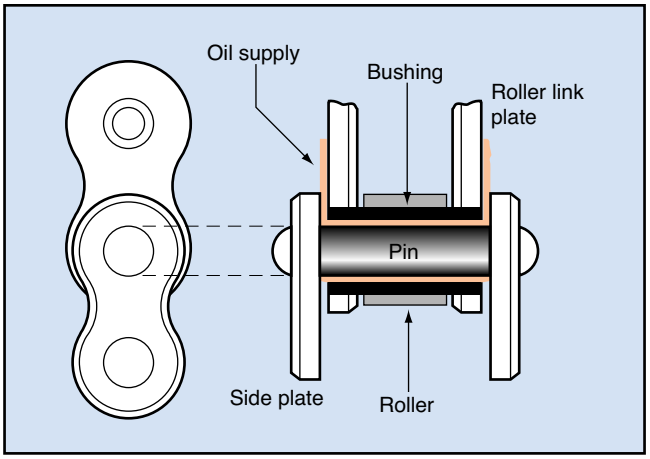
Lubrication Methods or Types

1.27 Chain drives have been vital components of manufacturing and processing equipment for many decades. The methods for lubricating them have been developed, refined, and tested extensively over many years. You can lubricate the chains in your plant by any of several methods. Most chain manufacturers publish *horsepower rating* tables for their chains. These tables list the preferred lube methods on the basis of chain speed, chain size,and small sprocket size. See Table 1-3 on the following page.

1.28 Table 1-3 shows the horsepower ratings for No. 50 roller chain (5/8 in. pitch). (Chain handbooks and manufacturers' catalogs contain a table such as this for *each* size of roller chain.) It tells you which type of lubrication to use under various combinations of chain size and speed. In Table 1-3, shading is used to define the horsepower limits within which you can safely use each type.

1.29 For example, No. 50 roller chain operating at 500 rpm, with the smallest sprocket having 21 teeth, will transmit 7.15 hp. The table indicates Type II lubrication for these conditions. If the speed is increased to 900 rpm, you could transmit 12.2 hp. But you would also have to use Type III lubrication. The following paragraphs describe the four basic types of lubrication. Your supervisor's schedule shows how often—and how much of which lubricant you should use—to lubricate every drive chain in your plant.

Fig. 1-12. Paths of oil bearing surfaces of chain



1.30 **Type I lube**. This is a manual method, and it is satisfactory for very slow chains. Apply oil to the chain with a brush or an oil can. Be sure the oil enters the spaces between the side plates so that it can get into the chain joints.

1.31 **Type II lube** (Fig. 1-13 on page 13). In this drip method, use a drip cup, mounted on a pipe, located where it can drip onto the lower strand of chain. Ten to 20 drops per minute should be sufficient, depending on the drive speed. The brush keeps dirt from building up.

1.32 **Type III lube** (Fig. 1-14 on page 13). For this splash method, you need to enclose the chain in an oil-tight casing. The oil settles in the bottom of the casing, and the lower strand of chain should dip into it to a depth of about 1/2 in.

Table 1-2. Recommended oils for chain lubrication

Operating temperature		Recommended oil
°F	°C	
20 to 40	-6.7 to 4.4	SAE 20
40 to 100	4.4 to 37.8	SAE 30
100 to 120	37.8 to 49.0	SAE 40
120 to 140	49.0 to 60.0	SAE 50

Table 1-3. Horsepower ratings for No. 50 (5/8-in. pitch) single-strand roller chain

No. of teeth small spkt.	Revolutions per minute–small sprocket																			
	50	100	300	500	900	1200	1500	1800	2100	2400	2700	3000	3300	3500	4000	4500	5000	5400	5800	6200
	Type I		Type II				Type III lubrication							Type IV lubrication						
11	0.45	0.84	2.25	3.55	6.07	7.86	7.44	5.58	4.42	3.62	3.04	2.59	2.25	2.06	1.68	1.41	1.21	1.07	0.97	0
12	0.50	0.92	2.47	3.91	6.66	8.64	8.50	6.38	5.04	4.13	3.47	2.96	2.57	2.35	1.92	1.61	1.38	1.22	1.10	0
13	0.54	1.01	2.70	4.26	7.26	9.42	9.56	7.17	5.67	4.65	3.90	3.33	2.89	2.65	2.16	1.81	1.55	1.37	1.24	0
14	0.58	1.09	2.92	4.60	7.87	10.2	10.7	8.01	6.34	5.20	4.36	3.72	3.23	2.96	2.41	2.02	1.73	1.53	0	
15	0.63	1.17	3.15	4.97	8.48	11.0	11.9	8.89	7.03	5.76	4.83	4.13	3.58	3.28	2.68	2.24	1.92	1.70	0	
16	0.67	1.26	3.37	5.33	9.09	11.8	13.1	9.79	7.74	6.35	5.32	4.54	3.94	3.62	2.95	2.47	2.11	1.88	0	
17	0.72	1.34	3.60	5.69	9.70	12.6	14.3	10.7	8.48	6.95	5.83	4.98	4.32	3.96	3.23	2.71	2.32	2.05	0	
18	0.77	1.43	3.83	6.05	10.3	13.4	15.6	11.7	9.24	7.58	6.35	5.42	4.70	4.31	3.52	2.95	2.53	0		
19	0.81	1.51	4.06	6.42	10.9	14.2	16.9	12.7	10.0	8.22	6.89	5.88	5.10	4.68	3.82	3.20	2.74	0		
20	0.86	1.60	4.30	6.78	11.6	15.0	18.2	13.7	10.8	8.87	7.44	6.35	5.51	5.05	4.12	3.45	2.96	0		
21	0.90	1.69	4.53	7.15	12.2	15.8	19.3	14.7	11.6	9.55	8.01	6.83	5.93	5.44	4.44	3.71	3.19	0		
22	0.95	1.77	4.76	7.52	12.8	16.6	20.3	15.8	12.5	10.2	8.59	7.33	6.36	5.83	4.76	3.98	3.42	0		
23	1.00	1.86	5.00	7.89	13.4	17.4	21.3	16.9	13.3	10.9	9.18	7.83	6.79	6.25	5.10	4.26	0			
24	1.04	1.95	5.23	8.26	14.1	18.3	22.3	18.0	14.2	11.7	9.78	8.34	7.24	6.66	5.44	4.54	0			
25	1.09	2.04	5.47	8.63	14.7	19.1	23.3	19.1	15.1	12.4	10.4	8.88	7.70	7.09	5.78	4.83	0			
28	1.20	2.30	6.18	9.76	16.6	21.6	26.3	22.7	17.9	14.8	12.4	10.6	9.19	8.46	8.37	6.83	0			
30	1.33	2.42	6.66	10.5	17.9	23.2	28.4	25.1	19.3	16.3	13.7	11.7	10.1	9.28	7.57	0				
32	1.42	2.66	7.14	11.3	19.2	24.9	30.4	27.1	21.9	18.0	15.0	12.9	11.1	10.2	8.34	0				
35	1.57	2.93	7.86	12.4	21.2	27.4	33.4	29.8	25.1	20.5	17.2	14.7	12.8	11.7	9.55	0				
40	1.81	3.38	9.08	14.3	24.4	31.5	38.4	34.3	29.0	25.1	21.0	18.0	15.6	14.3	0					
45	2.06	3.84	10.3	16.2	27.8	35.8	43.9	39.1	33.0	28.6	25.1	21.4	18.6	0						
50	2.30	4.30	11.6	18.2	31.1	40.3	49.2	54.1	42.8	37.1	32.6	28.4	25.1	0						
55	2.56	4.77	12.8	20.2	34.5	44.7	54.6	62.4	49.3	40.5	33.9									
60	2.81	5.25	14.1	22.2	37.9	49.1	59.9	71.1	56.2	46.1	0									

Type I **Manual lubrication:** Oil applied periodically with bru or spout . 0 fpm max. chain speed)
Type II **Drip lubrication:** Oil applied between li from a dr ubr or. (100 fpm max.)
Type III **Oil bath or oil slinger:** Oil level mair ed in casi predc mined height. (2000 fpm max.)
Type IV **Oil stream:** Oil supplied by circulating mp insid cha on lower span. (up to max. speed shown)

1.33 **Type IV lube** (Fig. 1-15). For this force feed method, equip the chain casing with an oil pump, a spray pipe, and an oil sump. The pump should have a capacity of 1 gal/min. This method keeps the oil from drawing air into its flow and frothing at high speeds.

Test Running with Full Load

1.34 After providing for proper lubrication, test run the chain drive again—this time under full load conditions. Be sure the chain casing, if used, is tight. Start the drive, and apply as much of the normal full load as you can. Listen for unusual noises, like scraping or slapping, that could indicate the chain is striking something.

1.35 Check the shaft seals in the casing. Small amounts of seepage through the seals are permissible. If the lubricant leaks excessively, however, stop the drive, open the casing, and replace the seals. Let the drive run at full load for a few minutes—then shut it down and inspect the chain.

Preventive Maintenance of Chain

1.36 In chain drive operation, the areas of greatest load are the chain joints. The OD of the pins and ID of the bushings are case-hardened to resist wear. The purpose of *preventive maintenance* (often called simply "PM") is to keep equipment working and prevent breakdowns by making inspections and repairs at regularly scheduled intervals. The aim of chain drive

Fig. 1-13. Equipment for drip lubrication of chain

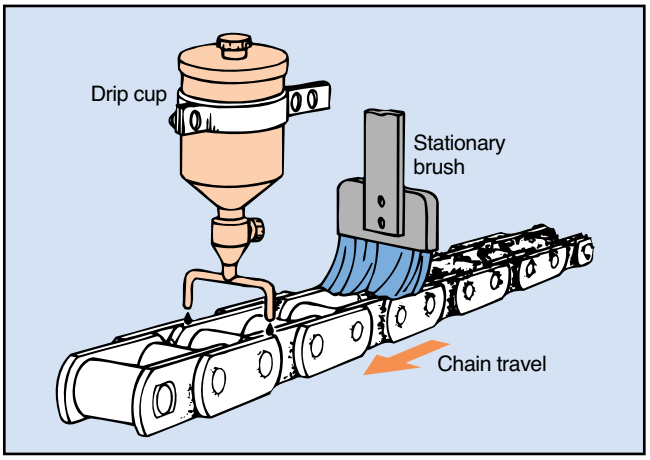
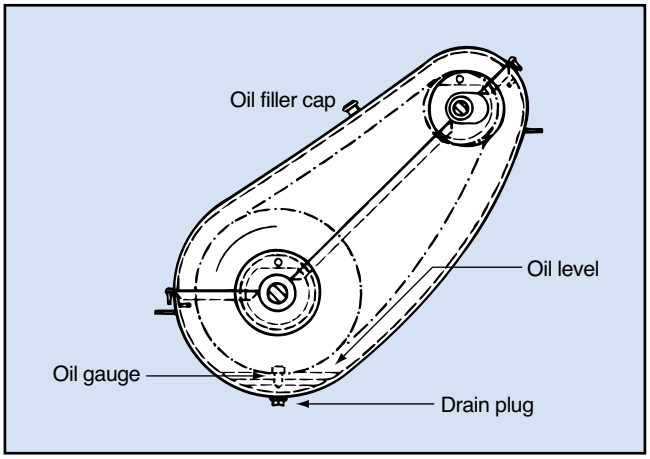


Fig. 1-14. Method of splash lubrication of chain



maintenance is to reduce the rate of wear of the load-carrying surfaces of pins and bushings. This involves the careful planning of inspections, lubrication, etc.

1.37 **Chain inspection**. Carefully inspect every new chain drive after 24 hr of operation. Be sure it is receiving the right amount of the right lubricant. Periodically shut down the drives equipped with chain casings and inspect their lube systems. Check the pump, spray pipe, and sump. Be sure all orifices are clear so the oil flows freely.

WARNING

When you shut down the drive to make an inspection, make sure to lock out the power.

1.38 Check the chain sag. With normal wear and stretch, the sag will be slightly more than when the chain was new. Too much sag, however, may indicate rapid chain wear, or even movement of the shaft centers. Recheck the shaft center distance.

1.39 **Chain stretch**. As its joints wear, a chain stretches. Stretching changes the chain's pitch slightly; but the pitch of the mating sprockets does not change. So, as wear continues, the chain begins to ride higher and higher on the sprocket teeth. If you fail to correct this, the chain will start jumping some teeth altogether (Fig. 1-16A on the following page) peening them over into a useless, hooked shape (Fig. 1-16B).

1.40 At intervals scheduled by your supervisor, remove a chain from its drive, stretch it out on the

Fig. 1-15. Forced lubrication for high-speed chain

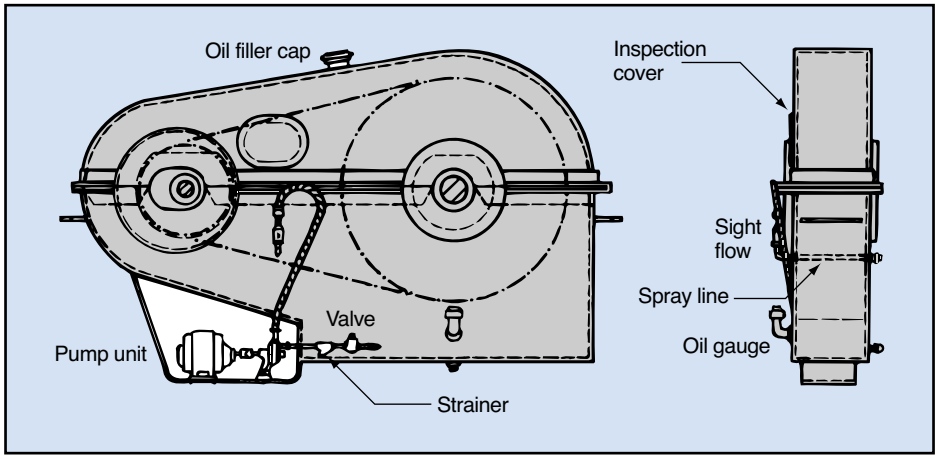
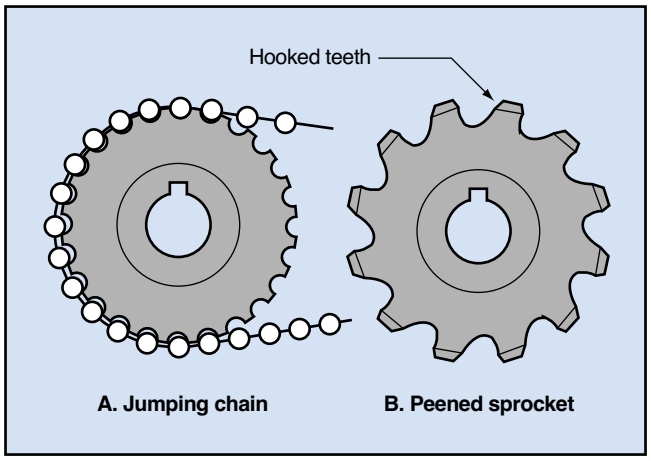


Fig. 1-16. Jumping chain and resulting damaged sprocket



floor or workbench, and measure its length. If it measures 2% or 3% longer than its original length, replace it before it starts to damage the sprocket teeth. On some high-ratio drives it may take even less stretch than this to justify replacing the chain.

1.41 Another way to check chain stretch visually is to grasp it as it wraps around an idle sprocket. Pull it away from the sprocket teeth, and note the amount of slack in it. If you can move it away from all the teeth it normally engages, the chain joints are too badly worn.

1.42 **Sprocket inspection**. At regularly scheduled intervals, inspect both the sides and faces of the sprocket teeth. Look for patterns of uneven wear on the sides. Uneven wear may be a sign that the drive is out of alignment. Replace any sprocket that has cracked or broken teeth. Damaged teeth can harm drive equipment—and even cause personal injury.

1.43 **Side plate and roller inspection**. Check the inside surfaces of the chain side plates regularly. The side plate areas that contact the sprocket teeth should show the same amount of wear on both sides of the chain. Uneven wear usually indicates that the drive is misaligned.

1.44 Cracked rollers often result when the chain skips teeth as it engages the sprockets. This, of course, means that the chain has stretched. Replace the chain if the rollers are cracked or the stretch is excessive. Rollers also wear rapidly when lubrication is inadequate.

1.45 **Periodic lubrication**. Initial lubrication, as you have seen, takes place between no-load and full-load testing. Periodic lubrication is a vital part of preventive maintenance and continues for the life of the machinery. It pays to lubricate drives thoroughly and on schedule. Use only oils specified for your drives.

1.46 When doing routine lubricating tasks, it is wise to check the chain drive as you work. Whenever you drain the oil from a casing, have the oil checked for filings (metal flakes worn off the chain). You may even find pieces of broken cotter keys in it. Before putting new oil in the casing, check the shaft seals, and be sure no metal-carrying sludge lies in the casing. Add oil until the oil gauge (Fig. 1-11) shows you have a full gauge of oil.

Care of Stored Chain

1.47 Another step in preventive maintenance is to keep chain that is stored in the maintenance shop free from dirt. Many sizes of roller chain are available in boxed lengths of 5 or 10 ft. They are usually wrapped in an oiled paper, such as that used to wrap packaged bearings. Keep the chain dry and in its wrapper until you are ready to install it.

1.48 You may find the most widely used sizes of chain in your plant stored on open reels of 100 to 150 ft for easy accessibility. Open reel storage is dusty and dirty; the joints of the unwrapped chain quickly become contaminated with particles of dirt. Therefore, always clean chain on open reels thoroughly with a good solvent before installing it.

1.49 Sometimes, when repairing a machine, you may have to leave it torn down for a few days—or even a couple of weeks—while awaiting new parts from the factory. In such cases, remove the chain from the drive and protect it well until you have to reinstall it. Wrap it in clean paper or cloth, and store it in a clean area.

Troubleshooting Chain Drives

1.50 A regular schedule of preventive maintenance can minimize the number of drive chain failures in your plant. You'll still encounter occasional breakdowns, however. You must learn to *troubleshoot* breakdowns quickly and accurately, so that little production time is lost and costly production equipment doesn't stand idle. The sources of most breakdowns are fatigue breaks, tensile breaks, rapid wear, roller failure, and side plate spreading.

1.51 **Fatigue breaks**. Breaks due to chain fatigue are usually very clean. Most often found on moderate- to high-speed drives, the breakage is usually caused by overloading. Failure most often occurs through the side plates. Check the system for overloads. If you still experience breakage after reducing an overload, ask your supervisor to consult the chain manufacturer.

1.52 **Tensile breaks**. Chain breaks due to tensile stress show up as taffy-like pullouts. They usually occur on low-speed drives because the pull on the top (tight) side of the chain is greater than the chain's yield strength. Failure occurs through the ends of the side plates. Here again, check the chain for overloading. See your chain manufacturer's catalog for the allowable pull on the chain. On very low-speed drives, the pins for the chain rollers can sometimes break. Follow the same procedure for pin breakage as for side plate tensile breaks.

1.53 **Rapid chain wear**. If your periodic inspection shows that a chain is wearing rapidly, remove it and measure its length. If it is more than 2% or 3% longer than its original length, the stretch is probably due to an overload. Check the drive for overloading. Replace damaged or stretched chain. Also replace sprockets that have badly worn teeth.

1.54 **Roller failure**. Roller failure is often indicated by cracked or broken rollers. Check the drive lubricant. Contaminated oil can cause rollers to freeze in one position, which results in excessive wear in one area. Be sure all the rollers are free to rotate on their bushings. If the rollers are badly worn, replace the chain. Also check the alignment of the sprockets on their shafts. Misaligned sprockets can place a damaging extra load on the chain.

1.55 **Side plate spreading**. When side plates spread on a chain's pins or bushings, it is most often because the sprockets are out of line. This condition usually shows up as frozen chain joints that won't flex as they engage the sprocket teeth. Look for damaged sprocket teeth, and check the sprocket alignment.

Chain Drives and Safety

1.56 While not the largest part of a machine, chain drives can inflict serious personal injury because of their tension, speed, and sharp edges. Broken chains can fall into and damage costly machinery. It pays to be careful and to follow the general rules of shop safety when you work around chain drives. For the protection of yourself and your co-workers, always obey these rules of safety:

1. Before starting to work on a drive, stop the machine and lock out the power. Let your fellow workers know that you are—or will be—working on it.

2. When working on the drive, don't wear a long-sleeved sweater, a loose hanging tie, or jewelry like rings that could be easily caught in the chain and sprockets.

3. Handle lubricants and solvents carefully. Some contain irritants, so don't get them on your skin or in your eyes.

4. Never strain yourself by lifting machine parts that are too heavy. Use proper lifting devices for heavy chains and sprockets.

5. Keep your work area clean and free of oil spills, etc. You can suffer severe injury if your foot slips as you lift a heavy sprocket.

6. Be sure the chain and sprockets are tight and the chain casing is closed and sealed before starting up a repaired drive.

7. Be sure to remove all tools from the area and to warn your fellow workers before starting up a drive you've repaired.

1-9. The most common cause of drive chain failure is improper or inadequate _____.	1-9. LUBRICATION Ref: 1.25
1-10. The lube method for a chain drive depends on the chain's size, _____, and small sprocket size.	1-10. SPEED Ref: 1.27
1-11. To resist wear, the ODs of chain pins and IDs of bushings are _____.	1-11. CASE-HARDENED Ref: 1.36
1-12. A chain begins to ride higher and higher on the sprocket teeth when it becomes worn and _____.	1-12. STRETCHED Ref: 1.39, Fig. 1-16
1-13. Uneven wear on a chain's sideplates usually indicates that the drive is _____.	1-13. MISALIGNED Ref: 1.43
1-14. Always clean a chain that is stored on open reels with a good _____ before you use it.	1-14. SOLVENT Ref: 1.48
1-15. A taffy-like break through the end of a sideplate is a characteristic _____ break.	1-15. TENSILE Ref: 1.52
1-16. Before starting to work on a chain drive, _____ the machine and _____ the electric power.	1-16. STOP; LOCK OUT Ref: 1.56 (1)

Answer the following questions by marking an "X" in the box next to the best answer.

1-1. Whenever possible, install a horizontal chain drive so that

- ☐ a. the top strand is tight
- ☐ b. both strands are loose
- ☐ c. the bottom strand is tight
- ☐ d. both strands are tight

1-2. Which of the following statements is true of idler sprockets?

- ☐ a. They are always placed inside the chain loop
- ☐ b. At least three idler sprocket teeth should engage the chain
- ☐ c. At least five idler sprocket teeth should engage the chain
- ☐ d. Idlers increase center distance

1-3. What should you use to check the levelness of two shafts for a chain drive?

- ☐ a. Framing square
- ☐ b. Spirit level
- ☐ c. Yard stick
- ☐ d. Straightedge

1-4. A Type B sprocket (which has only one hub) should be mounted with

- ☐ a. the hubless face against the bearing
- ☐ b. the hub against the bearing
- ☐ c. a clearance fit of .008 in.
- ☐ d. the chain as far away from the bearing as possible

1-5. The amount of the sag in the top strand for 125 in. sprocket centers should be _____ in.

- ☐ a. 3 1/2
- ☐ b. 3
- ☐ c. 2 1/2
- ☐ d. 2

1-6. The most common cause of drive chain failure is

- ☐ a. overloaded chains
- ☐ b. cotter keys coming loose
- ☐ c. poor lubrication
- ☐ d. chain too small for load

1-7. Which lubrication method is satisfactory for very slow chains?

- ☐ a. Splash
- ☐ b. Manual
- ☐ c. Forced feed
- ☐ d. Drip

1-8. After how many hours of operation should you inspect a new drive chain?

- ☐ a. 24 hr
- ☐ b. 72 hr
- ☐ c. 120 hr
- ☐ d. 168 hr

1-9. Which of the following is caused by the wearing of chain pins and stretching of chain?

- ☐ a. The chain rides high on the sprockets
- ☐ b. The chain jumps or skips some teeth
- ☐ c. The sprocket teeth become peened over
- ☐ d. All of the above

1-10. A break in a drive chain caused by metal fatigue or stress is usually

- ☐ a. twisted in appearance
- ☐ b. very clean
- ☐ c. fragmented
- ☐ d. stretched, like taffy

SUMMARY

The popular chain drive, consisting of precision roller chain on steel sprockets, can be installed in any of several arrangements. Idler sprockets control chain slack and maintain the right tension. For good performance, make sure the drive shafts are parallel. Mount the sprockets on the shafts, lay the chain over the sprockets, and fasten the chain's ends with a connecting link. Place the proper tension on the chain, and enclose it in a casing if the environment is dirty. Use the type of lubrication indicated in the horsepower rating table: manual, drip, splash, or force feed. Be sure to change the oil at the recommended intervals.

It is safe to test run a new chain with no load (and no lubrication) briefly. Then add lubrication and run it under full load before putting it on line. Chain drives need preventive maintenance to reduce the wear on their load-carrying surfaces. This involves carefully planned inspection, lubrication, and other functions. Keeping a chain clean while it is stored will make it last longer. Even with the best maintenance, drives still fail. When a failure occurs, you must be prepared to repair breakdowns quickly and accurately—so that little production time is lost and costly equipment doesn't stand idle any longer than necessary.

Answers to Self-Check Quiz

1-1. a. The top strand is tight. Ref: 1.03, Fig. 1-1

1-2. b. At least three idler sprocket teeth should engage the chain. Ref: 1.04

1-3. b. Spirit level. Ref: 1.09, Fig. 1-5

1-4. a. The hubless face against the bearing. Ref: 1.12

1-5. c. 2½. Ref: 1.20, Table 1-1

1-6. c. Poor lubrication. Ref: 1.25

1-7. b. Manual. Ref: 1.30

1-8. a. 24 hr. Ref: 1.37

1-9. d. All of the above. Ref: 1.39

1-10. b. Very clean. Ref: 1.51

Contributions from the following sources are appreciated:

Figure 1-5. PT Components, Inc., Link-Belt Chain Division
Figure 1-7. PT Components, Inc., Link-Belt Chain Division
Figure 1-8. Emerson Electric Company, Browning Manufacturing Div.
Figure 1-9. PT Components, Inc., Link-Belt Chain Division
Figure 1-10. PT Components, Inc., Link-Belt Chain Division