Industrial Maintenance

Chain Drives 2

Job Sheets - Instructor

54978-F0

Order no.: 54978-3C
First Edition
Revision level: 11/2017

By the staff of Festo Didactic

Internet: www.festo-didactic.com
e-mail: did@de.festo.com

Printed in Canada

ISBN 978-2-89789-108-4 (Printed version)
ISBN 978-2-89789-110-7 (CD-ROM)
Legal Deposit – Bibliothèque et Archives nationales du Québec, 2017
Legal Deposit – Library and Archives Canada, 2017

Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
⚠ DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger. Consult the relevant user documentation.
	Caution, lifting hazard
	Caution, belt drive entanglement hazard
	Caution, chain drive entanglement hazard
	Caution, gear entanglement hazard
	Caution, hand crushing hazard
	Notice, non-ionizing radiation
	Consult the relevant user documentation.
	Direct current
	Alternating current

Safety and Common Symbols

Symbol	Description
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

Table of Contents

Preface

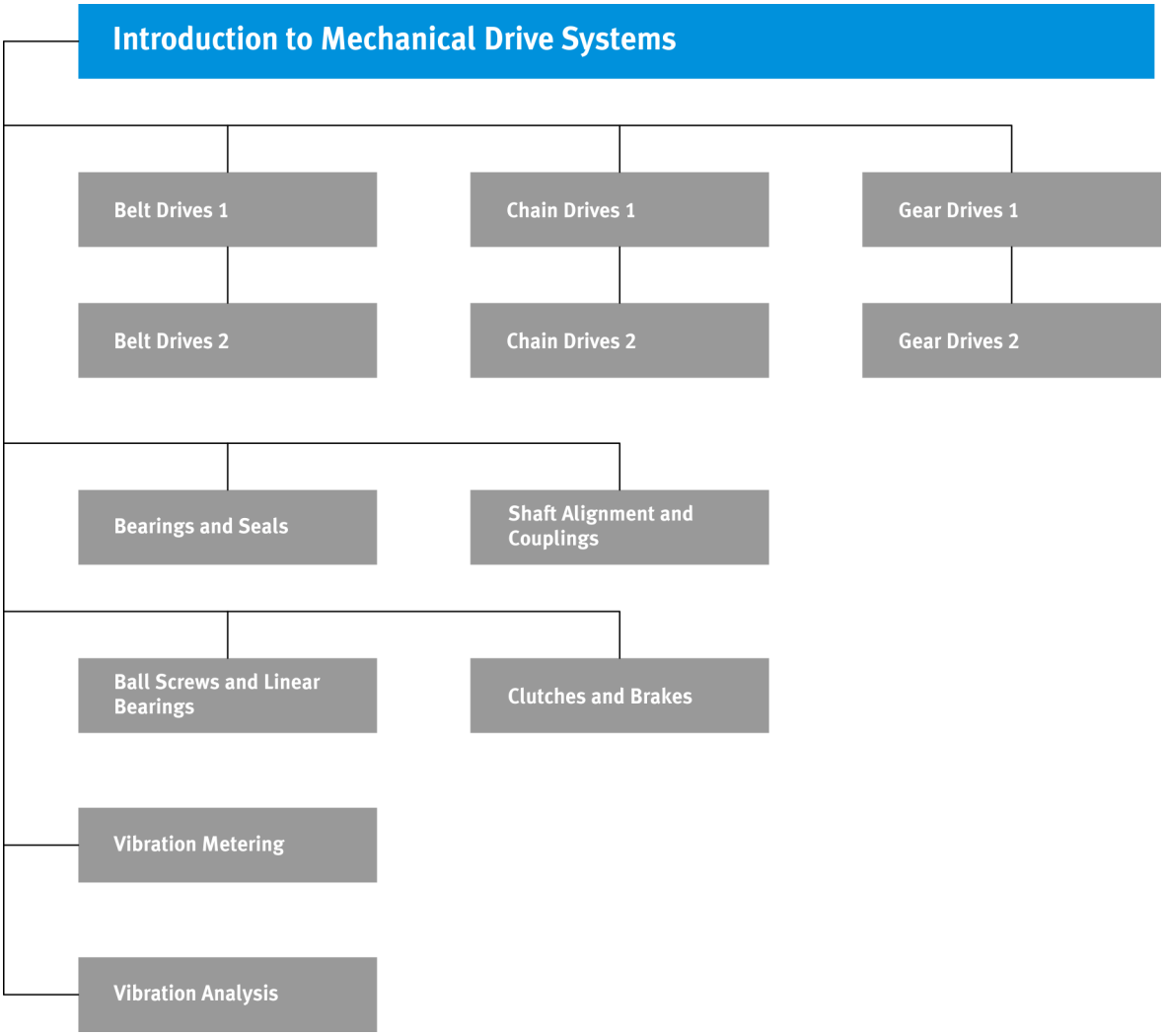
The Mechanical Drives Training System covers the installation, use, maintenance, and troubleshooting of mechanical drives.

The curriculum is divided into levels and covers the following topics:

- Introduction to mechanical drive systems
- Belt drives
- Chain drives
- Gear drives
- Shaft alignment and couplings
- Bearings and seals
- Ball screws and linear bearings
- Clutches and brakes
- Vibration metering and analysis
- Notions of lubrication

The figure below shows the available course material for the Mechanical Drives Training System.

Preface



Mechanical Drives Training System course material.

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

About This Manual

The Chain Drives 2 manual completes the basics of chain drives.

The topics covered in this manual are presented in the form of job sheets. The job sheets include a description of the objectives, a list of equipment required, safety procedures, and a list of steps required to attain the objectives.

The topics are usually introduced in an information job sheet. However, to obtain detailed information about the covered topic, you should refer to your text book or ask your instructor to guide your learning process.

The job sheets follow a logical sequence which allows you to assimilate the concepts efficiently. The job sheets should be performed one after another since the content of a given job sheet builds up on the knowledge acquired in the previous one.

Manual objectives

When you have completed this manual, you will be familiar with multiple strand chain drives, and idler sprockets. You will know how to properly install them and the importance of following specific protocols. You will be able to identify the main components of such chain drive systems in industrial installations.

Safety considerations

Safety symbols that may be used in this manual and on the equipment are listed in the Safety and Common Symbols table at the beginning of the manual.

Safety procedures related to the tasks that you will be asked to perform are indicated in each exercise.

Make sure that you are wearing appropriate protective equipment when performing the tasks. You should never perform a task if you have any reason to think that a manipulation could be dangerous for you or your teammates.

Prerequisite

As a prerequisite to this course, you should have read the manual titled *Chain Drives 1.*

System of units

Units are expressed using the International System of Units (SI).

To the Instructor

You will find in this Instructor Guide all the elements included in the Student Manual together with the answers to all questions, results of measurements, graphs, explanations, suggestions, and, in some cases, instructions to help you guide the students through their learning process. All the information that applies to you is placed between markers and appears in red.

Accuracy of measurements

The numerical results of the hands-on exercises may differ from one student to another. For this reason, the results and answers given in this manual should be considered as a guide. Students who correctly performed the exercises should expect to demonstrate the principles involved and make observations and measurements similar to those given as answers.

Before a student begins a job sheet, ensure that the equipment is in good condition and does not represent any risk when used.

When a student must complete a setup that is partially already mounted, ensure that the setup corresponds to the job description.

When the jobs are performed in teams, ensure that each student has and installs a padlock when performing the Lockout/Tagout procedure.

Sample
Extracted from
the Job Sheets Student
and the Job Sheets Instructor

Multiple-Strand Chain Drives

Multiple-strand chains

Multiple-strand chains are a variation of roller chains. They consist of two or more chains connected to form a wider chain that can support larger loads than single-strand chains. Multiple-strand chains are an inexpensive solution to transmit a great amount of power. They can also be enhanced to be resistant to corrosion. Figure 1 shows a triple-strand (triplex) chain in an industrial machine.

Chains with one, two, and three strands are sometimes referred to as simplex, duplex, and triplex chains.

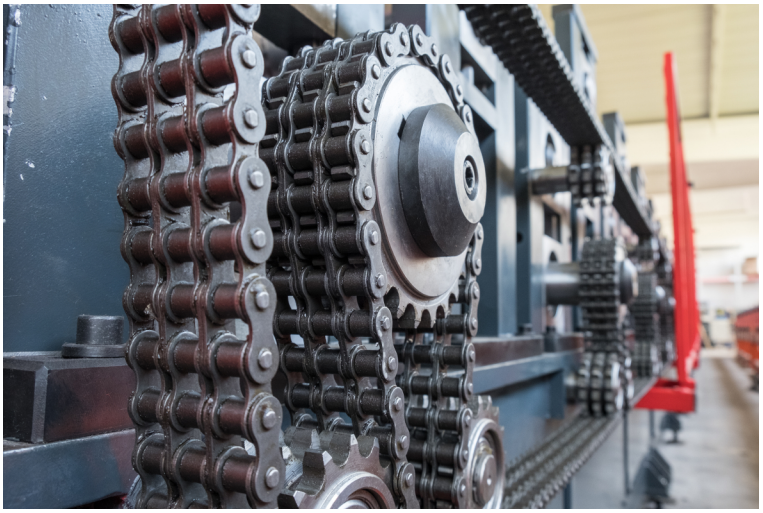


Figure 1. Triple-strand chain in an industrial machine.

Chain designation

The designation of roller chains has the following format, and the rules are explained below.

XXB –No.

- The first two digits (XX) represent the pitch size in sixteenths of an inch. For example, 08 represents 8/16 in or 1/2 in while 05 represents 5/16 inch. Measurements are made in inches because roller chains are designed to match with the British Standards.
- The letter B (third digit) indicates the European Standards.
- If the chain is a multiple-strand chain, a dash with the number of strands (-No.) follows the first digits.

Although uncommon, single-strand chains can be indicated by -1.

Following these guidelines, a 5/16 inch pitch double-strand chain can be identified as a 05B-2 roller chain.

Chain geometry and chain length

The geometry of a basic chain drive system is shown in Figure 2. This geometry is also suitable for multi-strand chains.

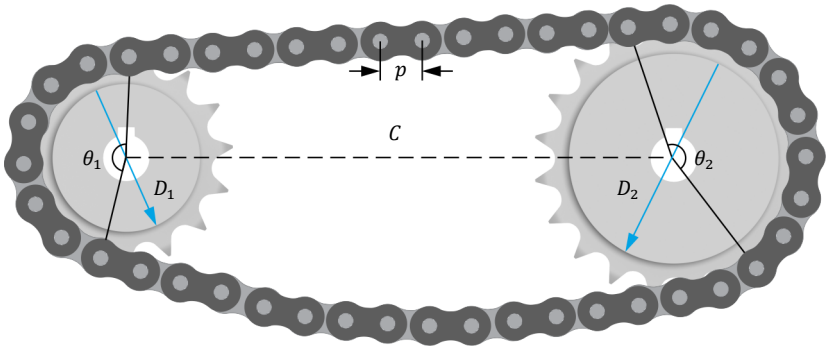


Figure 2. Basic chain drive geometry.

As Figure 2 shows, the geometric aspects of a basic chain drive can be defined by the following parameters:

- The distance between the shafts center (C);
- The chain pitch (p);
- The pitch diameter of the driving sprocket (D_1);
- The pitch diameter of the driven sprocket (D_2);
- The angle of contact of the driving sprocket (θ_1) with the chain;
- The angle of contact of the driven sprocket (θ_2) with the chain.

The primary identifying parameter for any chain is the chain pitch. Pitch is the distance from the hinge or joint of one chain link to the same point on the next link (see Figure 2). In a chain drive, the pitch of the sprockets must match the pitch of the chain. The pitch of the sprockets, or circular pitch, can refer to the distance between two chain pin centers.

Based on the chain geometry, the chain length can be calculated using the following formula:

$$L \approx \frac{N_1 + N_2}{2} + \frac{2C}{p} + \left(\frac{N_2 - N_1}{2\pi}\right)^2 \frac{p}{C} \qquad (1\text{-}1)$$

where L is the chain length in pitches;
N_1 is the number of teeth on the driving sprocket;
N_2 is the number of teeth on the driven sprocket;
C is the distance between the shafts center in mm;
p is the chain pitch in mm.

When selecting a chain for a drive the value obtained using this formula must be rounded up to the nearest even number of pitches.

The number of pitches often refers to the number of links.

Connecting links

The ends of a multiple-strand chain are connected together using a connecting link. Common types of connecting links are the spring clip, split (or cotter) pin, and riveted. They are shown in Figure 3, Figure 4, and Figure 5. The spring clip and split pin types are easy to disassemble, while the riveted type provides a much stronger link.

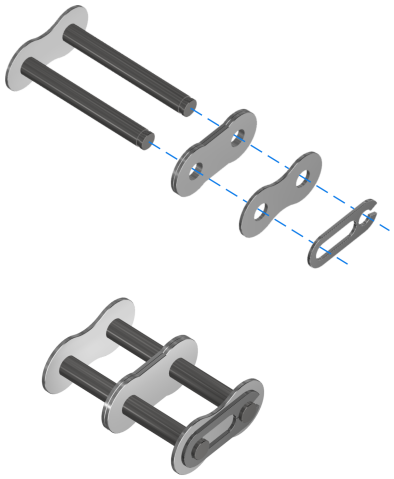


Figure 3. Spring clip connecting link.

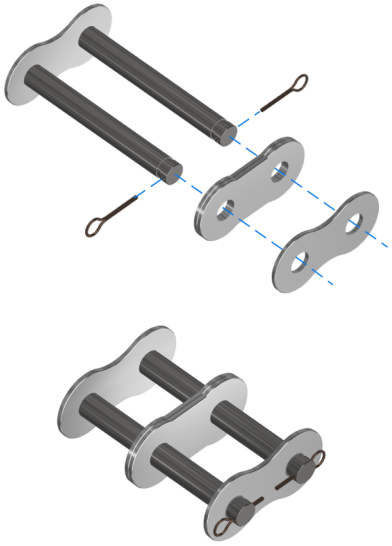


Figure 4. Split (or cotter) pin connecting link.

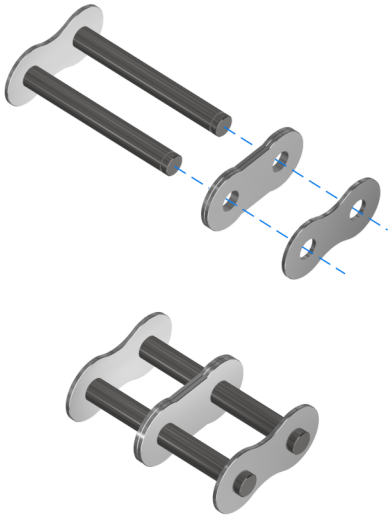


Figure 5. Riveted connecting link.

The above figures show connecting links for double-strand (duplex) chains. Chains with more strands have plates with larger pins and more rows of evenly distributed inner plates.

When installing a spring clip connecting link, you must determine the direction of the chain travel first. Then you must locate the closed end of the clip so that it heads toward the direction of the travel. These considerations are illustrated in Figure 6.

Figure 6. Installation of a spring clip connecting link.

Offset links

To connect an odd number of links, an offset link is used. Two common types of offset links, standard and double offset links, are shown in Figure 7. An odd number of links decreases the power rating of a chain. For this reason, offset links are not suitable for high-speed or high-shock applications.

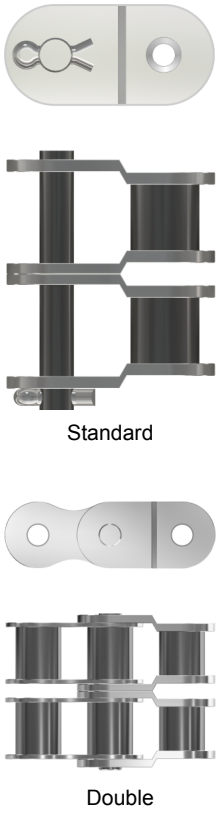


Figure 7. Most common types of offset links for double-strand chains.

Taper bore sprockets and bushings

Taper bore (or taper-lock) bushings are used to secure sprockets in many chain drive systems. A typical taper bore bushing and sprocket assembly consists of three threaded holes with two setscrews. Two of the threaded holes with setscrews lock the bushing on the shaft. The third threaded hole is used to remove the bushing from the sprocket.

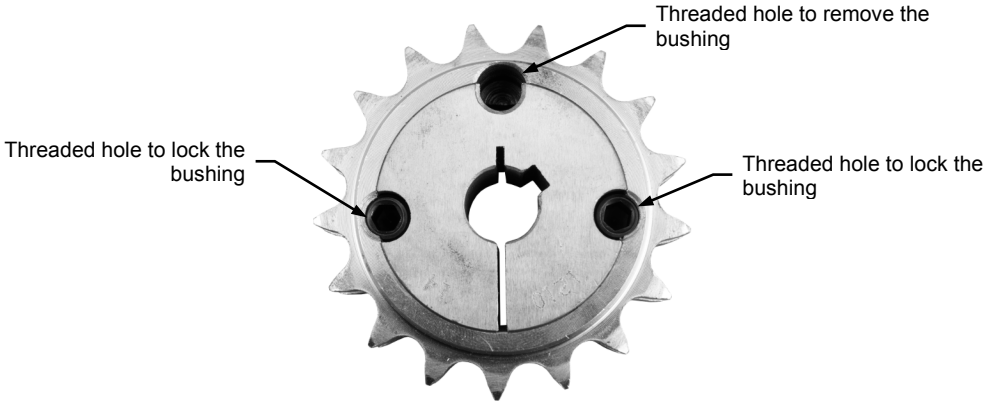


Figure 8. Mounted taper bore sprocket and bushing assembly.

The double-row sprocket shown in Figure 9 is secured using a taper bore bushing. The tightening holes are located on the each side of the assembly and compress the part in contact with the shaft and streches the part in contact with the sprocket. This secures both the bushing on the shaft and the sprocket on the bushing. The removing hole is located on the top side, and forcing the thread allows to separate the bushing from the sprocket easily.

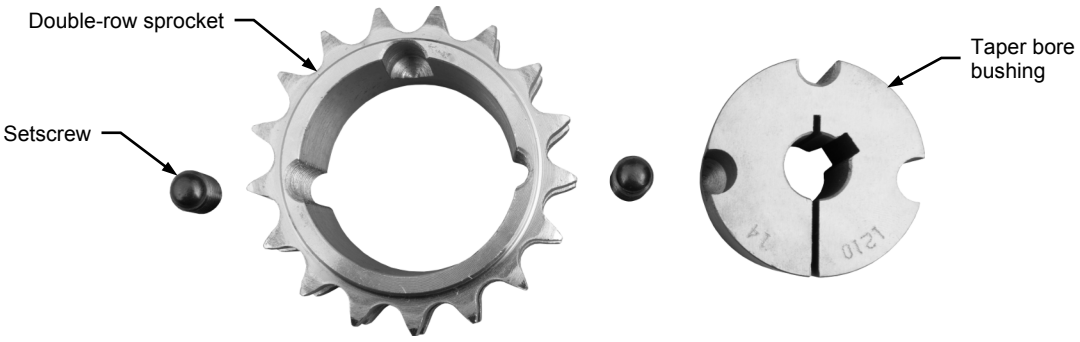


Figure 9. Dismounted taper bore sprocket and bushing assembly.

To lock the bushing of these sprockets on the shaft, the setscrews must be tightened to the recommended torque value indicated in Table 1.

Table 1. Recommended torque value for taper bore sprocket and bushing assemblies.

Sprocket and bushing assembly	Recommended torque value N·m
17 tooth	20
20 tooth	20

Torque wrench

A click-type torque wrench such as the one shown in Figure 10 is used to tighten fasteners such as screws and bolts to a specific torque value.

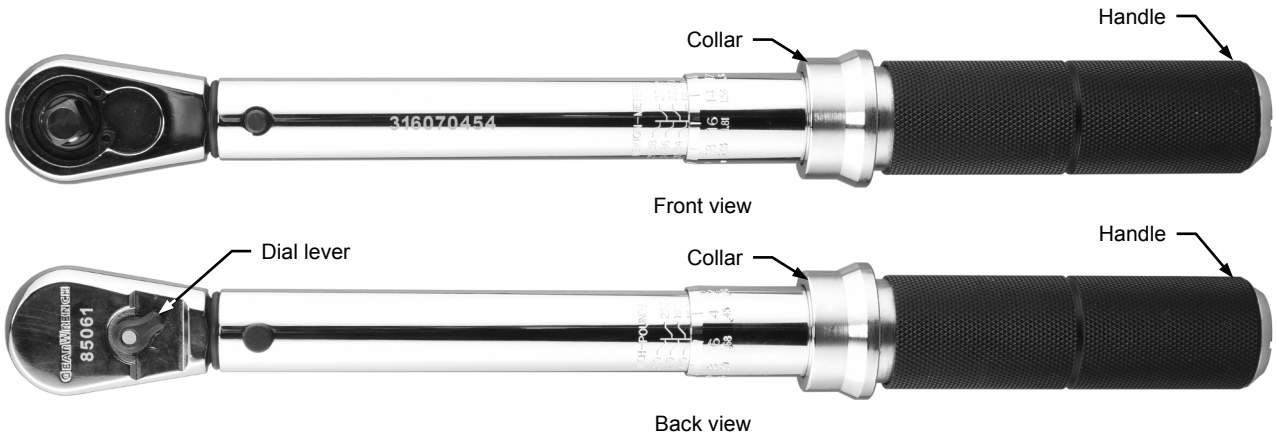


Figure 10. Torque wrench.

To set the torque, pull down the collar and rotate the handle until you obtain the desired torque value. Then release the collar. Figure 11 shows how to set a torque of 8.16 N·m, for example.

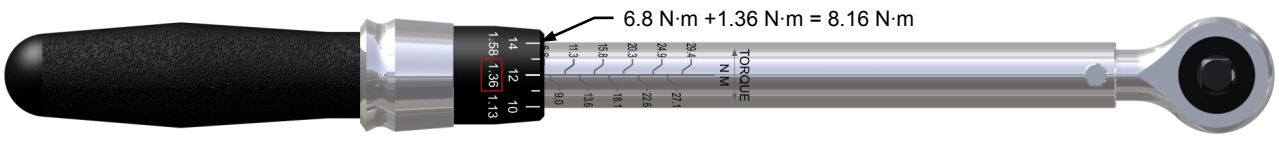


Figure 11. Example of wrench adjustment.

To apply torque, perform the following:

- Attach the proper socket. A great variety of sockets available in the industry. Sockets are designed based on the type and characteristics of the fasteners on which they are used. For each type of fastener, sockets are provided in sets, each containing different drive sizes. In general, every fastener has its corresponding socket. Sockets often have 6 or 12 corners (or points), which allows a good grip on fasteners that have hexagonal or square heads, or worn corners.
- Set the direction of operation properly. To do so, set the dial lever right or left. The torque wrench can be used in counterclockwise direction because some fasteners are threaded in the other direction (left-hand threads).
- Follow the recommendations of the component manufacturer as to how to torque the fasteners. Hold the handle by the grip and apply a slow and steady force. Usually, you should follow a pattern (crisscross, clockwise, etc.) and apply at first only a small torque to the fasteners. You will increase the torque during subsequent rounds, until you hear and/or feel a little “click” for all bolts during a single round.

General recommendations:

- You should always return a torque wrench adjustment to zero after use to maintain the tool calibration.
- To tighten a fastener to a lesser torque value, loosen the fastener first before you retighten it.
- Do not apply excessive force to a torque wrench (more than the rated capacity).
- For disassembly, always use a different tool, such as a ratchet.

CAUTION

Never use a torque wrench for disassembly. Applying excessive force could damage the torque wrench and affect its precision.

Ratchet

A ratchet (or socket wrench), such as the one shown in Figure 12, can be used to tighten or loosen fasteners quickly. Ratchets and torque wrenches are similar because they use the same detachable sockets and have a dial lever to adjust the direction. The main difference is that the ratchet has no adjustable torque, which makes it less precise.

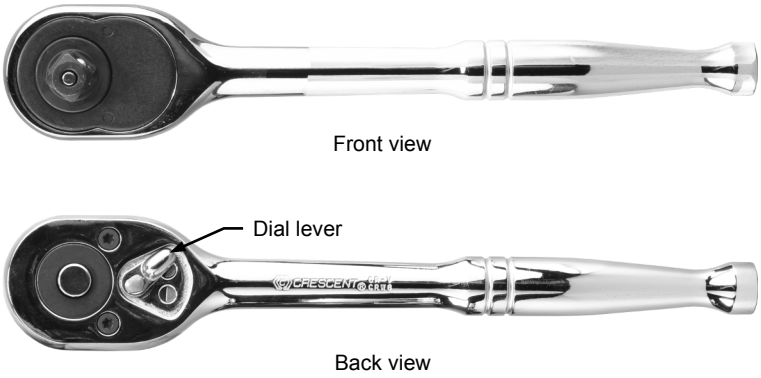


Figure 12. Ratchet.

Strap wrench

A strap wrench, such as the one shown in Figure 13, is used to hold an object via a strap or a chain (usually a roller chain) to prevent it from moving. The object is held in place by the high static friction between the object and the strap or chain. Straps can be made from a variety of materials with more or less friction and flexibility.

Figure 13. Strap wrench.

Speed and sprocket ratios

In a chain drive system, the speed and torque ratios are directly related to the number of teeth of the driving and driven sprockets, as shown in Figure 14.

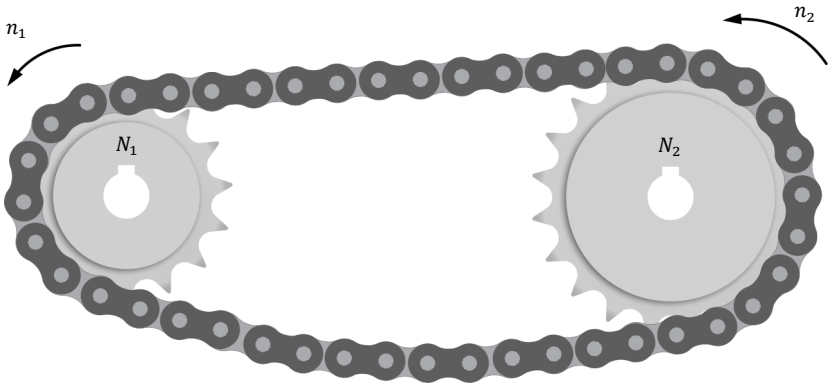


Figure 14. Speed and number of teeth of the driving and driven sprocket.

The teeth, speed, and torque ratios in a chain drive system are expressed as follows:

$$\frac{N_2}{N_1} = \frac{n_1}{n_2} = \frac{T_2}{T_1} \tag{1-2}$$

where N_1 is the number of teeth of the driving sprocket;
N_2 is the number of teeth of the driven sprocket;
n_1 is the speed of the driving sprocket in rpm;
n_2 is the speed of the driven sprocket in rpm;
T_1 is the torque of the driving sprocket in N·m;
T_2 is the torque of the driven sprocket in N·m.

It is possible to rearrange the formula to determine any of the parameters. For example, to determine the speed of the driven sprocket, the formula is rearranged as follows:

$$n_2 = n_1 \cdot \frac{N_1}{N_2} \tag{1-3}$$

Multiple-Strand Chain Drives

OBJECTIVE

- Install double-row sprockets using taper bore bushings;
- Install couplings and align shafts;
- Install a double-strand roller chain;
- Align double-row sprockets and bushings assemblies;
- Tension a double-strand roller chain;
- Lubricate a double-strand roller chain;
- Perform basic measurements on a multiple-strand chain drive.

PROCEDURE

Equipment required

Refer to the Equipment Utilization Chart in Appendix A to obtain the list of equipment required for this job.

Safety procedures

Before proceeding with this job, make sure to complete the following checklist.

- ❑ You are wearing safety glasses.
- ❑ You are wearing safety shoes.
- ❑ You are not wearing anything that might get caught such as a tie, jewelry, or loose clothes.
- ❑ If your hair is long, tie it out of the way.
- ❑ The working area is clean and free of oil.
- ❑ The floor is not wet.
- ❑ Your sleeves are rolled up.

1. Perform the Lockout/Tagout procedure.

Refer to Appendix B if necessary.

Components preparation and taper bore bushing installation

You will prepare some components and install a taper bore bushing inside double-row sprockets.

Components preparation

2. Take a long shaft and a short shaft and prepare each of them using the following procedure. This ensures the shafts are free of dirt and debris.
   - ❑ Inspect the shaft for damages and clean up any dirt and debris from the keyway and the shaft.
   - ❑ Clean up the edge of the keyway using an emery paper or a fine tooth file.
   - ❑ Using an emery paper, clear the shaft of rust and corrosion.
   - ❑ Make sure that the surface of the shaft and the keyway are clean of debris using a clothing and a cleaning solvent.

   Perform this procedure each time you install a shaft.

3. Take the jaw coupling hubs, inspect them, and clean up any dirt and debris.

4. Take the 08B-2 roller chain and inspect it for damages. Make sure to:
   - ❑ Clean up any debris and dirt from the surface of the chain using a rag and a suitable cleaner.

   Some penetrating oils (also known as penetrating fluids) that come as water-displacing sprays are recommended cleaners. They are used as lubricant, cleaners and corrosion stoppers.
   - ❑ Using the rag, remove all excess of oil and dirt.
   - ❑ Using an emery paper, clear the chain of persistent rust and corrosion.

   Whenever you install a new chain, you should prepare it by performing the general guidelines enumerated above.

Taper bore bushing installation

5. Take the 17 tooth and 20 tooth double-row sprockets and perform the following steps if the bushings are not assembled:
   - ❑ Inspect each bushing and sprocket and clean up any dirt and debris using a degreaser, if you are equipped with one.
   - ❑ Slide the corresponding taper bore bushing in each sprocket. The bushing should slide freely. If not, install it on the opposite side of the sprocket.
   - ❑ Line up the unthreaded bushing half holes with the threaded half holes on the sprocket.
   - ❑ Lubricate the setscrews if necessary.

   Make sure you are equipped with an adequate oiler.
   - ❑ Hand-tighten each setscrew in a threaded hole to lock the bushing into the sprocket.

Setup

6. Fix four extrusion bars to the positions shown in Figure 15.

Make sure that the other extrusion bars present in the workstation are fixed tight at the back of the workstation.

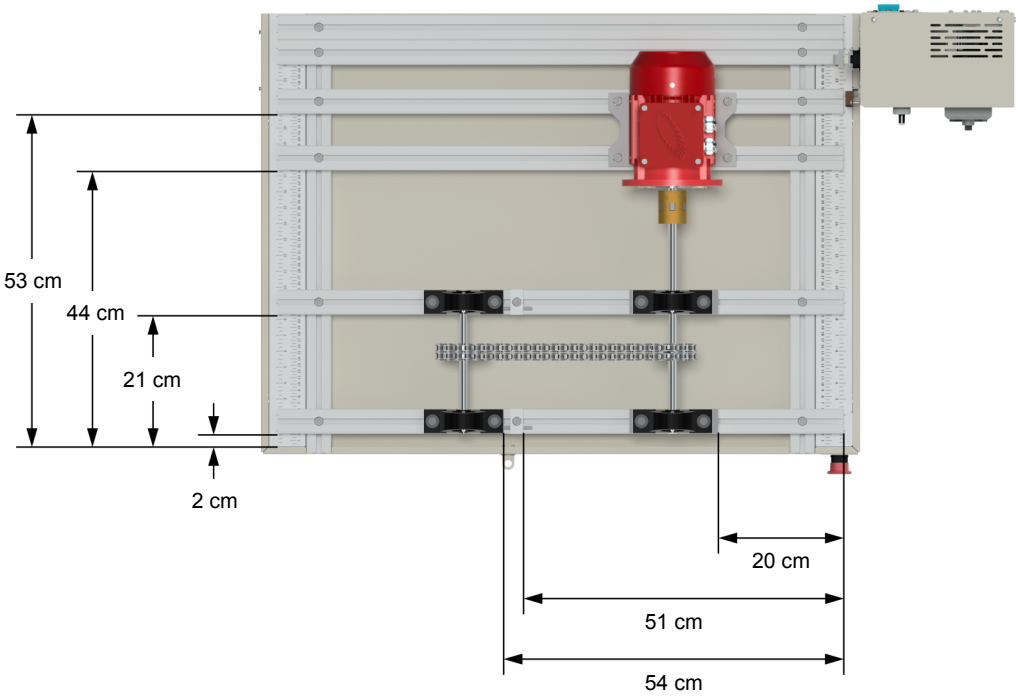


Figure 15. Workstation setup for Job Sheet 1.

7. Install the motor on the extrusion bars as shown in Figure 15. Do not tighten the screws yet.

8. Check for motor soft-foot before proceeding further. Apply corrections if necessary.

9. Install two pillow block bearings and two risers on the extrusions facing the motor as shown in Figure 15. Use M8-1.25 X 75 mm screws, flat washers, and T-nuts. Do not tighten the screws yet.

10. Install and fix two tensioner blocks to the position shown in Figure 15. Make sure that only a small part of each adjustment screw exceeds from the block. That part must be of the same length on each block.

    Tighten the tensioner blocks using the M8-1.25 X 25 mm screws and T-nuts.

11. Install the two other pillow block bearings to the position shown in Figure 15. Use M8-1.25 X 25 mm screws, flat washers, and T-nuts. Do not tighten the screws yet.

Do not install these pillow block bearings on risers.

Coupling installation and shaft alignment

You will couple the motor with the long shaft using a jaw coupling. Then you will perform angular and parallel shaft alignments in the horizontal and vertical planes.

12. Install a key in the keyseat of the motor shaft. The key should fit snuggly on the keyseat with no side-to-side movement.

13. Slide a jaw coupling hub on the motor shaft and make sure the coupling hub is flush with the shaft end. Then tighten the coupling setscrews on the shaft key with a 3 mm hexagonal T-handle key.

CAUTION

Do not overtighten or undertighten the setscrews to prevent the equipment from damaging.

14. Insert the long shaft in the furthest pillow block bearing that faces the motor.

15. Slide the 17 tooth double-row sprocket and bushing assembly on the long shaft and then insert the long shaft in the other pillow block bearing that directly faces the motor. Make sure that there is enough space between the shaft supported by the pillow block bearings and the motor shaft and do not tighten any setscrew yet.

From now on, the double-row sprocket and bushing assembly on the long shaft will be referred as the driving sprocket.

16. Install a key in the keyseat of the shaft supported by the pillow block bearings. The key should fit snuggly on the keyseat with no side-to-side movement. Align the key with the end of the shaft.

17. Slide the other jaw coupling hub onto the shaft supported by the pillow block bearings. Make sure the coupling hub is flush with the shaft end and properly tighten the coupling setscrew on the shaft key.

18. Take the insert and slide it into the jaw coupling hub on the motor shaft.

19. Slide the shaft supported by the pillow block bearings to join both jaw coupling hubs.

If needed, reposition the motor and pillow blocks until both jaw coupling hubs match.

20. Tighten the motor screws following a crisscross pattern. Use the 6 mm hexagonal T-handle key, M8-1.25 X 20 mm screws, and T-nuts.

21. Tighten the pillow block bearing setscrews on the flat surface of the shaft. Then tighten the pillow block bearings and risers screws.

CAUTION

Do not overtighten or undertighten the setscrews to prevent the equipment from damaging.

22. Align the shafts in the horizontal and vertical planes. Make sure to:

- ❑ Check vertical angular alignment using a feeler gauge and correct with shims if necessary.
- ❑ Check vertical parallel alignment using a feeler gauge and a straightedge. Then correct with shims if necessary.
- ❑ Check horizontal angular alignment using a feeler gauge and correct by rotating the motor if necessary.
- ❑ Check horizontal parallel alignment using a feeler gauge and a straightedge. Then correct by rotating the motor if necessary.

You can use the square head of the combination square as a straightedge. Refer to manual Introduction to Mechanical Drive Systems if necessary.

23. Install a key in the keyseat of the long shaft, midway between the pillow block bearings.

24. Slide the driving sprocket to align it with the key midway between the pillow block bearings.

Setscrews tightening procedure

25. Take the strap wrench and use it to grip the jaw coupling as shown in Figure 16.

Figure 16. Grip the jaw coupling using the strap wrench.

You can also use the strap wrench to grip the sprocket. To do so, make sure to roll a piece of cloth around the teeth of the driving sprocket to protect the strap wrench from damages.

CAUTION

Do not use the strap wrench on a sprocket without covering it. The teeth of sprockets are sharp and may damage the strap wrench.

26. Take the torque wrench, pull down its collar, and rotate its handle until you obtain a torque value of 20 N·m.

27. Take an H5 socket from the hexagonal bit socket set and attach it to the torque wrench as shown in Figure 17.

Figure 17. Attach an H5 socket to the torque wrench.

28. Make sure to set the direction of the dial lever properly.

29. Tighten the setscrews evenly until the desired torque is reached.

When the torque is reached, you will hear and/or feel a little click indicating that you have reached the desired torque.

Chain installation

You will join the two free ends of a double-strand roller chain using a connecting link.

30. Insert the short shaft in one of the remaining pillow block bearings.

31. Slide the 20 tooth double-row sprocket and bushing assembly on the short shaft and then insert the short shaft in the other pillow block bearing.

From now on, the double-row sprocket and bushing assembly on the short shaft will be referred as the driven sprocket.

32. Tighten the pillow block bearings setscrews on the flat surface of the shaft.

CAUTION

Do not tighten the setscrew on any surface other than a flat surface. This may damage the components.

33. Roughly align the sprockets. Do not tighten the setscrews of the driven sprocket yet.

34. Make sure the distance between the shafts center is equal to 340 mm. If needed, reposition the pillow block bearings supporting the short shaft. If necessary, move the tensioner blocks so that their adjustment screws make contact with the pillow block bearings again.

35. Install the 08B-2 roller chain on the sprockets. Make sure the two free ends are laid on the driven sprocket as shown in Figure 18.

Figure 18. Lay the double-strand roller chain on the sprockets.

36. Lift the front side of the chain ends and align the holes of the center plates with the holes of the remaining side of the chain ends. Then push the plate with pins so that the ends of the pins are flush with the end of the center plates, as shown in Figure 19.

Figure 19. Pushing the pate with pins through the center plates.

37. Lower the front side of the chain ends and push the remaining part of the plate with pins through the remaining part of the chain ends, as shown in Figure 20.

Figure 20. Pushing the plate with pins through the ends of the double-strand chain.

CAUTION

Take great care to avoid mixing the center plates with the outer plate. The outer plate has a bigger curve in its middle.

38. Install the outer plate on the front side of the chain as shown in Figure 21.

Figure 21. Installing the side plate.

39. Determine the direction of the chain travel and install a locking clip using a needle nose plier as shown in Figure 22. Make sure the closed end of the clip heads toward the direction of travel.

Figure 22. Locking clip installation.

Chain sag adjustment

40. Calculate the recommended sag for this chain drive by multiplying the shafts center distance by 4%.

    Recommended sag: _____

    Recommended sag: 13.6 mm

41. Make sure the slack is transferred on the top of the chain and lay a straightedge on the top of both sprockets.

42. Use a ruler to measure the sag at mid-span, as shown in Figure 23.

You can position the connecting link at mid-span to mark the position where you should measure the sag.

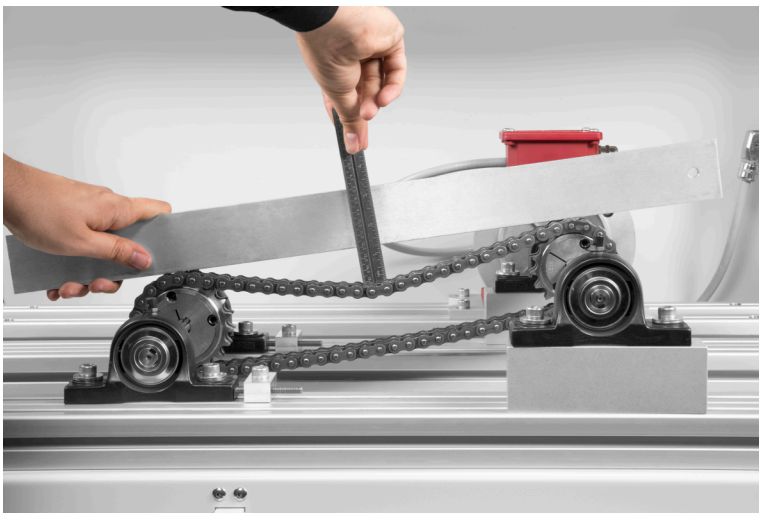


Figure 23. Sag measurement.

43. Add or remove tension by rotating the adjustment screws of the tensioner blocks evenly to obtain the recommended chain sag value.

It is preferable to increase the tension of the chain gradually to obtain the recommended sag, instead of removing tension after over-tensioning.

Sprocket alignment

You will perform angular and parallel alignment using a straightedge, a combination square, and tensioner blocks.

Sprocket angular alignment

44. Verify the vertical angular alignment by laying a combination square against the face of the driving sprocket as shown in Figure 24. Note the position of the bubble.

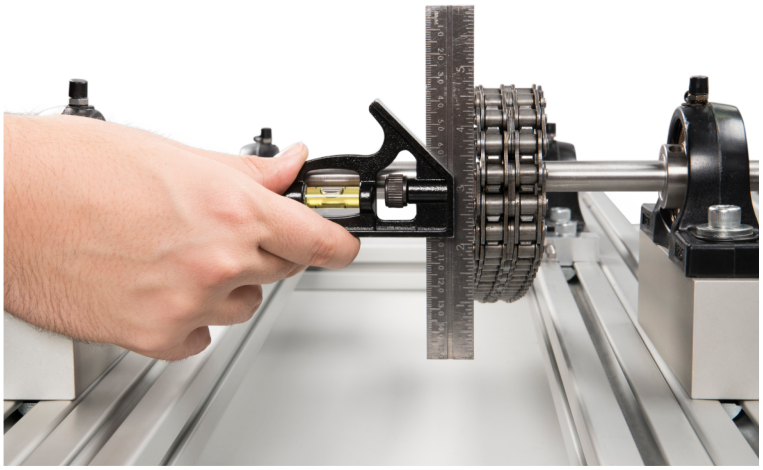


Figure 24. Vertical angular alignment.

45. Lay the combination square against the face of the driven sprocket and note the position of the bubble.

46. Adjust the vertical angular alignment so that the position of the bubble on the driven sprocket coincides with its position on the driving sprocket. Insert shims under the pillow block bearings as required.

The bubble does not need to be perfectly centered, but it must be at the same position for both sprockets.

47. Verify the horizontal angular alignment by laying a straightedge on the face of both sprockets.

48. Adjust the position of the pillow blocks by rotating the adjustment screws of the tensioner blocks until the distances A and B shown in Figure 25 are the same.

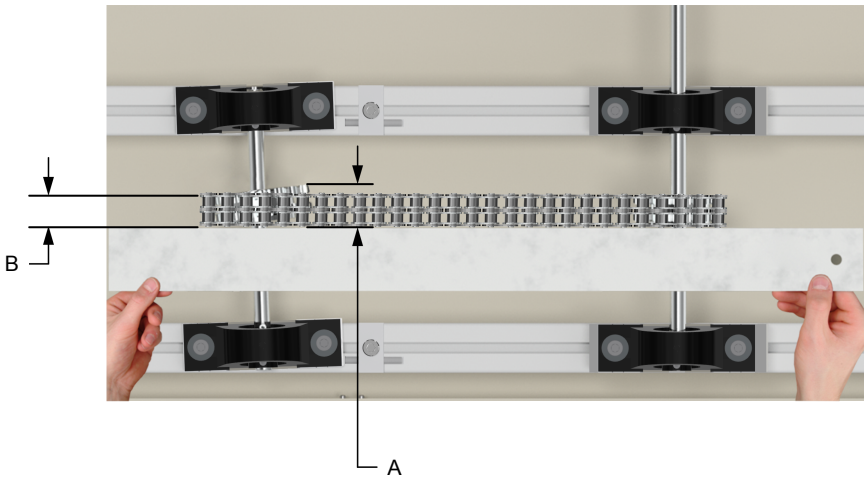


Figure 25. Horizontal angular alignment.

Sprocket parallel alignment

49. Lay a straightedge against the face of both sprockets and move the driven sprocket along the shaft until both sprockets are in contact with the straightedge, as shown in Figure 26.

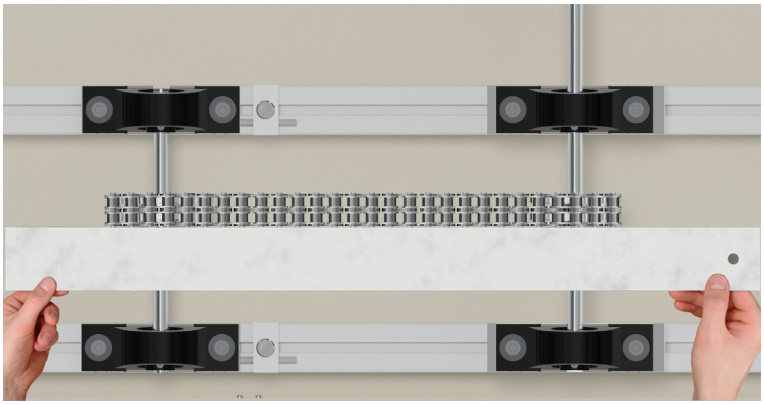


Figure 26. Parallel alignment.

50. Tighten the driven sprocket setscrews by performing the Setscrews tightening procedure.

51. Re-check for chain sag before proceeding further. Apply corrections if necessary.

The sprockets were aligned using the tensioner blocks, which has an influence on the chain sag.

52. Tighten the pillow block bearings screws.

53. Make sure that a reflective tape is present on the front side of both the driving and the driven sprocket.

54. Connect the motor to the variable frequency drive. To do so, clip the end of the motor connector to the power inlet inside the workstation enclosure.

CAUTION

Tuck the motor cable far from the rotating parts so that it does not get damaged when the motor starts.

Chain lubrication

You will lubricate a chain using a chain oiler. If you don't have a chain oiler, read carefully the instruction to understand the lubrication procedure.

55. Take a chain oiler and fill its reservoir with oil, if necessary.

56. Place a clean rag under the chain so that any excess of oil is collected.

57. Slowly rotate the sprockets and apply one or two drops of oil between the plates, on the slack side of the chain as shown in Figure 27. Lubricate each link.

Make sure the slack is still on the top of the chain drive.

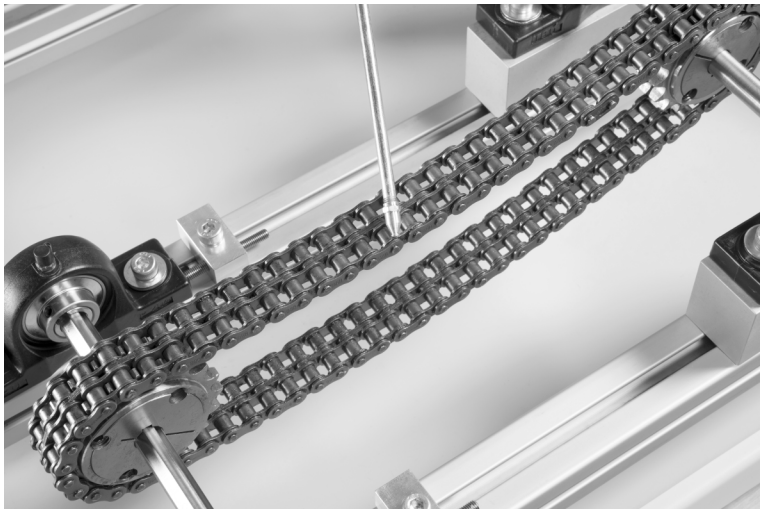


Figure 27. Application of oil on the double-strand chain.

58. Using a rag, remove excess of oil. The chain lubrication is complete.

Start-up procedure

59. Remove the lockout and tagout devices from the main switch.

60. Close the safety guard and install a lockout device in the padlock eyes.

61. Turn the power on by setting the main switch to the I (on) position. Make sure the power light on the control panel is turned on.

62. Press the safety reset button.

Testing the system and basic measurements

You will start the motor and vary its speed to make sure the system works properly. Furthermore, you will perform basic measurements.

63. Start the motor by pressing the start button on the variable frequency drive. Then set the frequency of the drive to 15 Hz.

    Make sure the system works properly.

64. Increase the motor speed by steps of 10 Hz until you reach 50 Hz.

    Make sure there are no abnormal sounds or vibrations.

65. Measure the speed of the driving sprocket (n_1) using the photo-reflective tachometer.

Driving sprocket speed (n_1): _____

Driving sprocket speed (n_1): 1452 rpm

66. Measure the speed of the driven sprocket (n_2) using the photo-reflective tachometer.

Driven sprocket speed (n_2): _____

Driven sprocket speed (n_2): 1234 rpm

67. Stop the motor.

68. Calculate the teeth ratio $\left(\frac{N_2}{N_1}\right)$.

Teeth ratio: _____

$$\frac{N_2}{N_1} = \frac{20}{17} = 1.18$$

Teeth ratio: 1.18

69. Using your measured speed values, calculate the speed ratio $\left(\frac{n_1}{n_2}\right)$.

Speed ratio: _____

Speed ratio: approximately 1.18

70. Does this ratio correspond to the teeth ratio $\left(\frac{N_2}{N_1}\right)$ you calculated?

❑ Yes ❑ No

Yes

71. Turn off the system.

Components removal

You will remove all components following a precise guideline. Furthermore, you will remove the taper bore bushings from the sprockets by tightening a setscrew.

72. Dismount the spring clip of the connecting link using a needle nose plier as shown in Figure 28. Then remove the other components of the connecting link and, finally, remove the 08B-2 roller chain.

Figure 28. Connecting link dismantlement.

73. Attach an H5 socket to the ratchet and use the ratchet to loosen the setscrews of the double-row sprocket and bushing assemblies until they are completely removed.

CAUTION

Never use a torque wrench for disassembly. Use a ratchet instead.

74. Loosen all screws and setscrews and return all components to the storage location except the double-row sprocket and bushing assemblies.

Taper bore bushing removal

75. Perform the following steps to remove the bushings from the sprockets:

- ❑ Take a setscrew and insert it in the upper threaded hole.
- ❑ Using the ratchet, tighten the setscrew until the bushing can come out of the sprocket easily.

76. Ask the instructor to check your work.

Name: _____ Date: _____

Instructor's approval: _____