Industrial Maintenance

Shaft Alignment and Couplings

Course Sample

49138-3C

Order no.: 49138-3C
First Edition
Revision level: 03/2018

By the staff of Festo Didactic

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Internet: www.festo-didactic.com
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Printed in Canada
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ISBN 978-2-89789-089-6 (Printed version)
ISBN 978-2-89789-092-6 (CD-ROM)
Legal Deposit – Bibliothèque et Archives nationales du Québec, 2018
Legal Deposit – Library and Archives Canada, 2018

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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

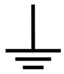
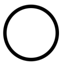
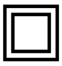
Symbol	Description
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position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

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Table of Contents

Preface

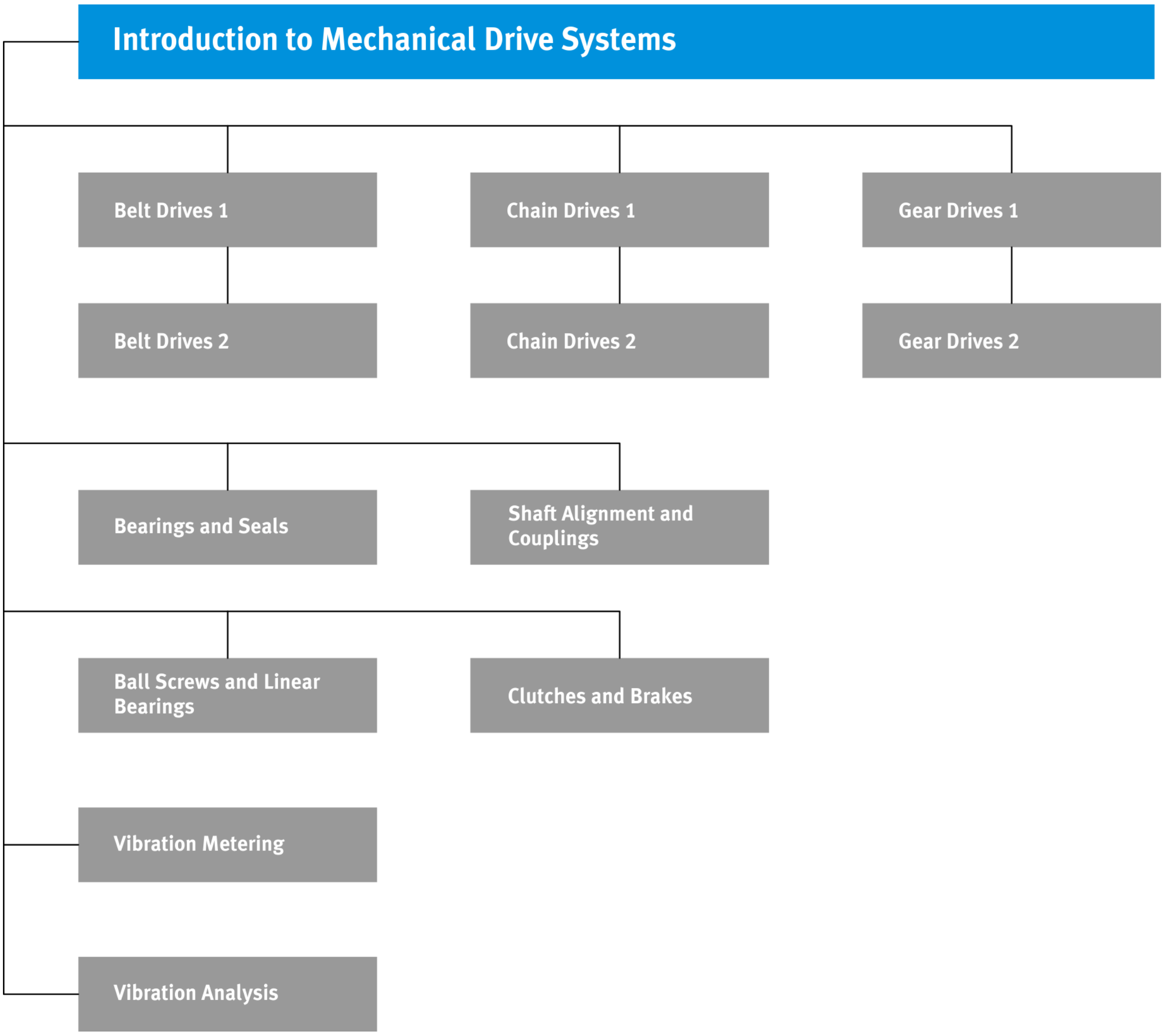
The Mechanical Drives Training System covers the installation, use, maintenance, and troubleshooting of mechanical drives.

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
- Vibration 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.

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About This Manual

The Shaft Alignment and Couplings manual introduces the basics of shaft alignment and couplings.

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 textbook 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 on the knowledge acquired in the previous one.

Manual objectives

When you have completed this manual, you will be familiar with the basic principles of shaft alignment in applications requiring the coupling of two machines. You will learn how to perform shaft alignment using the straightedge and feeler gauge, rim and face, reverse dial indicator, and laser (optional) methods. You will also learn how the coupling of two machines requires a device called a coupling. You will learn the different characteristics and typical applications of the following coupling types: flange, flexible sleeve, chain, gear, grid, and universal joint couplings.

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 *Introduction to Mechanical Drive Systems.*

Systems 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 already partially 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

Job Sheets - Instructor

Shaft Alignment – Rim and Face Method

Rim and face method

The rim and face method, also called dial indicator method, is one of the most common shaft alignment methods. It consists of installing two dial indicators on the shaft of one machine, and positioning them on the rim and face of the coupling of the other machine, as shown in Figure 15. By simultaneously rotating both shafts, as well as the dial indicator assembly, and taking measurements at certain points, it is possible to measure the offset of the movable machine shaft in relation to the stationary machine shaft. The rim dial indicator measures the parallel offset, while the face dial indicator measures the angular offset.

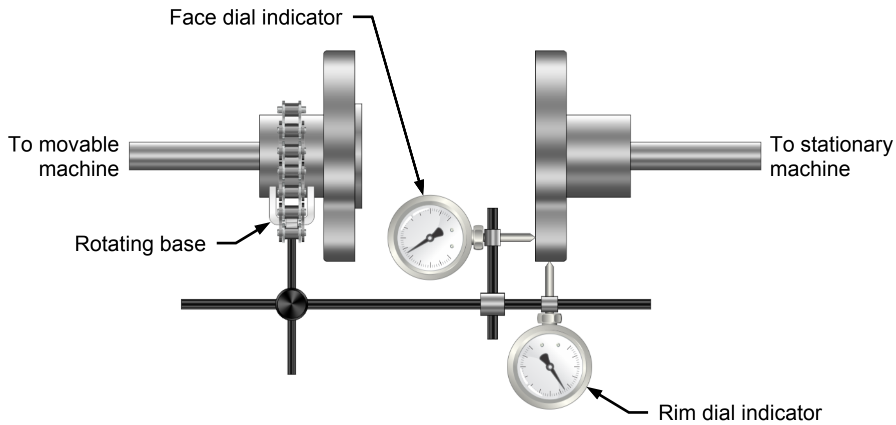

Figure 15. Common arrangement for a shaft alignment using the rim and face method.

Various different arrangements are possible for the face and rim method, depending on the position of the dial indicators. Figure 15 shows the most common arrangement, while Figure 16 shows other possible arrangements.

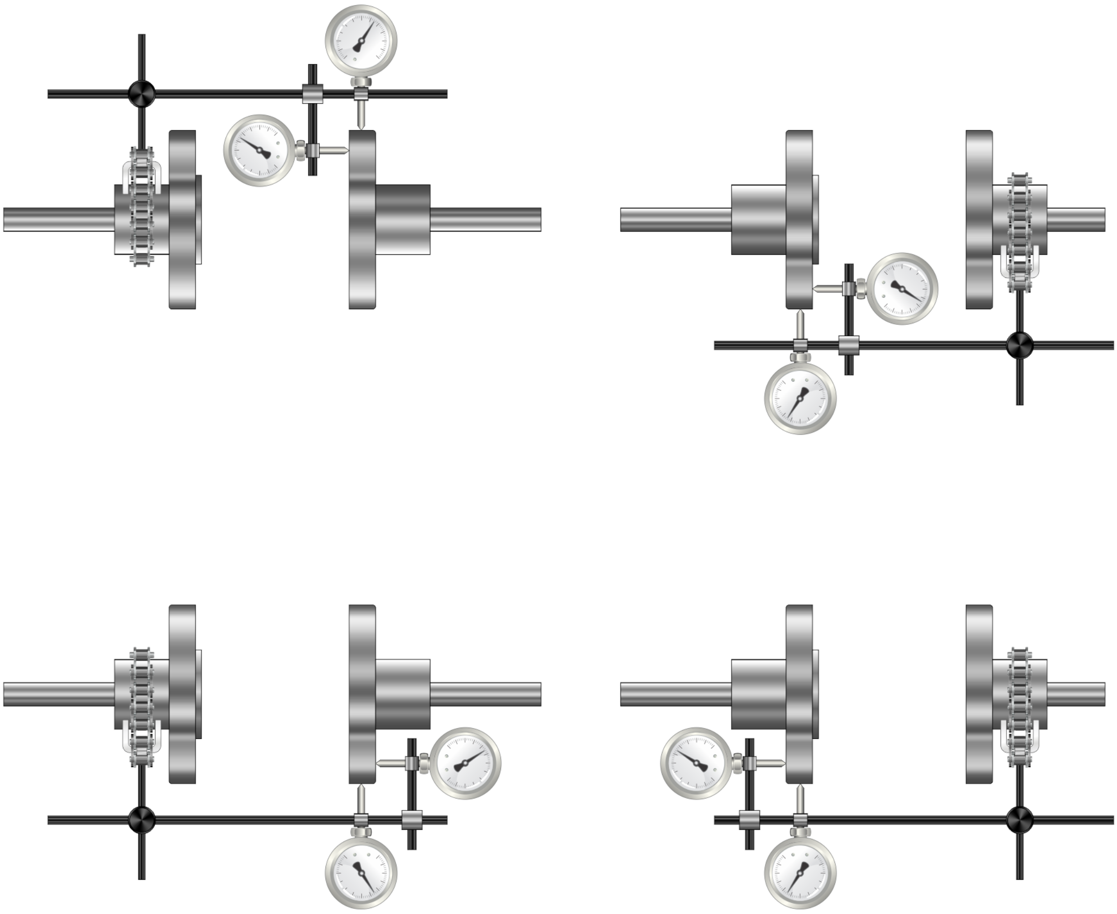

Figure 16. Possible arrangements of the dial indicators for the rim and face method.

Vertical alignment

To perform the vertical alignment, the dial indicators are set according to a chosen arrangement. See Figure 17 for an example. In this arrangement, the dial indicators are set to the 6 o'clock position.

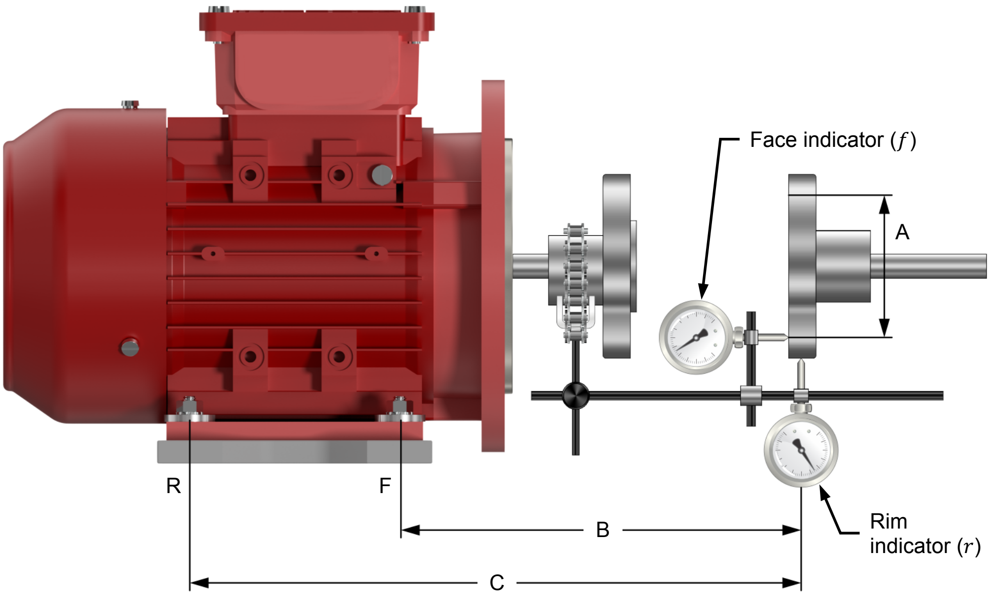

Figure 17. Vertical alignment using the rim and face method.

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The dial indicators are now at their initial position. To indicate this, the rotating dials on the dial indicators are rotated so that they both indicate 0 mm. The dial indicators are rotated around the shaft axis until they are located at the 12 o'clock position. Both dial indicators should now measure the total indicator reading or TIR for the vertical misalignment. The TIR for both the rim and face dial indicators can then be used to calculate the shim thickness required for vertical alignment using Equations (2-1) and (2-2):

Make sure to record the polarity (+ or -) of the dial indicator readings and take them into account in the calculations.

$$F_V = \frac{r_V}{-2} + \frac{f_V \cdot B}{A} \tag{2-1}$$

where F_V is the shim thickness required under the front feet of the movable machine for vertical alignment, in mm
r_V is the TIR of the rim dial indicator, on the vertical plane, in mm
f_V is the TIR of the face dial indicator, on the vertical plane, in mm
B is the distance between the rim of the stationary machine coupling and the front feet of the movable machine (see Figure 17), in mm
A is the distance between the 12 o'clock and 6 o'clock positions of the plunger of the face dial indicator (see Figure 17), in mm

$$R_V = \frac{r_V}{-2} + \frac{f_V \cdot C}{A} \tag{2-2}$$

where R_V is the shim thickness required under the rear feet of the movable machine for vertical alignment, in mm
C is the distance between the rim of the stationary machine coupling and the rear feet of the movable machine (see Figure 17), in mm

Due to the nature of dial indicator measurements, the offset (vertical or horizontal) is always measured twice. This is why the TIR must be divided by 2.

In these equations, the first term corrects the vertical parallel misalignment. It is equal to the TIR measured by the rim dial indicator divided by two. The second term corrects the vertical angular misalignment. It is obtained through the correspondence of similar triangles.

Once the shim thickness values for a proper vertical alignment are calculated, shims can be inserted or removed as required under the movable machine feet, as described in Job Sheet 1. If the vertical alignment has been made properly, this should correct the vertical misalignment to within acceptable limits. This can be confirmed by repeating the above vertical alignment procedure.

Horizontal alignment

The horizontal alignment is very similar to the vertical alignment, but this time on the horizontal plane. It involves setting up the dial indicators according to a chosen arrangement, such as the one in Figure 18. In this arrangement, the dial indicators are set to the 9 o'clock position.

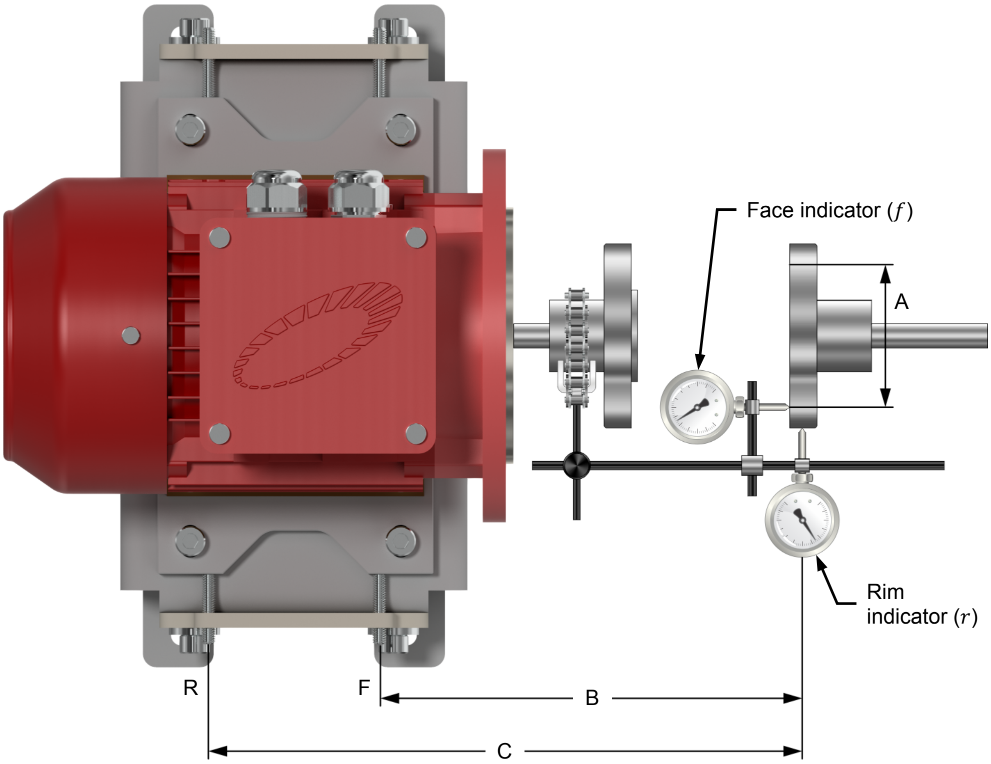

Figure 18. Horizontal alignment using the rim and face method.

The dial indicators are now at their initial position. To indicate this, the rotating dials on the dial indicators are rotated so that they both indicate 0 mm. The dial indicators are rotated around the shaft axis until they are located at the 3 o'clock position. Both dial indicators should now measure the total indicator reading or TIR for the horizontal misalignment. The TIR for both the rim and face dial indicators can then be used to calculate the adjustments required at the front and rear motor feet for horizontal alignment using Equations (2-3) and (2-4):

Make sure to record the polarity (+ or -) of the dial indicator readings and take them into account in the calculations.

$$F_H = \frac{r_H}{-2} + \frac{f_H \cdot B}{A} \tag{2-3}$$

where F_H is the adjustment required at the front feet of the movable machine for horizontal alignment, in mm

r_H is the TIR of the rim dial indicator, on the horizontal plane, in mm

f_H is the TIR of the face dial indicator, on the horizontal plane, in mm

B is the distance between the rim of the stationary machine coupling and the front alignment setscrews of the movable machine (see Figure 17), in mm

A is the distance between the 3 o'clock and 9 o'clock positions of the plunger of the face dial indicator (see Figure 17), in mm

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$$R_H = \frac{r_H}{-2} + \frac{f_H \cdot C}{A} \tag{2-4}$$

where R_H is the adjustment required at the rear feet of the movable machine for horizontal alignment, in mm

C is the distance between the rim of the stationary machine coupling and the rear alignment setscrews of the movable machine (see Figure 17), in mm

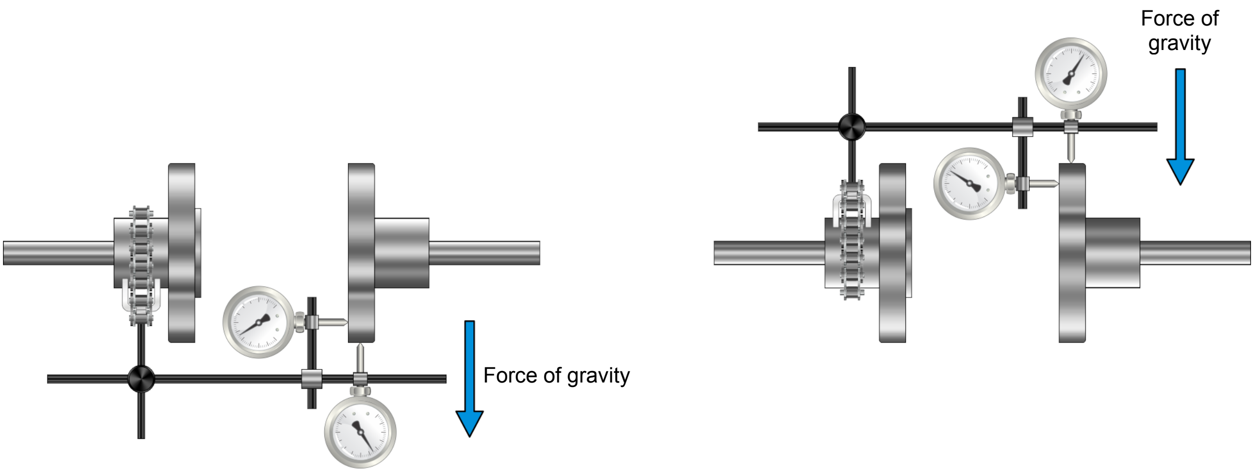
As you can see, these equations are identical to the equations for calculating the shim thickness required for vertical alignment.

Once the adjustment for a proper horizontal alignment is calculated, the front and rear of the movable machine can be pushed and pulled as needed, as described in Job Sheet 1. If the horizontal alignment has been made properly, this should correct the horizontal misalignment to within acceptable limits. This can be confirmed by repeating the above horizontal alignment procedure.

After both the vertical and horizontal alignments are performed, the shafts of the movable machine and the stationary machine are aligned to within acceptable limits.

Bar sag

Bar sag, also called indicator sag, is an important factor to take into account whenever making dial indicator measurements in the vertical plane. It refers to the effect of gravity on the measurements taken by dial indicators. The heavier the dial indicator assembly and the less stable the bracket mountings, the more important the effects of bar sag. Figure 19 shows the effects of bar sag on the measurements of dial indicators.



(a) At the 6 o'clock position

(b) At the 12 o'clock position

Figure 19. Effects of bar sag on the measurements of dial indicators.

As Figure 19a shows, when the dial indicator assembly is at the 6 o'clock position, the force of gravity causes the following:

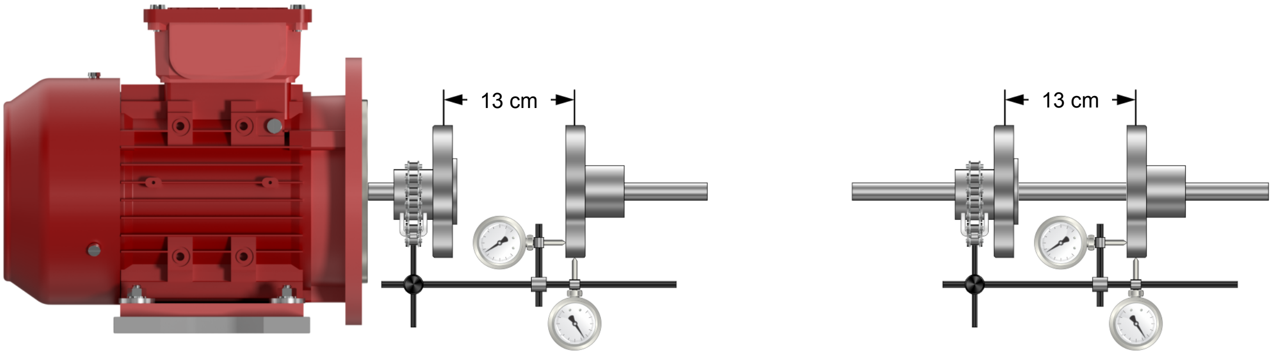
- The rim dial indicator underestimates the measured offset.
- The face dial indicator overestimates the measured offset.

On the other hand, as Figure 19b shows, when the dial indicator assembly is at the 12 o'clock position, the force of gravity causes the following:

- The rim dial indicator overestimates the measured offset.
- The face dial indicator underestimates the measured offset.

Measuring the bar sag

The magnitude of the bar sag can be measured by removing all other factors impacting the TIR, leaving only the bar sag to be measured. This can be achieved by reproducing the actual setup between the movable and stationary machines in another setup where both machines are connected by the same shaft, as shown in Figure 20. This ensures that there is no offset between the shafts of both machines. The rim and face method is then applied to measure the TIR in the new setup. The TIR values measured by the rim and face dial indicators are entirely due to the effects of bar sag. These values must be recorded so that they can be used to correct the measurements taken by the dial indicators in the actual setup.



(a) Actual setup

(b) Corresponding setup for measuring bar sag

Figure 20. Measuring the bar sag.

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Correcting for the bar sag

To properly measure the shaft misalignment using the rim and face method, it is necessary to correct for the TIR of the dial indicators in the setup for measuring bar sag. This can be achieved by subtracting the TIRs measured for bar sag from the TIRs measured in the actual setup. It is thus possible to reformulate Equations (2-1) and (2-2) as follows:

$$F_V = \frac{(r_V - r_{BS})}{-2} + \frac{(f_V - f_{BS}) \cdot B}{A} \tag{2-5}$$

where F_V is the shim thickness required under the front feet of the movable machine for vertical alignment, in mm

r_V is the TIR of the rim dial indicator in the actual setup, on the vertical plane, in mm

r_{BS} is the TIR of the rim dial indicator in the setup for measuring bar sag, in mm

f_V is the TIR of the face dial indicator in the actual setup, on the vertical plane, in mm

f_{BS} is the TIR of the face dial indicator in the setup for measuring bar sag, in mm

B is the distance between the rim of the stationary machine coupling and the front feet of the movable machine (see Figure 17), in mm

A is the distance between the 12 o'clock and 6 o'clock positions of the plunger of the face dial indicator (see Figure 17), in mm

$$R_V = \frac{(r_V - r_{BS})}{-2} + \frac{(f_V - f_{BS}) \cdot C}{A} \tag{2-6}$$

where R_V is the shim thickness required under the rear feet of the movable machine for vertical alignment, in mm

C is the distance between the rim of the stationary machine coupling and the rear feet of the movable machine (see Figure 17), in mm

Shaft Alignment – Rim and Face Method

The results given in this job sheet are typical measurements. The actual results obtained by students vary.

OBJECTIVE

- Measure and correct for the bar sag in a setup for shaft alignment using the rim and face method
- Perform a shaft alignment between a movable machine and a stationary machine using the rim and face method

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.

Lockout/tagout procedure

Perform the lockout/tagout procedure described in Appendix B.

Preliminary procedures to this job sheet

Before doing this job sheet, make sure you have performed the following procedures from Job Sheet 1:

- Motor installation
- Soft foot detection and correction
- Stationary machine installation
- Flange coupling installation
- Run-out detection
- Shaft alignment using the straightedge and feeler gauge method

Figure 21 shows the current equipment setup after the above procedures.

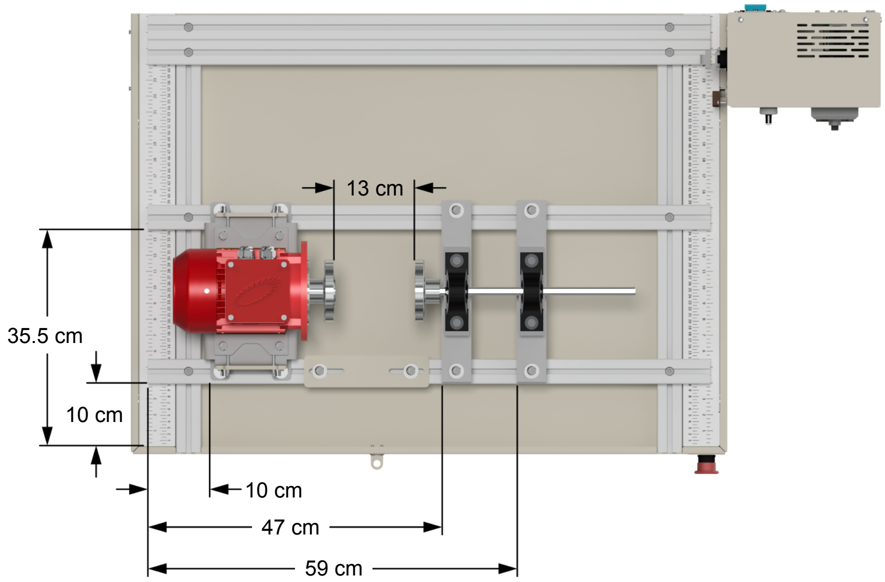

Figure 21. Current equipment setup.

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Measuring the bar sag

1. Install the equipment as shown in Figure 22. As the figure shows, one of the 29 cm risers has been slid slightly to the right. The hubs of the flange coupling have been installed on the long shaft. Since the coupling hubs are on the same shaft, their keysets are aligned.

   Make sure the distance between both hubs is 13 cm. This is to make sure the bar sag you will measure in the current section will be equal to the bar sag measured in the actual setup.

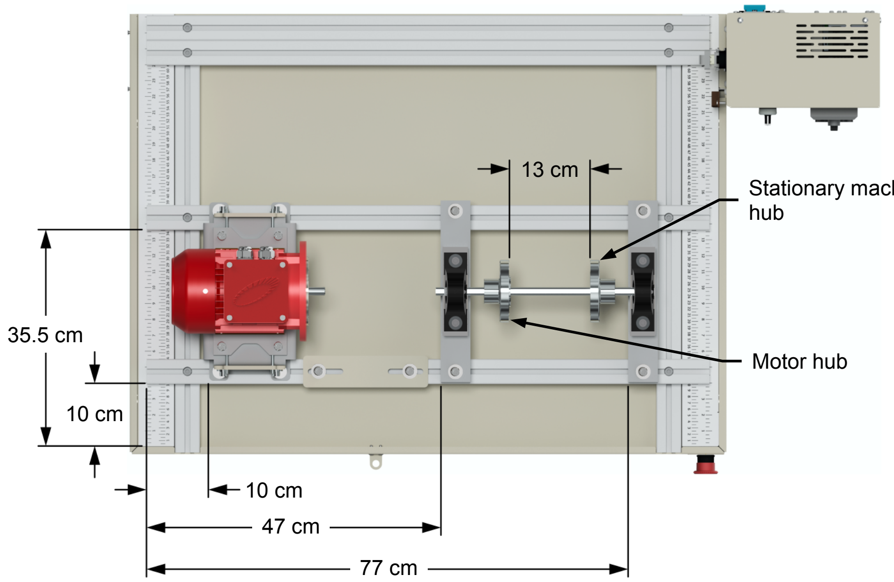

Figure 22. Bar sag measurement setup for shaft alignment using the rim and face method.

2. Rotate the shaft so that the keyseat is at the 6 o'clock position.

Dial indicator assembly installation for the rim and face method

3. Locate the components for the dial indicator assembly. You will need them in this job sheet. Figure 23 shows a typical dial indicator assembly for the rim and face method, with the components identified.

For the dial indicator assembly in this job sheet, use the long spanning rod. The short spanning rods are used in Job Sheet 3.

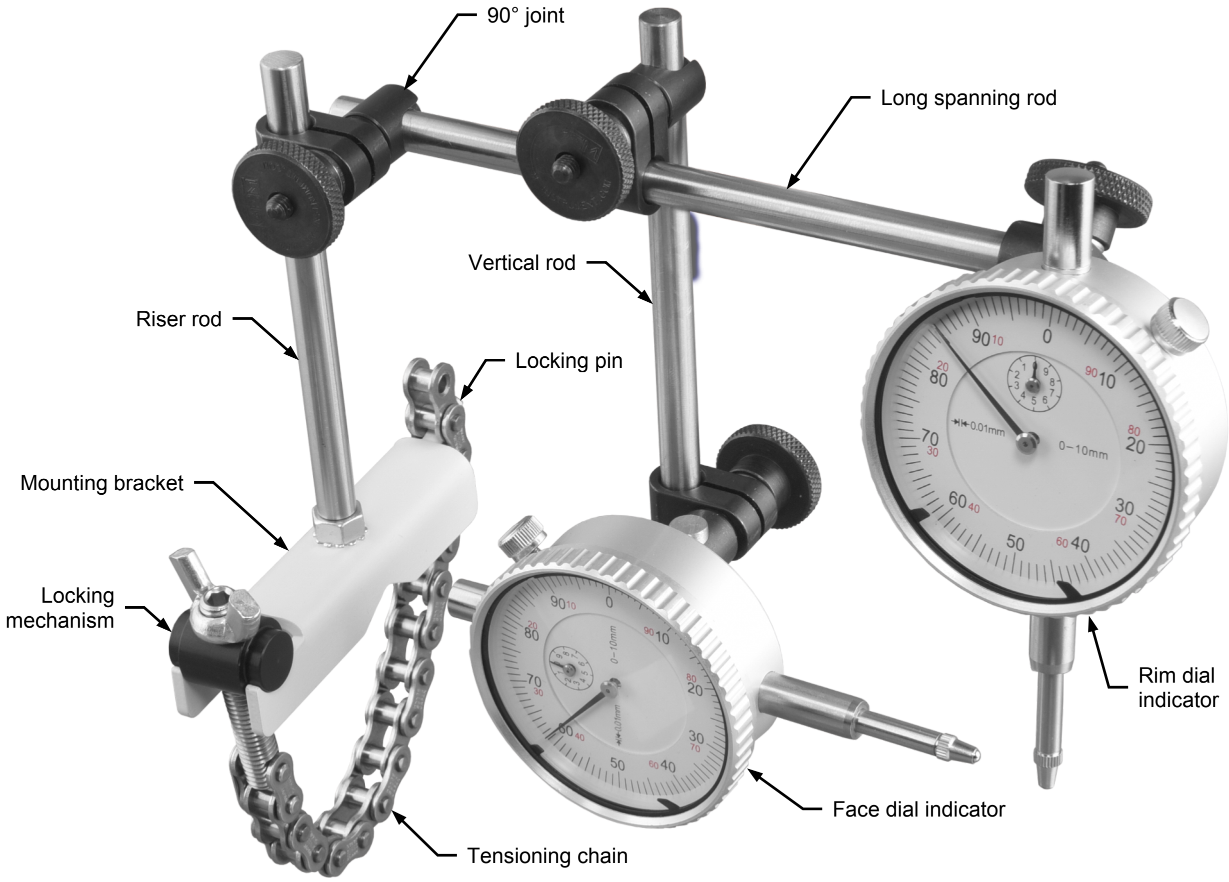

Figure 23. Typical dial indicator assembly for the rim and face method.

4. On the dial indicator assembly, unscrew the wing nut along the locking mechanism so that the wing nut is about flush with the tip of the screw.

5. Lay the mounting bracket on the coupling hub of the movable machine so that the riser rod is at the 12 o'clock position. Press the mounting bracket firmly against the back of the flange.

   As a reference during installation, Figure 24 shows the dial indicator assembly installed on the coupling hub of the movable machine.

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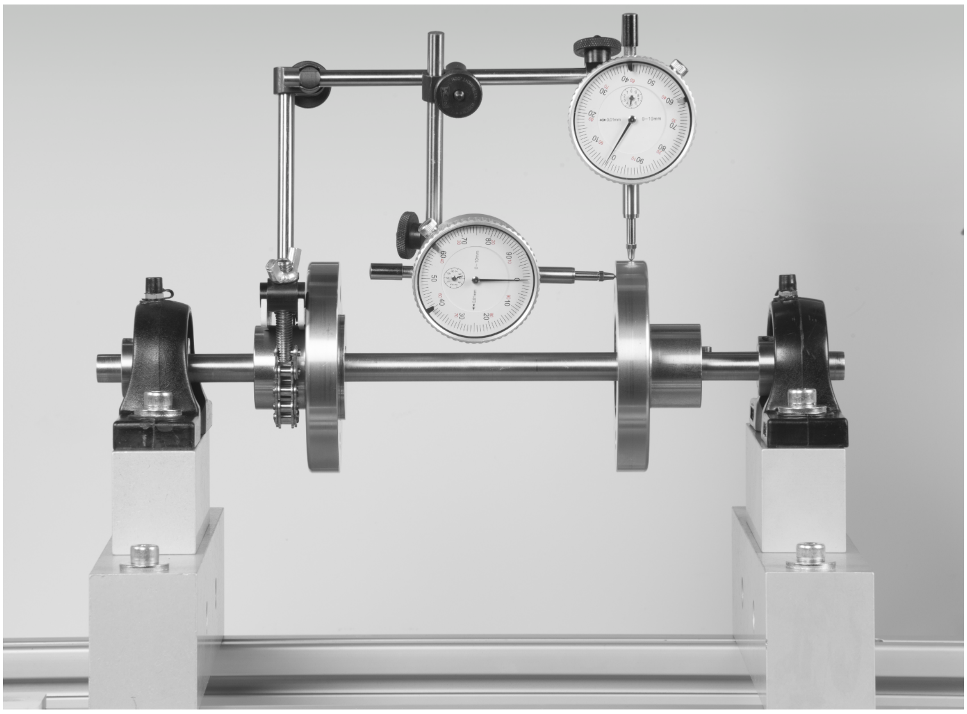

Figure 24. Dial indicator assembly installed on the coupling hub of the movable machine.

6. Loop the tensioning chain under the coupling hub of the motor until it reaches the locking pin of the mounting bracket. Insert the locking pin into the furthest chain groove attainable.

7. Tighten the tensioning chain by screwing the ear nut of the locking mechanism as much as possible. The dial indicator assembly should now be firmly attached to the coupling hub of the motor.

8. Install the long spanning rod on the riser rod using a 90° joint. Make sure the long spanning rod is parallel to the shaft and oriented toward the stationary machine hub.

9. Install the vertical rod about halfway on the long spanning rod using a 90° joint. Make sure the vertical rod is perpendicular to and oriented toward the shaft.

10. Install the rim dial indicator using a dial indicator joint. Make sure the plunger of the dial indicator touches perpendicularly the rim of the stationary machine hub.

    Adjust the rods and joints if necessary to install the dial indicator in the correct position.

11. Install the face dial indicator using a dial indicator joint. Make sure the plunger of the dial indicator touches perpendicularly the face of the stationary machine hub.

    Adjust the rods and joints if necessary to install the dial indicator in the correct position.

12. The dial indicator assembly is now installed. Make sure that all joints are properly tightened in place. It is important that the assembly remains identical for the rest of this job sheet.

Bar sag measurement

13. Rotate the shaft so that the dial indicator assembly is at the 12 o'clock position.

14. Rotate the display of both dial indicators so that they read zero.

15. Slowly rotate the shaft until the dial indicator assembly is at the 6 o'clock position. Observe the measurement of the rim dial indicator as you are rotating the shaft. Record the value measured at the 6 o'clock position (positive or negative) below. This corresponds to the TIR for the vertical parallel bar sag (r_{BS}).

    TIR for the vertical parallel bar sag (r_{BS}) =________ mm

    Never lose sight of a dial indicator reading during shaft rotation. Use an inspection mirror if necessary. This is important because each complete turn (if any) of the dial indicator needle must be taken into account in the final reading. A complete turn of a dial indicator needle corresponds to 1 mm.

    TIR for the vertical parallel bar sag (r_{BS}) = -0.82 mm

16. Repeat steps 13 to 15 for the face dial indicator. The measured value corresponds to the TIR for the vertical angular bar sag (f_{BS}).

    TIR for the vertical angular bar sag (f_{BS}) =________ mm

    TIR for the vertical angular bar sag (f_{BS}) = -0.11 mm

Shaft alignment using the rim and face method

17. Install the equipment as shown in Figure 25. As the figure shows, the equipment is now similar to the initial setup.

    Make sure the distance between both hubs is 13 cm. This is necessary so the bar sag measured in the previous section can be used for shaft alignment in this section.

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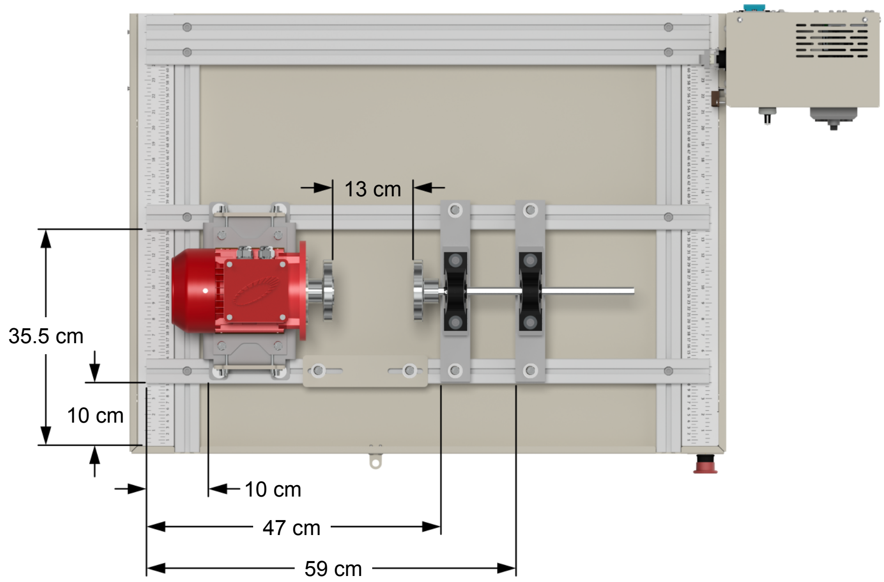

Figure 25. Setup for shaft alignment using the rim and face method.

Vertical alignment

18. Rotate both shafts so that the dial indicator assembly is at the 12 o'clock position, as shown in Figure 26.

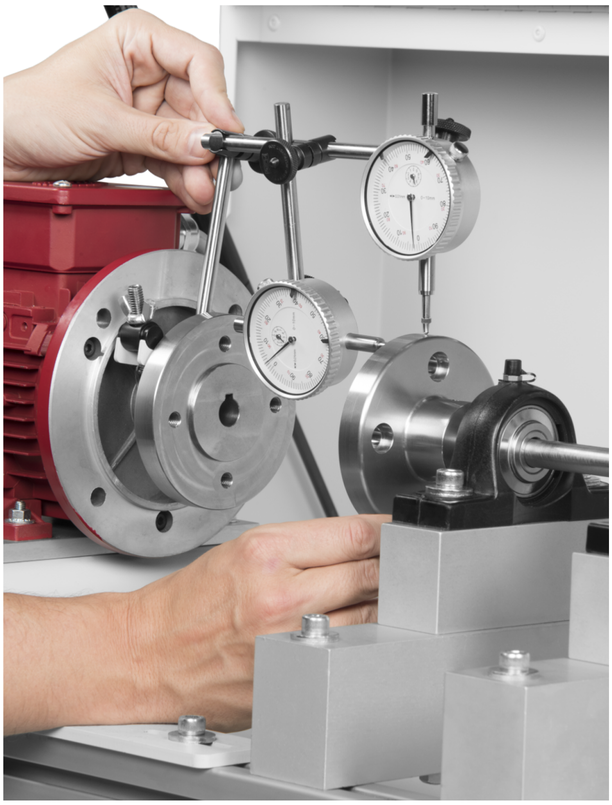

Figure 26. Dial indicator assembly at its initial position for vertical misalignment measurement.

19. Rotate the display of both dial indicators so that they read zero.

20. Slowly rotate both shafts simultaneously until the dial indicator assembly is at the 6 o'clock position. Observe the measurement of the rim dial indicator as you are rotating the shafts. Record the value measured at the 6 o'clock position (positive or negative) below. This corresponds to the TIR for the vertical parallel misalignment (r_V).

TIR for the vertical parallel misalignment (r_V) =________ mm

Never lose sight of a dial indicator reading during shaft rotation. Use an inspection mirror if necessary. This is important because each complete turn (if any) of the dial indicator needle must be taken into account in the final reading. A complete turn of a dial indicator needle corresponds to 1 mm.

Make sure to always keep the keyseats and soapstone marks of both shafts aligned.

TIR for the vertical parallel misalignment (r_V) = -1.45 mm

21. Repeat steps 18 to 20 for the face dial indicator. The measured value corresponds to the TIR for the vertical angular misalignment (f_V).

TIR for the vertical angular misalignment (f_V) =________ mm

TIR for the vertical angular misalignment (f_V) = -0.20 mm

22. Using Equations (2-5) and (2-6), calculate the shim thickness required under the front and rear feet of the motor for vertical alignment.

Shim thickness under front feet of the motor (F_V) =________ mm

Shim thickness under rear feet of the motor (R_V) =________ mm

The shim thickness required under the front and rear feet of the motor for vertical alignment is calculated below.

$$F_V = \frac{(r_V - r_{BS})}{-2} + \frac{(f_V - f_{BS}) \cdot B}{A}$$

$$F_V = \frac{(-1.45 \text{ mm} + 0.82 \text{ mm})}{-2} + \frac{(-0.20 \text{ mm} + 0.11 \text{ mm}) \cdot 219 \text{ mm}}{90 \text{ mm}}$$

$$F_V = -0.32 \text{ mm} - 0.22 \text{ mm} = -0.54 \text{ mm}$$

$$R_V = \frac{(r_V - r_{BS})}{-2} + \frac{(f_V - f_{BS}) \cdot C}{A}$$

$$R_V = \frac{(-1.45 \text{ mm} + 0.82 \text{ mm})}{-2} + \frac{(-0.20 \text{ mm} + 0.11 \text{ mm}) \cdot 309 \text{ mm}}{90 \text{ mm}}$$

$$R_V = -0.32 \text{ mm} - 0.31 \text{ mm} = -0.63 \text{ mm}$$

Shim thickness under front feet of the motor (F_V) $= -0.54$ mm

Shim thickness under rear feet of the motor (R_V) $= -0.63$ mm

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23. If the motor feet on the side nearest to you need more or less shimming, loosen their screws. Install or remove the shim thickness determined in the previous step on both feet.

A positive shim thickness value indicates that shims must be added, while a negative shim thickness value indicates that shims must be removed.

Use as few shims as possible, including the shims already present underneath the motor feet. Furthermore, do not assume the thickness of the shims. Measure each shim combination with the digital caliper to ascertain its exact thickness.

When you've finished shimming the feet, retighten all screws.

24. Repeat the previous step for the motor feet on the side furthest from you.

25. The motor shaft should now be aligned with the stationary machine shaft on the vertical plane. To confirm this, you can repeat steps 18 to 21 and make sure the measured vertical misalignments are within the tolerance values specified by your instructor. If not, repeat steps 22 to 25.

For the current setup and with an operating speed of up to 2000 r/min, a misalignment tolerance of 0.1 mm is recommended in the industry.

Horizontal alignment

26. Rotate both shafts so that the dial indicator assembly is at the 3 o'clock position, as shown in Figure 27.

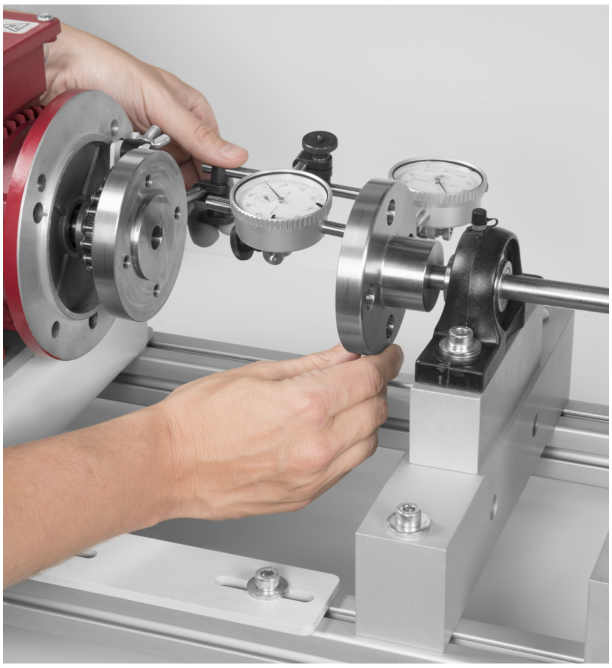

Figure 27. Measuring the horizontal misalignment using the rim and face method.

27. Rotate the display of both dial indicators so that they read zero.

28. Slowly rotate both shafts simultaneously until the dial indicator assembly is at the 9 o'clock position. Observe the measurement of the rim dial indicator as you are rotating the shafts. Record the value measured at the 9 o'clock position (positive or negative) below. This corresponds to the TIR for the horizontal parallel misalignment (r_H).

TIR for the horizontal parallel misalignment (r_H) =_________ mm

Never lose sight of a dial indicator reading during shaft rotation. Use an inspection mirror if necessary. This is important because each complete turn (if any) of the dial indicator needle must be taken into account in the final reading. A complete turn of a dial indicator needle corresponds to 1 mm.

Make sure to always keep the keyseats and soapstone marks of both shafts aligned.

TIR for the horizontal parallel misalignment (r_H) = 0.67 mm

29. Repeat steps 26 to 28 for the face dial indicator. The measured value corresponds to the TIR for the horizontal angular misalignment (f_H).

TIR for the horizontal angular misalignment (f_H) =_________ mm

TIR for the horizontal angular misalignment (f_H) = -0.27 mm

30. Using Equations (2-3) and (2-4), calculate the adjustments required at the front and rear motor feet for horizontal alignment.

Adjustment at the front feet of the motor (F_H) =_________ mm

Adjustment at the rear feet of the motor (R_H) =_________ mm

The adjustments required at the front and rear motor feet for horizontal alignment are calculated below.

$$F_H = \frac{r_H}{-2} + \frac{f_H \cdot B}{A} = \frac{0.67\text{ mm}}{-2} + \frac{-0.27\text{ mm} \cdot 219\text{ mm}}{90\text{ mm}}$$

$$F_H = -0.34\text{ mm} - 0.66\text{ mm} = -1.00\text{ mm}$$

$$R_H = \frac{r_H}{-2} + \frac{f_H \cdot C}{A} = \frac{0.67\text{ mm}}{-2} + \frac{-0.27\text{ mm} \cdot 309\text{ mm}}{90\text{ mm}}$$

$$R_H = -0.34\text{ mm} - 0.93\text{ mm} = -1.27\text{ mm}$$

Adjustment at the front feet of the motor (F_H) $= -1.00\text{ mm}$

Adjustment at the rear feet of the motor (R_H) $= -1.27\text{ mm}$

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31. If the motor feet require horizontal adjustment, perform the following steps:

- Loosen the screws of all motor feet.
- Loosen all setscrews on the feet in the direction in which the motor front and rear must be moved. Unscrew these setscrews the number of turns necessary to allow the motor front and rear to move by the horizontal adjustment determined in step 30.
- Screw by the same number of turns the horizontal alignment setscrews of the feet located on the opposite side.

A positive adjustment value indicates that the motor feet must be moved toward the 3 o'clock position, while a negative adjustment value indicates that the motor feet must be moved toward the 9 o'clock position.

A complete turn of the horizontal alignment setscrews corresponds to a horizontal displacement of 1 mm.

32. When you've finished making the horizontal adjustments on the motor feet, retighten all screws.

33. The motor shaft should now be aligned with the stationary machine shaft on the horizontal plane. To confirm this, you can repeat steps 26 to 29 and make sure the measured horizontal misalignments are within the tolerance values specified by your instructor. If not, repeat steps 30 to 33.

For the current setup and with an operating speed of up to 2000 r/min, a misalignment tolerance of 0.1 mm is recommended in the industry.

Shaft coupling of a flange coupling

34. Untighten the screws of the pillow block bearings to release the stationary machine shaft.

35. Couple the shafts by sliding the stationary machine shaft toward the motor shaft and pressing the coupling hub of the stationary machine on the coupling hub of the motor. Make sure to insert the male coupling hub in the female coupling hub. If shaft alignment has been done properly, the coupling hubs should fit together easily.

Using a torque wrench and M8-1.25 x 25 mm screws, screw both coupling hubs together up to a torque of 30 N·m. If you do not have a torque wrench, use a hex key instead to tighten the screws firmly in place. Make sure to insert the screws in the coupling hub with the clearance holes.

36. Tighten the screws of the pillow block bearings to lock the stationary machine shaft in place.

Motor operation

37. 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.

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

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

40. 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.

41. Press the safety reset button.

42. Start the motor by pressing the start button (green button) on the variable frequency drive.

43. Slowly rotate the OK button in the clockwise direction until you reach a frequency of 50 Hz.

44. Let the motor run for 10 seconds approximately.

45. Stop the motor by pressing the stop button (red button) on the variable frequency drive.

    Did the system work correctly?

    ❑ Yes ❑ No

    If the shaft alignment and coupling have been properly performed, the answer should be yes.

46. Ask the instructor to check your work.

47. Deactivate the emergency stop button by rotating the knob in the clockwise direction.

48. Turn off the system by setting the main switch to the O (off) position.

49. Disassemble the setup and return the components to the storage location.

    Alternately, if you wish to perform other job sheets in this manual (except Job Sheet 1 and 4), make the necessary changes to return to the setup shown in Figure 21. In particular, make sure to remove all shims from the motor feet and modify the current position of the horizontal adjustment setscrews.

Name: ______________________________ Date: ____________________

Instructor's approval: ____

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