Industrial Maintenance

Gear Drives 1

Courseware Sample

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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
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current

Safety and Common Symbols

Symbol	Description
	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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Sample Job Sheet

Extracted from

Gear Drives 1

Gear Trains

Some applications require many gears to achieve a desired speed or torque ratio between a driving component and a driven component. Such a combination of gears is called a gear train. If the gear train is enclosed in a housing, it is called a gearbox.

It is possible to predict the speed of the driven shaft if the speed of the driving shaft, the number of teeth of each gear, and the disposition of the gears in the gear train are known. A simple gear train composed of three gears is shown in Figure 7-1.

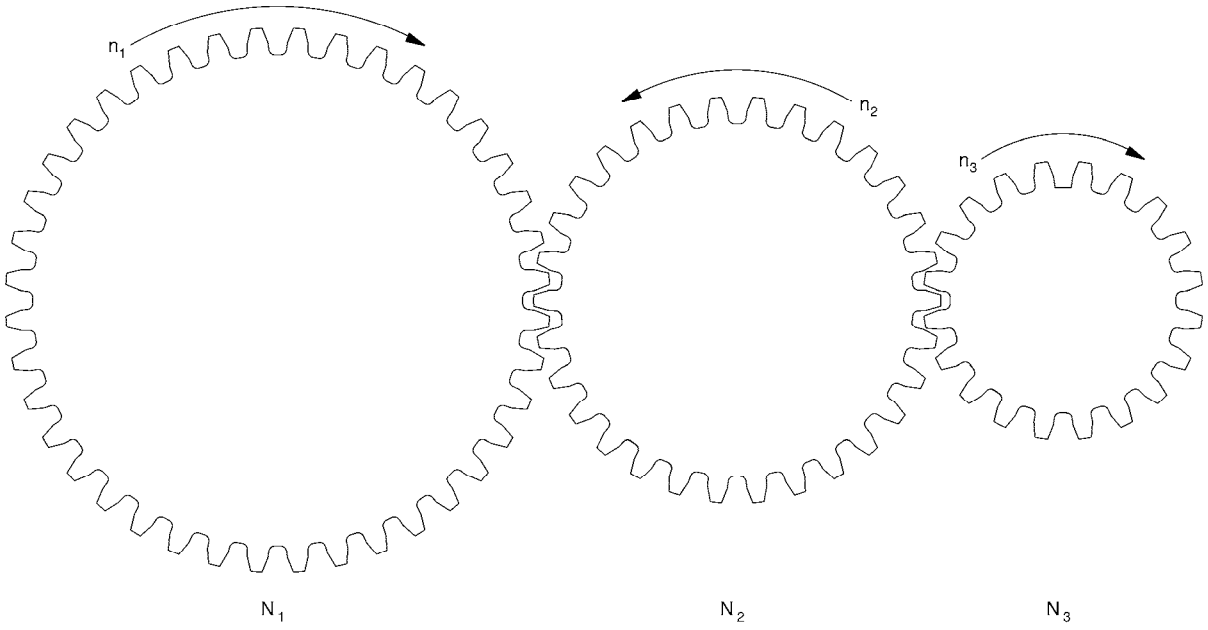

Figure 7-1. Simple gear train.

The speed of the last shaft is determined as follows:

$$n_3 = n_1 \frac{N_1}{N_3}$$

where n_1 is the speed of the driving shaft in r/min;
n_3 is the speed of the last driven shaft in r/min;
N_1 is the number of teeth of the driving gear;
N_3 is the number of teeth of the last driven gear.

This equation shows that, on gears installed in series as shown in Figure 7-1, the speed of the last shaft depends only on the speed of the first shaft and on the teeth ratio between the first and last gear no matter how many gears are present in

between. Such gear combinations are used to drive multiple shafts at different speeds or to change the direction of rotation between the input and output shafts.

When gears of different diametral pitch and pressure angle are used in the same gear train, it is called a compound gear train. A compound gear train is composed of gears installed in series and in parallel as shown in Figure 7-2.

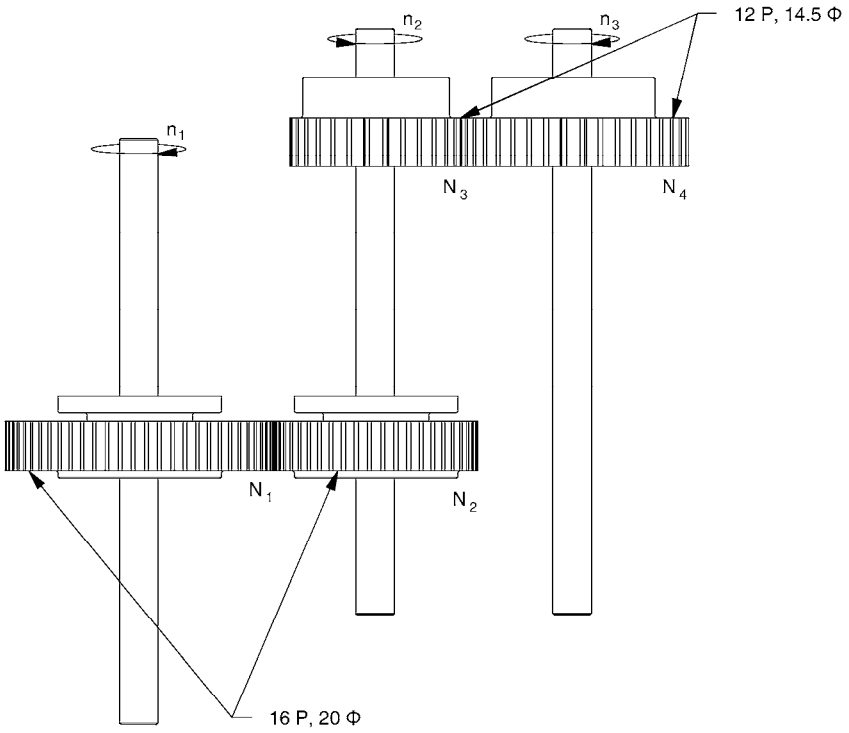

Figure 7-2. Compound gear train.

The speed of the last shaft in the gear train of Figure 7-2 is determined as follows:

$$n_3 = \frac{N_1}{N_2}\frac{N_3}{N_4}\, n_1$$

where n_1 is the speed of the driving shaft in r/min;
n_3 is the speed of the last driven shaft in r/min;
$N_{1,2,3,4}$ are the number of teeth.

The speed of the second and third gears is the same because they are installed on the same shaft.

Gear Trains

OBJECTIVES

In this job, you will assemble a compound gear train composed of six gears. You will also align the gears and adjust the backlash.

EQUIPMENT REQUIRED

- Universal Base Assembly, model 46603
- Couplings – Shafts Panel, model 46610
- Pillow Block Bearings Panel, model 46611
- Gears Drives, model 46614
- Test/Measurement Package, model 46630
- Tool Box Component Package, model 46631

SAFETY PROCEDURES

Before proceeding with this job, complete the following check list.

☐ 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.

PROCEDURE

Lockout/Tagout Procedure

☐ 1. Set the disconnecting switch to OFF.

☐ 2. Write your name on a tag, and install it in the lockout device.

☐ 3. Lock the disconnecting switch with the lockout device.

☐ 4. Lock the lockout device with your padlock.

☐ 5. Ask the instructor and each teammate to install their own padlocks in the lockout device.

Universal Base Setup

☐ 6. Fix four T-slotted extrusions to the universal base as shown in Figure 7-3.

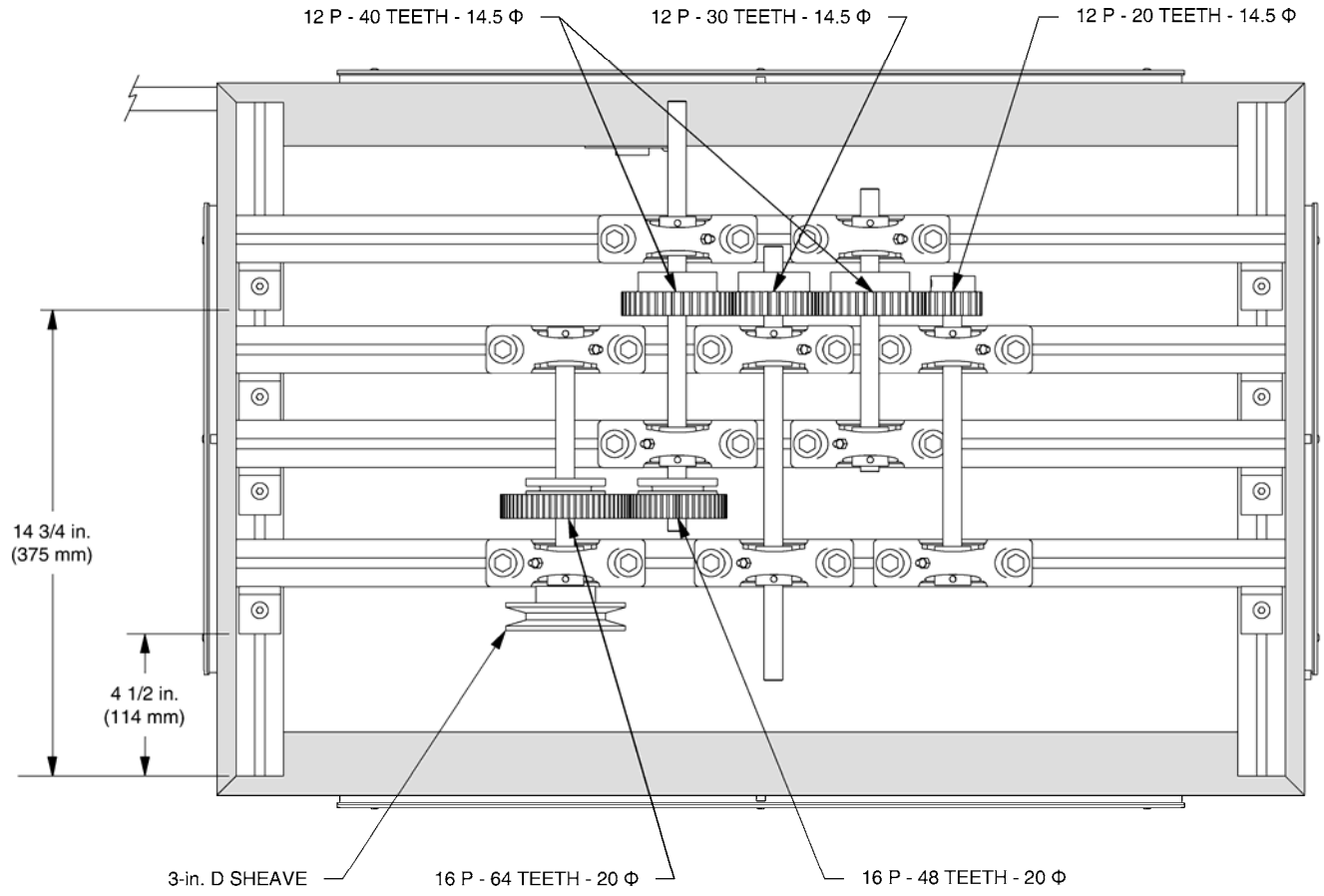

Figure 7-3. Universal base setup.

☐ 7. Install the pillow block bearings. Do not tighten the screws now.

Gear Installation

☐ 8. Install the gears, shafts, and sheave as shown in Figure 7-3.

Note: *The sheave is used as a handwheel to drive the gear train.*

☐ 9. Align the gears as described in Job Sheet 3.

☐ 10. Measure and adjust the backlash as described in Job Sheet 4. The setup should be as shown in Figure 7-4.

Figure 7-4. Gear drive setup.

Observations

☐ 11. Mark the 12 P - 40 teeth - 14.5°φ gears with a soapstone marker.

☐ 12. Turn the sheave in the clockwise direction. Note the direction of rotation of the two 12 P - 40 teeth - 14.5°φ gears.

Direction of rotation of the left gear as you face the universal base: _____

Direction of rotation of the right gear as you face the universal base: _____

☐ 13. Mark the sheave with a soapstone marker.

☐ 14. Turn the sheave two complete turns in the clockwise direction. Note the number of turns the two 12 P - 40 teeth - 14.5°φ gears rotate.

Number of turns of the left gear as you face the universal base: _____

Number of turns of the right gear as you face the universal base: _____

> **Note:** *The gear installed between these gears is called an idler gear. Its role is to change the direction of rotation between two gears.*

Speed Calculation

☐ 15. Based on the teeth ratios, calculate the number of turns the last driven gear will turn when the sheave rotates three turns.

Number of turns of the last driven gear: _____

☐ 16. Mark the last driven gear on the right with a soapstone marker.

☐ 17. Count the number of turns the last driven gear rotates when the sheave rotates three turns.

Number of turns of the last driven gear: _____

☐ 18. Is the number of turns observed the same as the calculated number of turns?

☐ Yes ☐ No

☐ 19. Ask the instructor to check your work.

☐ 20. Disassemble the setup and return the components to the storage location.

Name: _____ Date: _____

Instructor's approval: _____

Sample Work

Order Extracted

from Gear Drives 1

Gear Trains

Task: To assemble a compound gear train.

PROCEDURE

☐ 1. Perform the Safety Procedures listed in Appendix D.

☐ 2. Perform the Lockout/Tagout Procedure described in Appendix E.

☐ 3. Given that, in Figure 7-1, the speed of gear N_3 is calculated with the equation $n_3 = n_1 \frac{N_1}{N_3}$, what can you conclude about the influence of gear N_2 on the speed of gear N_3?

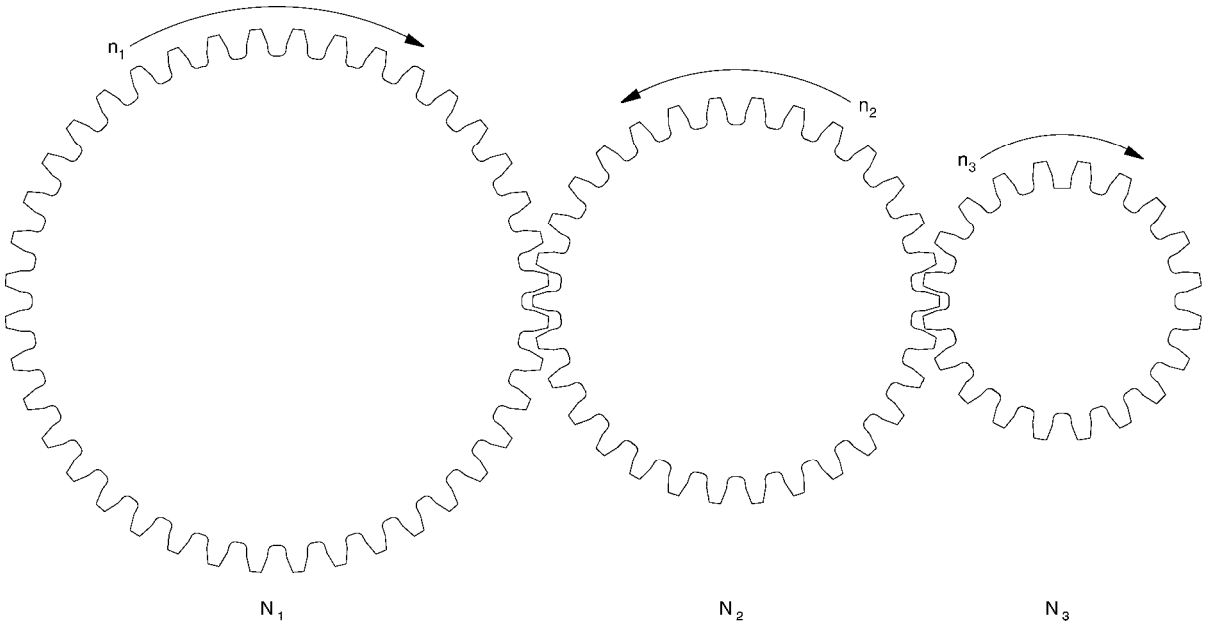

Figure 7-1. Simple gear train.

☐ 4. Explain the function of gear N_2 installed between the two other gears.

_____

_____

☐ 5. Is it possible to use gears of different diametral pitches and pressure angles in the same gear train? Explain.

_____

_____

Installation

☐ 6. Set up a compound gear drive as shown in Figure 7-2.

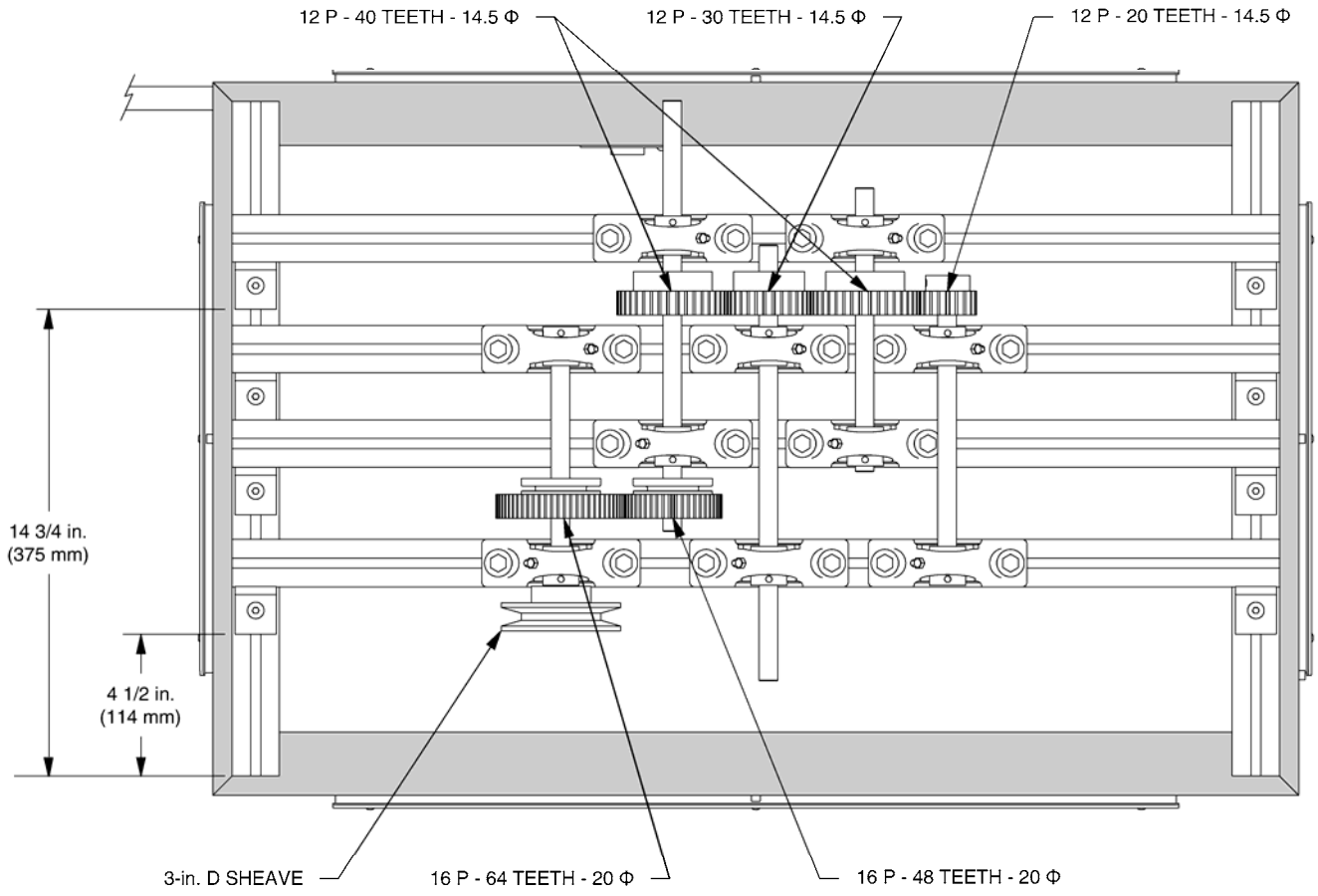

Figure 7-2. Universal base setup.

☐ 7. Align the gears.

☐ 8. Refer to Appendix F, and adjust the backlash.

Observations

☐ 9. Mark the 12 P - 40 teeth - 14.5°ϕ gears with a soapstone marker.

☐ 10. Turn the sheave in the clockwise direction. Note the direction of rotation of the two 12 P - 40 teeth - 14.5°ϕ gears.

Direction of rotation of the left gear as you face the universal base: _____

Direction of rotation of the right gear as you face the universal base: _____

☐ 11. Mark the sheave with a soapstone marker.

☐ 12. Turn the sheave two complete turns in the clockwise direction. Note the number of turns the two 12 P - 40 teeth - 14.5°ϕ gears rotate.

Number of turns of the left gear as you face the universal base: _____

Number of turns of the right gear as you face the universal base: _____

Speed Calculation

☐ 13. Based on the teeth ratios, calculate the number of turns the last driven gear will turn when the sheave rotates three turns.

Number of turns of the last driven gear: _____

☐ 14. Mark the last driven gear on the right with a soapstone marker.

☐ 15. Count the number of turns the last driven gear rotates when the sheave rotates three turns.

Number of turns of the last driven gear: _____

☐ 16. Ask the instructor to check your work.

☐ 17. Disassemble the setup and return the components to the storage location.

Name: _____ Date: _____

Instructor's approval: _____

Other Sample

Extracted from

Gear Drives 1

Post-Test

1. What characteristic(s) can a gear change in a gear drive?

   a. Direction and the speed of the rotary motion
   b. Speed of the rotary motion only
   c. Direction of the rotary motion only
   d. Power transmitted

2. What is an idler gear used for?

   a. Obtain a specific speed ratio in a gear train
   b. Maintain the same direction of rotation between a driving and a driven gear
   c. Prevent gear motion in one direction
   d. Allow the meshing of teeth cut at different pressure angles

3. What is the backlash in a gear drive?

   a. The energy used to force the gear teeth to mesh
   b. A hub on the back side of the gear
   c. The play between two meshed gear teeth
   d. The parallel misalignment between two adjacent gears

4. Which of the following characteristics must be the same on two gears for their teeth to mesh correctly?

   a. Diametral pitch and teeth width
   b. Pressure angle and circular pitch
   c. Pitch diameter and pressure angle
   d. Diametral pitch and pressure angle

5. Which of the following ratios are equivalent?

   a. Teeth and outside diameter ratios
   b. Pitch diameter and outside diameter ratios
   c. Pitch diameter and teeth ratios
   d. Backlash and circular pitch ratios

6. Which gears produce a thrust load?

   a. Spur gears
   b. Worm gears and helical gears
   c. Helical gears only
   d. None

7. As opposed to sprockets and sheaves, adjacent gears

   a. turn in the same direction.
   b. turn in opposite directions.
   c. cannot turn.
   d. always turn at the same speed.

8. If the driving gear of a two-gear drive has 40 teeth and the driven gear has 10 teeth, the driven gear rotates

   a. four times faster than the driving gear and in the same direction.
   b. four times faster than the driving gear and in the opposite direction.
   c. four times slower than the driving gear and in the same direction.
   d. four times slower than the driving gear and in the opposite direction.

9. Power is transferred between an electric motor and a pump with a two-gear drive. Calculate the required number of teeth on the driven gear if the driven shaft must rotate at 1765 r/min. The driving gear is installed directly on the motor shaft and has 30 teeth. The motor plate indicates a nominal speed of 1000 r/min.

   a. 30 teeth
   b. 15 teeth
   c. 17 teeth
   d. 54 teeth

10. Which instrument is used to measure the amount of backlash between two meshed gears?

    a. Tape rule
    b. Feeler gauge
    c. Dial indicator
    d. Straightedge