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MECHANICAL AND FLUID DRIVE SYSTEMS

Lesson One

Mechanical Brakes and Clutches

TPC Training Systems

34201

Lesson

1 Mechanical Brakes and Clutches

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OBJECTIVES

After studying this Lesson, you should be able to…

- Explain how friction-type and jaw-type clutches differ in construction.
- Name the precautions that should be taken when mounting body on a shaft.
- Explain how to test-run a mechanical clutch with no load.
- Explain how to install a mechanical brake.
- Describe the results of improper alignment between driving and driven shafts.
- Identify the problems that may be indicated by chatter and excessive noise.

KEY TECHNICAL TERMS

Friction clutch 1.02 one that depends on contact between a friction disc and a pair of metal plates
Actuator 1.15 a mechanism (often a system of levers) for engaging and disengaging brakes or clutches
Periodic inspection 1.38 scheduled inspections to prevent equipment breakdown and plant shutdown
Wear pattern 1.39 visible evidence of wear on load-carrying surfaces of brakes or clutches
Heat dissipation 1.46 passage of the heat of operation from a brake or clutch to surrounding air

A brake, part of which is attached to a stationary member of a machine, serves to stop the machine when power to its drive is shut off. A clutch serves to connect the machine to its power source—and to disconnect it as required. Both units are connected and disconnected by mechanical means.

The two most used clutches are the jaw type and the friction type. In order for the jaw-type clutch to be engaged or disengaged, the driving and driven shafts must usually be stopped. The friction type is engaged by applying pressure to a friction disc and two metal plates.

This Lesson explains how to install and maintain mechanical brakes and clutches. It also tells how to utilize compressed air and fluid power to operate them. In addition, you will learn how to lubricate, adjust, and troubleshoot them. Electric brakes and clutches are covered in Lesson Two of this Unit.

Basic Types of Mechanical Clutch

1.01 The two basic types of mechanical clutch are the jaw type and the friction type. The *jaw-type clutch* (Fig. 1-1) is used only for slow (low-speed) operations—usually on older equipment. With a jaw-type clutch, the driving and driven shafts must be at a complete stop for it to engage or disengage. A variation of this clutch has spiral jaws that permit engagement or disengagement at very low speeds.

1.02 The *friction-type clutch* (Fig. 1-2) depends on contact between a friction disc and a pair of metal plates. The disc is made of nonmetallic material. When the metal plates and disc are locked into an assembly, the clutch is engaged and the system is in drive. Relieving the pressure on the disc and plates disengages the clutch, and the driven member then idles.

1.03 The basic friction clutch design has many variations. Each depends, however, on the contact between its plates and friction disc for operation. Choosing one particular design over another depends greatly on the desired method of actuating the clutch (engaging and disengaging it) and on the power capacity of the drive system.

1.04 Jaw breakage is the most common cause of failure in jaw clutches. This breakage results from pure shear or shock loadings. Friction clutch failure is usually caused by excessive wear on the friction material in the disc. Friction clutches often slip during loading and/or operation after being overloaded. Slippage creates heat between the plates and the disc in the load-carrying area. This heat buildup must be properly dissipated by the clutch, or rapid wear will result.

Fig. 1-1. Jaw-type clutch with square jaws

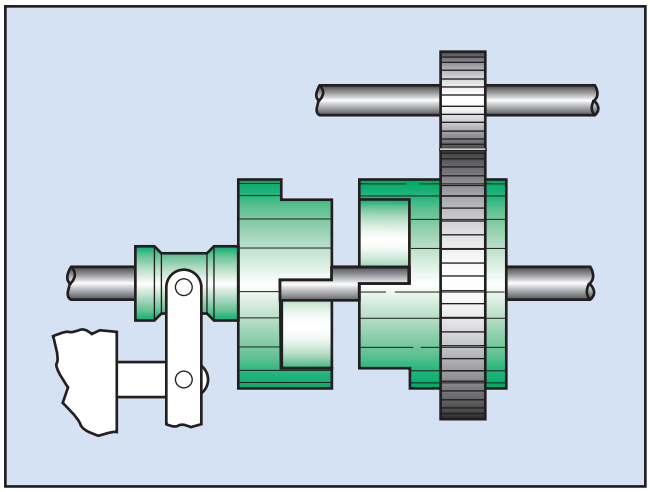


Fig. 1-2. Friction-type clutch

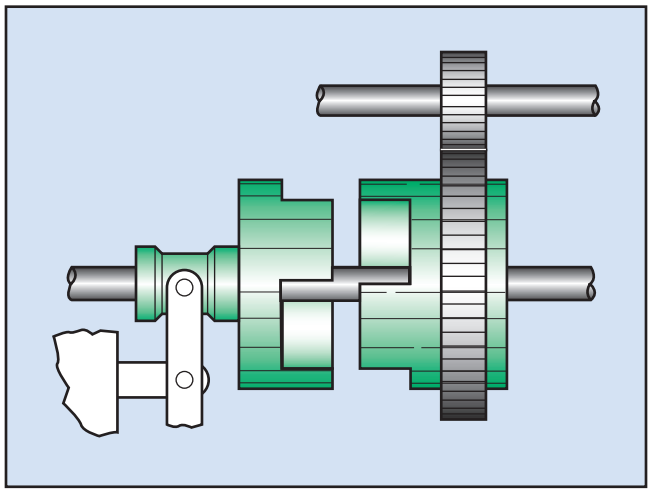
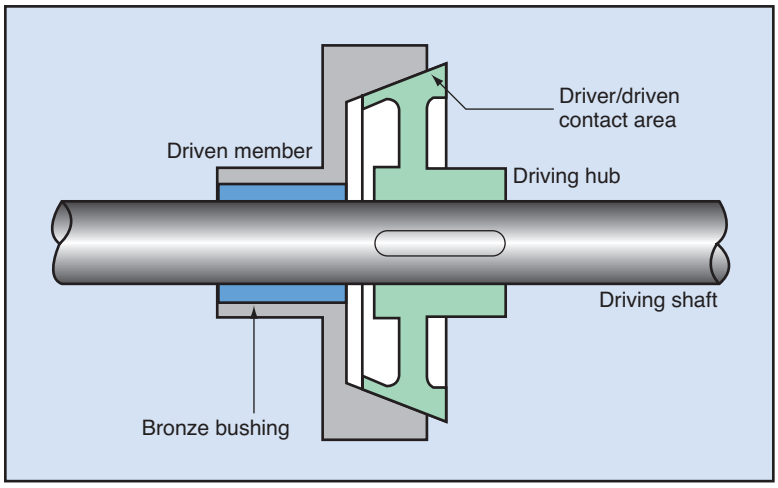


Fig. 1-3. A conical-type friction clutch



1.05 Figure 1-3 shows a conical-type friction clutch. When this clutch is engaged, the internal conical surface of the driven member contacts the external conical surface of the driving hub. This is done by shifting the driving hub forward on the driving shaft. The clutch is disengaged by sliding the driving hub in the opposite direction.

1.06 The power capacity of a friction clutch is a function of the heat-dissipating ability of the clutch, its frictional contact area, and the pressure on the plates and discs. For example, a clutch with 12-in. diameter disc and plates may have the same capacity as one having several discs and plates of smaller diameter stacked in a common clutch body. The latter type is often called a *multiple-disc clutch*, and its main purpose is to save space in the plane of the diameter. You will often find this type of clutch in machine tools and similar plant equipment where space is limited.

1.07 Before you attempt to install, service, or overhaul a friction clutch, be sure that you identify the particular unit involved. Note specifically the construction of the clutch and how the driving and driven members are engaged (brought together), how they are held in that position for running, and how they are disengaged (separated).

Installing a Mechanical Clutch

1.08 Because there is a wide variety of mechanical clutches, it is not feasible to describe complete

Fig. 1-4. Driven plate squeezed between friction discs

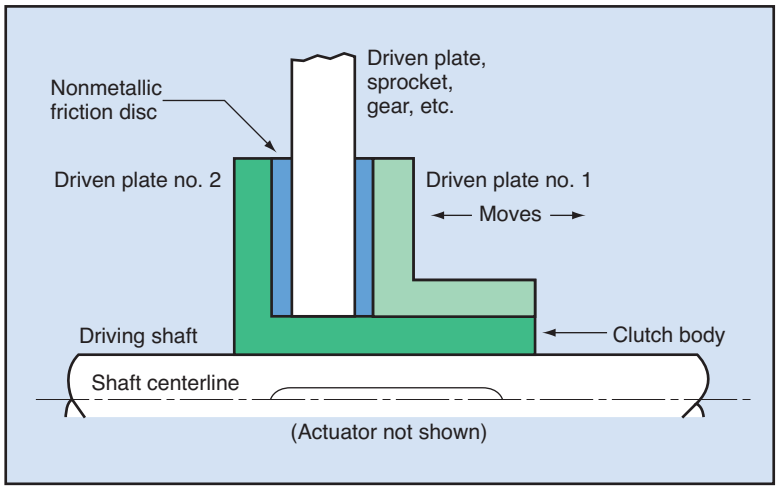
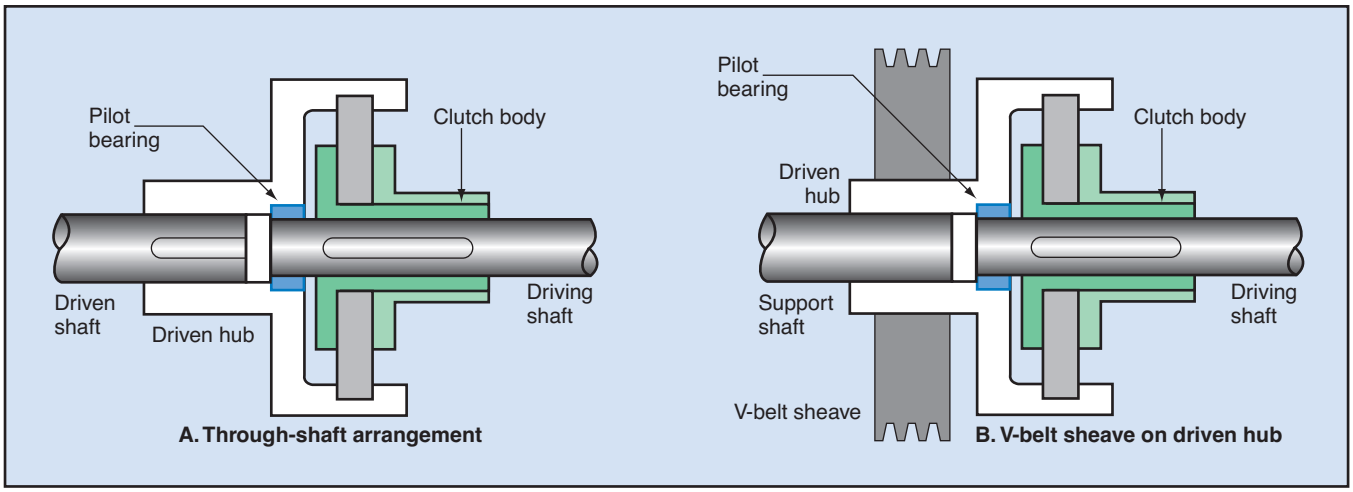


Fig. 1-5. Possible modifications of basic friction clutch



installation instructions for each type. Instead, we will describe some of the factors involved in clutch installation. The method of installing a mechanical clutch varies with its type, its takeoff location, and its actuator position.

1.09 **Clutch type.** The friction clutch shown in Fig. 1-4 is engaged by squeezing the driven plate between the two friction discs. The nonmetallic discs are bonded to the two metal drive plates. The clutch is engaged by moving drive plate no. 1 in the direction of drive plate no. 2. This is accomplished by shifting an actuating lever mounted on the yoke of the clutch. The yoke must have room to move on the shaft to engage and disengage the clutch properly.

1.10 When installing a clutch that requires space along the shaft for shifting in and out of engagement, be sure you provide enough room for proper operation. Jaw clutches are another type that requires such space.

1.11 **Takeoff location.** Figure 1-5A shows a through-shaft arrangement using a mechanically actuated friction clutch. The driving shaft is on the right. The clutch body is keyed to this shaft. The driving shaft fits into, and is supported by, a pilot bearing in the driven hub. With this type of friction clutch, the driven shaft (on the left) is keyed to the driven hub.

1.12 When the clutch is engaged, power is transmitted from the driving shaft, through the locked disc-and-plate assembly, and into the driven hub. The driven hub then turns the driven shaft. This is called a through-shaft clutch. *Through-shaft clutches* cannot be used as flexible couplings because they cannot withstand any misalignment between shafts.

1.13 The clutch arrangement shown in Fig. 1-5B is similar to that shown in Fig. 1-5A. The difference is that a V-belt sheave (a takeoff) is mounted on and keyed to the driven hub. The sheave rotates when the clutch is engaged and transmits the power through the V-belts to another driven member. The shaft on the left simply supports the driven hub. In other configurations, the V-belt sheave might be replaced with a chain sprocket or a gear.

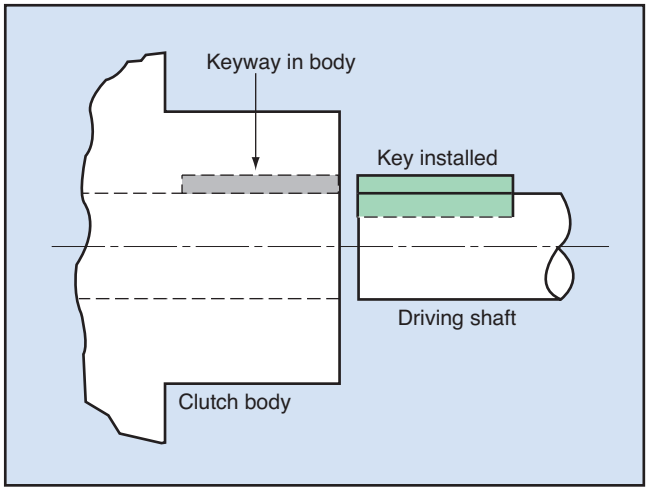
1.14 Before installing a clutch, study the final assembly. Notice where the takeoff member (V-belt sheave, shaft, or gear) is to be mounted. Be sure that there is room to install the takeoff member properly and to service it after installation.

1.15 **Actuator position.** Mechanical clutches are usually actuated by levers or other manual shifting mechanisms. However, air and hydraulic systems are also used as actuators for this type of clutch. Leave space enough to permit the actuating device to achieve full clutch engagement and disengagement. With a pneumatic or hydraulic actuating system, be sure there is an ample supply of air or hydraulic fluid available to the clutch. Also provide plenty of clearance for proper installation of air and fluid lines.

Preparing the Shafting

1.16 Before installing the clutch, closely inspect the shaft surfaces on which you will mount the clutch

Fig. 1-6. Carefully key the clutch to the shaft



parts. Clean up any nicks, burrs, or other defects. Pay close attention to keyseats to be certain they harbor no filings or other foreign materials. Jaw clutches often have extra-long keys and keyways to allow the clutch halves to slide into and out of engagement. With a dial indicator or other suitable measure, check these longer keyways to be sure they are straight and true their entire length. Repeat the test for the keyseats in the shaft. Before mounting the clutch parts, apply a light coat of machine oil to the shaft mounting surfaces. This makes it easier to slide the parts onto the shaft. Then install the keys in the keyseats.

Installing the Clutch Body

1.17 Check to be sure that the shafting is well aligned and properly supported. The method of supporting the shafting varies with the type of clutch. Some special-design clutches incorporate a flexible coupling in the clutch to allow for some misalignment. However, standard clutches cannot act as flexible couplings, so align the shafts accurately. Line up the keyway in the clutch with the key installed in the shaft, as shown in Fig. 1-6.

1.18 Slide the clutch body onto the shaft and key. The fit between the clutch body and the shaft varies with the design of the clutch. You must know the type of fit you want for each particular installation. Study the clutch manufacturer's assembly instructions. After positioning the clutch correctly on the shaft, tighten any setscrews or other holding devices.

1.19 Check to be sure the clutch is square on the shaft. Use the same procedures as you would for checking the squareness of sheaves or sprockets on the shaft. If the clutch body must slide freely along the shaft, be certain it is free to do so. Should binding occur, remove the clutch from the shaft. Check for burrs or other defects on the shaft and in the clutch bore. Clean these surfaces as necessary. Also check the key size. It may be necessary to file the key slightly on its corners and edges to obtain a looser fit.

Initial Lubrication of Clutch

1.20 Certain parts of some mechanical clutches need lubrication to allow for smooth operation. The lubricant is usually grease, applied through fittings in the clutch. For lubricating any given unit, follow the manufacturer's recommendations. This material usually tells where the lubrication points are and suggests the kind of lubricant to use. Apply lubricants only at the specified points. Be extremely careful when handling lubricants around a clutch. Avoid getting any on the friction surfaces. Grease or oil on the friction surfaces will cause slipping, resulting in excessive heat.

Providing the Power Supply

1.21 Clutches actuated by air or hydraulic pressure must have the proper amount of air and the right amount and type of hydraulic fluid. Make sure there is enough of each and that it is free to flow to the clutch. Inspect the air or hydraulic fittings on the clutch. Replace damaged fittings. Be certain all fittings are tight and not clogged. The smallest obstacle can harm clutch actuation.

Making Initial Adjustments

1.22 After assembling the clutch on the shaft, mount the driven member on the hub. For throughshaft arrangements, install the driven shaft. Move the actuating mechanism, and observe the action between friction discs and plates. Place the actuator in the engaged position, and see that the plates and discs are in full contact with one another. Be sure that the actuator moves easily and that there is no binding of parts.

1.23 Use the following procedure to check engagement on smaller clutches. Hold the driven member firmly. Turn the driving shaft by hand. If slippage occurs between the discs and plates, adjust the clutch

according to the manufacturer's instructions. On clutches of larger size, mechanical means are necessary to turn and hold the clutch parts. Use firm holding devices to avoid personal injury and damage to the clutch.

1.24 The methods for adjusting contact pressure on mechanical clutches vary with the type and design of the clutch. Usually the procedures are simple and available in published literature from the clutch manufacturer. If such data are unavailable, contact the manufacturer for instructions. Many clutch failures are the direct result of poor installation or adjustment. After adjusting the clutch properly (to obtain free and effective engagement and disengagement), lock all adjusting mechanisms.

Test Running with No Load

1.25 After making the initial adjustments, test run the clutch without an applied load. Place the clutch actuator in the disengaged position. Start the motor, or other prime mover, and engage the clutch slowly. Listen for chatter between the discs and plates. The engagement should be smooth and without vibration.

1.26 Gradually apply pressure at a rate that causes a minimum of slippage and heat. Be sure the actuating mechanism moves freely (no binding at any point). Engage the clutch fully, and allow it to run in this no-load condition. Note any slippage while the clutch is operating. Also note when the slippage occurs. This helps in making adjustments. Watch for smoke or heat buildup. If the clutch smokes, shut down the drive at once. Adjust the pressure mechanisms to relieve the condition.

WARNING

Be sure to alert your co-workers that you are about to test the system. Make certain that the area around the drive is clear of tools, rags, and the like.

1.27 Allow the clutch to run under no load for several minutes. Then stop the drive and disengage the clutch. Inspect the friction material. Look for signs of localized wear, which could indicate misalignment of clutch parts. Make any needed adjustments. If lubricant has leaked onto the friction surfaces, determine the source of the leak and correct the problem. Clean any lubricant off the friction surfaces before attempting to operate the clutch again.

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.

1-1. Name the two basic types of mechanical clutch.	1-1. JAW TYPE; FRICTION TYPE Ref: 1.01
1-2. The disc of a friction-type clutch is made of _____ material.	1-2 NONMETALLIC Ref: 1.02
1-3. The commonest type of failure in jaw-clutches is _____.	1-3. JAW BREAKAGE Ref: 1.04
1-4. Through-shaft clutches can also be used as flexible couplings. True or False?	1-4. FALSE Ref: 1.12
1-5. Mechanical clutches are usually actuated by manual shifting mechanisms such as _____.	1-5. LEVERS Ref: 1. 15
1-6. Before mounting clutch parts on a shaft, apply a light coat of _____ to the shaft mounting surfaces.	1-6. MACHINE OIL Ref: 1.16
1-7. What type of lubricant is usually used on a clutch?	1-7. GREASE Ref: 1.20
1-8. Signs of localized wear on friction material can indicate _____ of clutch parts.	1-8. MISALIGNMENT Ref: 1.27

Making Final Adjustments

1.28 Adjustments of mechanical clutches are made in many ways. Some clutches require tightening of adjusting nuts or screws. Others are adjusted by increasing or decreasing the spring pressure against the plates and discs. Even air or hydraulic clutches usually have some means of adjusting the contact surfaces to compensate for normal wear. After test-running the clutch under no-load conditions, make any necessary final adjustments so that the unit will function properly with a load.

1.29 Observe the contact areas between the loadcarrying surfaces. Contact should be evenly distributed over the entire surface, with no localized wear points. Adjust the actuating mechanisms so that they slide or move easily. Adjust the air or hydraulic fluid flow so that it actuates and holds the clutch in the proper position during operation. Follow the manufacturer's instructions for adjustment and operation of the unit.

Test Running with Full Load

1.30 After test-running the clutch under no-load conditions and making final adjustments, you are ready to test the unit under a full load. Alert those around you that you are about to test. Place the clutch in its disengaged position. Start the motor or other prime mover, and slowly engage the clutch. However, don't engage the clutch so slowly that excessive slippage occurs, because this can damage contact surfaces and build up heat. As it operates, observe the fully loaded clutch carefully. Listen for chatter or unusual noises.

1.31 Be certain there is no binding of the components and that the discs and plates are in firm contact when the clutch is engaged. Disengage and engage the clutch several times during the first half hour. Check for excessive heat buildup. Look at the contact surfaces after each engagement and disengagement cycle. The wear patterns should be even across these surfaces.

1.32 After completing the full-load test, make any necessary adjustments to the actuating mechanisms and the wear-compensating devices. On a log sheet, note when the clutch goes into service. This helps in keeping maintenance records.

Installing a Mechanical Brake

1.33 Mechanical brakes and clutches are often similar in construction up to a point. With a mechanical clutch, power is transmitted from the driving member to the discs and plates and then to the driven member, causing the latter to turn. With a mechanical brake, the driven member is anchored to a fixed part of the equipment. When you apply or engage the brake, the anchored driven member stops the drive.

1.34 As with clutches, the techniques for installing a mechanical brake vary with the type of brake. When installing mechanical brakes, study the brake design carefully, noting the takeoff location and the location of the brake actuator. A major difference between a brake and a clutch is that the brake takeoff is an anchor point for the driven member.

1.35 Prepare the shaft mounting surfaces, and install the brake body as you did the clutch. Make any necessary adjustments, and test the brake under full-load conditions. Because most brakes do not operate properly under no-load conditions, there is no reason to run a no-load test. All anchor points for the brake must be solid and securely mounted on the driven equipment.

1.36 Check the brake actuating mechanisms for proper operation. Be certain that all moving parts are free to perform as designed. If you are installing air or hydraulic brakes, be certain that an ample supply of the required air or fluid is available at the brake. Refer to the manufacturer's recommendations for installation and any unusual mounting requirements.

Preventive Maintenance

1.37 Because of the similarity between mechanical brakes and clutches, preventive maintenance for both is basically the same. Wear points exist in both, and it is at these points that most failures occur. Actuating mechanisms in both brakes and clutches need preventive maintenance to ensure proper operation.

1.38 Develop a log chart so you can set and hold to a schedule for periodic inspection of the

Fig. 1-7. Suggested form for periodic inspection log

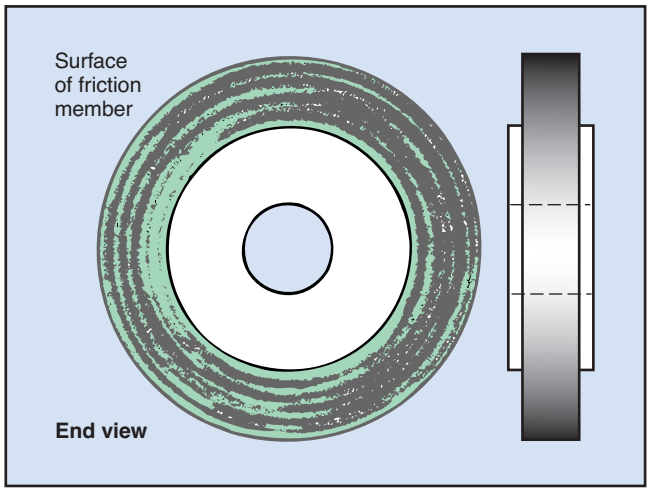
Department: _____ Machine: _____
Clutch make: _____ Location: _____
Brake make: _____ Supervisor: _____

Part inspected	Date of inspection								
• Actuator(s)									
• Friction surface									
• Plates									
• Shaft alignment									
• Lubrication									
• Bearings									
• Driving member									
• Driven member									
• Splines									
• Keys									
• Air fittings									
• Air lines									
• Hydraulic fittings									
• Hydraulic lines									

brake or clutch. Figure 1-7 is a sample log. The frequency of inspection depends on the use the brake or clutch receives. If the frequency of engagement and disengagement (cycling) is high, inspect the unit often. The inspection should include:

- friction surfaces (or wear surfaces)
- actuators
- shaft bearings
- driving and driven members
- position of unit.

Fig. 1-8. Normal wear pattern for friction material



1.39 **Wear surfaces.** Figure 1-8 shows a normal wear pattern on a properly maintained brake or clutch. This pattern appears on the friction material of the discs or other load-carrying surfaces. As normal wear occurs, it is taken up by adjusting the clutch. The method of adjustment depends on the design of the unit.

1.40 Make any necessary adjustments to the brake or clutch components during scheduled inspections. Nonetheless, if the unit starts to slip or otherwise malfunction between scheduled inspections, stop the machine. *lock out the power.* Make any adjustments or replace any faulty parts.

1.41 **Actuators.** Keep actuating devices in good repair. No brake or clutch can operate properly if it does not engage and disengage correctly. Keep lubricated surfaces well supplied with the prescribed grease.

1.42 **Shaft bearings.** Figure 1-9A shows a correctly aligned through-shaft clutch arrangement. The

shafts are in direct alignment, and there is no extra loading on the pilot bearing in the driven hub. Therefore, all the clutch parts should be lined up correctly and the load distributed evenly among them.

1.43 The condition shown in Fig. 1-9B is caused by a misalignment of the driving and driven shafts. The driving shaft is cocked at an angle in the pilot bearing. This results in rapid wear of the bearing and misalignment of other clutch parts. Correct this condition by realigning the shafts.

1.44 **Driving and driven machines.** To be sure that both the driving and the driven machines are secure in their positions, check their anchor bolts during regular inspections. Reposition a motor or driven shaft that has moved since installation of the brake or clutch.

1.45 **Position of unit.** Check the position of the clutch or brake body during inspections. The broken line in Fig. 1-10 shows a clutch body shifted from its original position (solid lines). This condition causes the discs and plates to move out from under the driven member, thereby reducing the effective load-carrying area of the brake or clutch. Be sure that the body of either unit is firmly held in position on its mounting surface.

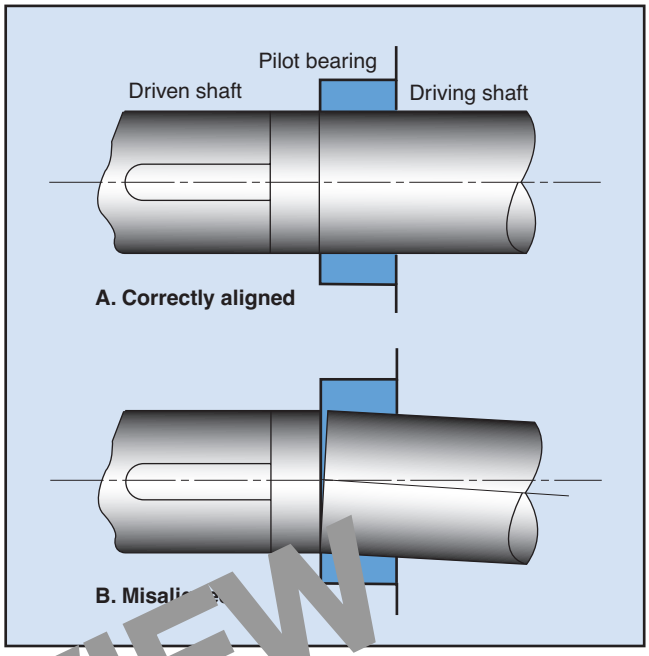
Operating Environment

1.46 In operation, mechanical brakes and clutches generate heat. Their design and application allow for this and for the dissipation of normal heat buildup. If you are using a brake or clutch in hot surroundings, however, provide some means of protecting the unit from the extra heat.

1.47 For example, Fig. 1-11 on the following page diagrams a clutch installation next to a baking oven. This situation calls for a baffle. To make a baffle, insert a block of good insulating material between two steel plates. Place the baffle between the outside wall of the oven and the brake or clutch to deflect the heat.

1.48 Keep the brake or clutch clean and free of dust and dirt. They interfere with heat dissipation and also can cause rapid wear of the contact surfaces because of abrasion.

Fig. 1-9. Correctly and incorrectly aligned shafts



Troubleshooting Brakes and Clutches

1.49 **Engagement/disengagement problems.** Problems arising during engagement or disengagement are frequently traceable directly to the actuating device on the brake or clutch. Look for binding of sliding parts. Also be sure that all lubricated surfaces are receiving the right amount of the right lubricant as specified by the manufacturer.

Fig. 1-10. Be sure clutch body hasn't shifted on shaft

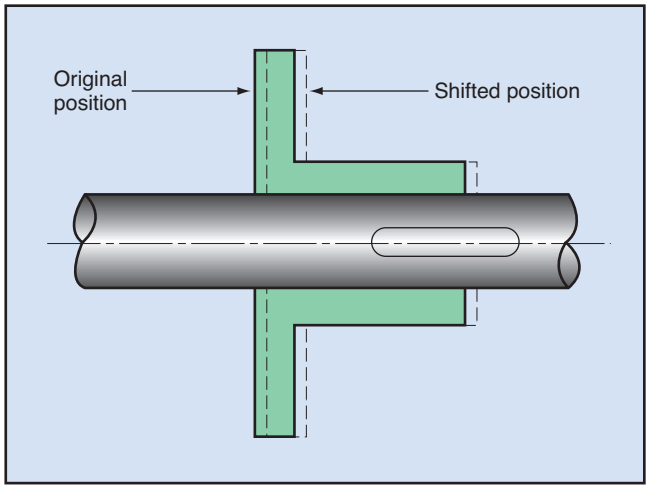


Fig. 1-11. Baffle protects clutch from oven's heat

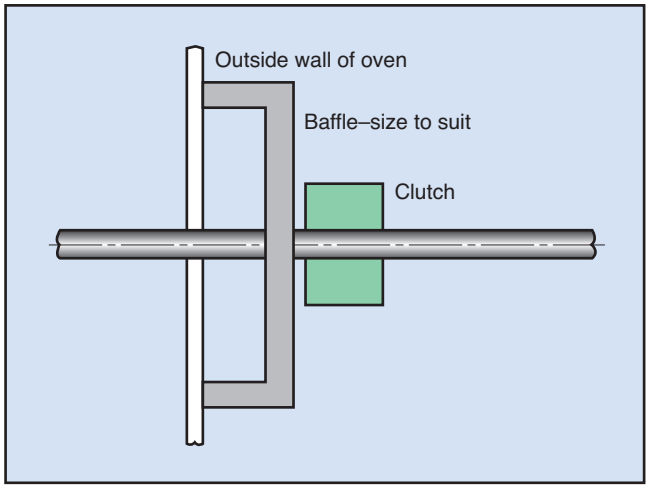
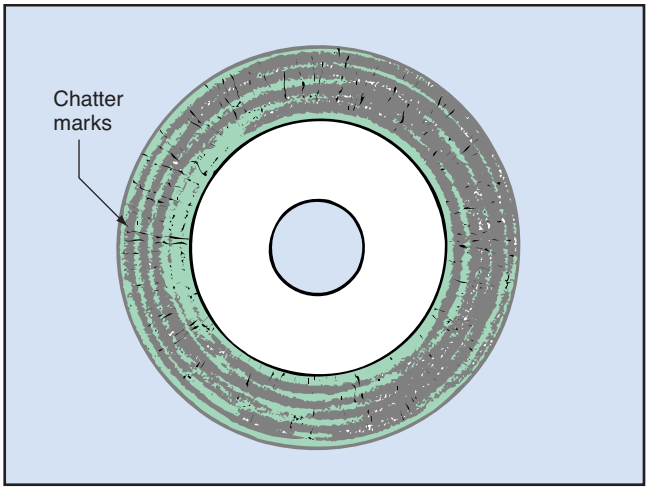


Fig. 1-12. Chatter marks on clutch wear surface



1.50 **Noise**. In operation, some brakes or clutches are noisier than others. Unusual noises—a loud clanking—is normally a sign of trouble. On hearing an unusual noise, stop the drive immediately. *Lock out the power.* Inspect all components, from the motor through the driven machine. Be sure you look at the brake or clutch wear surfaces.

1.51 Check for evidence of gouging on these surfaces and for loose parts, which may have entered the wear areas. Loose parts will continue to hammer each other while the drive is operating. Also check to make sure the actuating devices are holding the clutch or brake parts in proper contact after engagement.

1.52 **Excessive slippage**. Frequent slippage of a brake or clutch—particularly if it shows up again shortly after you adjust the unit-is an indication of a drastic increase in the rate of wear. Rapid wear, in turn, is usually an indication of overloading. Check the load rating of the brake or clutch against actual operating conditions. If necessary, replace the unit with a larger one to handle the load.

1.53 **Chatter**. Figure 1-12 shows a typical pattern of chatter marks on the wear surface of a brake or clutch. Chatter occurs mostly during engagement of the unit. It is usually caused by loose or faulty actuating devices. Check the condition of the actuator, and correct any problems by replacing the entire actuator or worn parts.

Brakes, Clutches, and Safety

1.54 Treat mechanical brakes and clutches as you would any other rotating equipment. *Always* alert your co-workers when you intend to adjust or service a brake or clutch. Place a *lockout device* on the main motor switch before attempting to service either unit. After servicing, remove all rags, tools, and other equipment from the work area. Replace all guards and protective shields around the drive. Always work carefully, using the proper tools to service the unit.

1-9. After test-running the clutch under no-load conditions and making final adjustments, you are ready to test the unit under _____.	1-9. A FULL LOAD Ref: 1.30
1-10. What is the major difference between a mechanical brake and a mechanical clutch?	1-10. THE BRAKE'S DRIVEN MEMBER IS ANCHORED TO A FIXED PART OF THE EQUIPMENT Ref: 1.33
1-11. Always be sure to test brakes under no-load conditions. True or False?	1-11. FALSE Ref: 1.35
1-12. The frequency of inspection of a brake or clutch depends on the _____ the unit receives.	1-12. USE Ref: 1.38
1-13. To be sure that both the driving and the driven machines are secure in their positions, check their _____.	1-13. ANCHOR BOLTS Ref: 1.44
1-14. Dust and dirt can interfere with heat _____.	1-14. DISSIPATION Ref: 1.48
1-15. What should you do if you hear an unusual noise coming from a drive?	1-15. STOP THE DRIVE IMMEDIATELY Ref: 1.50
1-16. Rapid wear is usually an indication of _____.	1-16. OVERLOADING Ref: 1.52

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

1-1. The two basic types of mechanical clutch are

- ☐ a. electric and hydraulic
- ☐ b. metallic and nonmetallic
- ☐ c. jaw and friction
- ☐ d. driving and driven

1-2. The usual cause of friction clutch failure is

- ☐ a. excessive wear of friction material
- ☐ b. slippage between metallic parts
- ☐ c. jaw breakage
- ☐ d. lack of lubrication

1-3. The power capacity of a friction clutch is directly related to

- ☐ a. the horsepower rating of the prime mover
- ☐ b. the size of the contact area between plates and discs
- ☐ c. the diameter of the driving shaft
- ☐ d. the amount of slippage allowed

1-4. Mechanical clutches are not actuated by

- ☐ a. electricity
- ☐ b. levers
- ☐ c. air systems
- ☐ d. hydraulic systems

1-5. The usual lubricant for mechanical clutches is

- ☐ a. graphite
- ☐ b. grease
- ☐ c. wax
- ☐ d. tallow

1-6. Localized wear on friction surfaces often indicates

- ☐ a. leaking lubricant
- ☐ b. overloading or underloading
- ☐ c. excessive vibration
- ☐ d. misalignment

1-7. A major difference between a clutch and a brake is that, with the brake, the takeoff is

- ☐ a. the driving member
- ☐ b. an anchor point for the driving member
- ☐ c. the driven member
- ☐ d. an anchor point for the driven member

1-8. Most brakes do not operate properly under

- ☐ a. full-load conditions
- ☐ b. half-load conditions
- ☐ c. no-load conditions
- ☐ d. test-run conditions

1-9. The frequency of conducting periodic inspections on clutches and brakes depends on

- ☐ a. the frequency of use
- ☐ b. the size of the units
- ☐ c. the thoroughness of the previous inspection
- ☐ d. the driven machine

1-10. Rapid wear of the load-carrying surfaces of a clutch usually indicates

- ☐ a. improper lubrication
- ☐ b. overloading
- ☐ c. an oversize clutch
- ☐ d. underloading

SUMMARY

Mechanical brakes and clutches have much in common. Each has two phases in its operation—engagement and disengagement. To work smoothly, their parts must be well mated. For that reason, proper installation is vital. The various parts must be clean and must fit well. Additionally, some parts must be carefully aligned.

Even though most mechanical clutches are of the friction type, they are not exactly alike. Thus their installation procedures vary. Because so many different designs are available, you must follow each manufacturer's instructions and recommendations carefully for installation, lubrication, testing, and adjustment.

After the brake or clutch is in working order, set up a maintenance log for it and inspect it on a regular schedule. Manufacturers generously offer troubleshooting charts and other diagnostic materials to help you locate and remedy troubles promptly.

Answers to Self-Check Quiz

1-1. c. Jaw and friction. Ref: 1.01

1-2. a. Excessive wear of friction material. Ref: 1.04

1-3. b. The size of the contact area between plates and discs. Ref: 1.06

1-4. a. Electricity. Ref: 1.15

1-5. b. Grease. Ref: 1.20

1-6. d. Misalignment. Ref: 1.27

1-7. d. An anchor point for the driven member. Ref: 1.34

1-8. c. No-load conditions. Ref: 1.35

1-9. a. The frequency of use. Ref: 1.38

1-10. b. Overloading. Ref: 1.52