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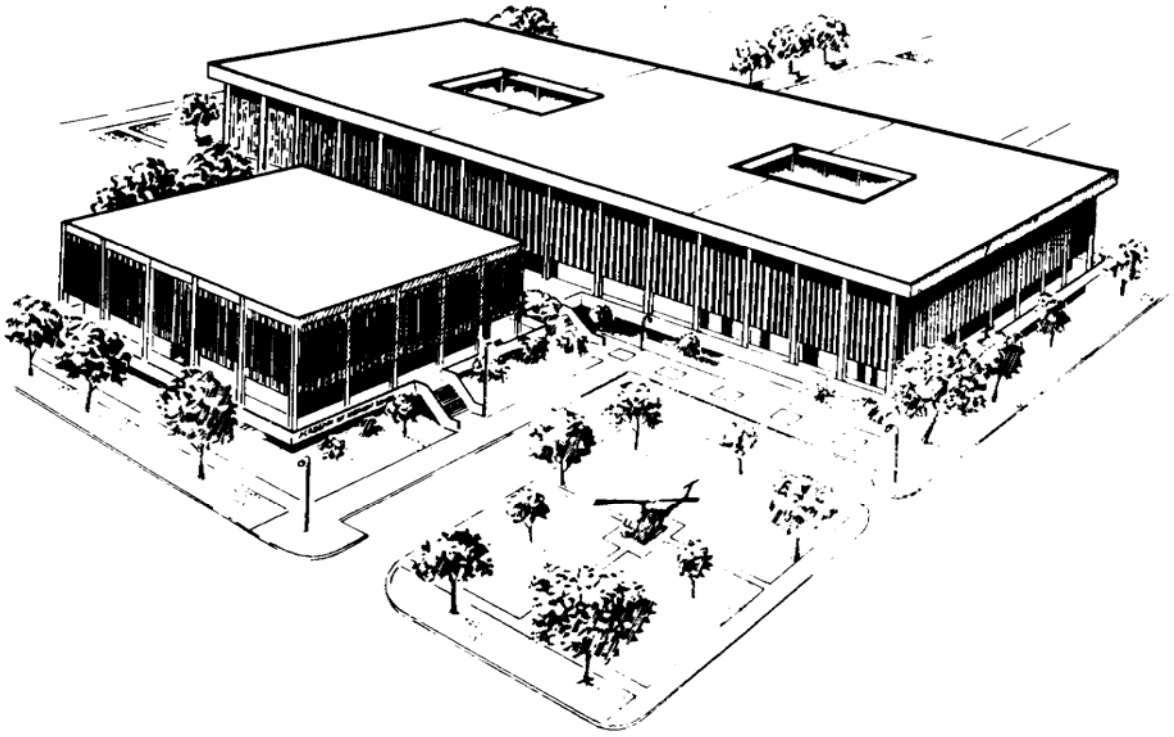

LABORATORY CENTRIFUGE

SUBCOURSE MD0368 EDITION 100

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0368

LABORATORY CENTRIFUGE

INTRODUCTION

The Dynac II Laboratory Centrifuge is a multipurpose unit designed for use in clinical laboratories of hospitals and medical facilities. It is used to separate the minute particles contained in fluid samples and other specimens. As a medical equipment repairer, your responsibility is to maintain, calibrate, and repair the unit to maintain maximum efficiency. This centrifuge is basically the same as all centrifuges. The difference is in the electrical circuitry. All centrifuges do the same job: some are faster, colder, and more complex.

Subcourse Components:

This subcourse consists of 2 lessons. The lessons are:

- Lesson 1, Perform Preventive Maintenance Checks and Services and Verification/Calibration.
- Lesson 2, Isolate Malfunctions and Remove and Replace or Repair Defective Components.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 5 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

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LESSON ASSIGNMENT

LESSON 1	Perform Preventive Maintenance Checks and Services (PMCS) and Calibration/Verification.
TEXT ASSIGNMENT	Paragraphs 1-1 through 1-10.
LESSON OBJECTIVES	After completing this lesson, you should be able to:
	1-1. Identify operational procedures.
	1-2. Identify the steps for performing preventive maintenance checks and services (PMCS).
	1-3. Identify the calibration and verification procedures.
SUGGESTION	After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES AND VERIFICATION/CALIBRATION

Section I. PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1-1. GENERAL

The DYNAC II Centrifuge is a multi-purpose machine. It is designed for use in clinical laboratories for frequently performed separations in hematology, chemistry, urinalysis, blood banking, micro-biology, and cytology. It is equally useful in the physician's and veterinarian's office, particularly where moderate-to-large numbers of Wintrobe hematocrits, urine and fecal sedimentations, and serum/plasma separations are performed. Additional applications for the centrifuge are in industrial and university laboratories for many general procedures in chemistry, pharmacology, food processing, and agriculture. Because of its compact size, the centrifuge will fit into most standard size refrigerators or can be placed in a cold room for low temperature centrifugations.

1-2. DESCRIPTION

a. **Safety Requirements.** The Dynac II Centrifuge was designed to meet the electrical safety requirements of Underwriters' Laboratories (UL) and Canadian Safety Association (CSA). Other advanced safety features to protect the operator are also incorporated to fulfill the safety standards of OSHA.

b. **Guard Bowl.** The centrifuge incorporates a one-piece aluminum guard bowl attached to a stable base assembly. The guard bowl, which is of heavy gauge construction, affords maximum protection to the operator. The finish is baked enamel inside and out to facilitate cleaning.

c. **Motor.** The centrifuge motor is attached to a mounting plate which is shock-mounted to the base by means of three vibration isolators. Four rubber feet are bolted to the bottom of the base plate. The motor incorporates permanently lubricated bearings. The cord set is a 6-foot, heavy duty, 3-wire grounded cord.

d. **Rotors.** Any of four swing-out horizontal rotors and four 52° angle rotors can be used in the centrifuge. Various shield configurations are available to accommodate tube sizes ranging from 1 milliliter (ml) to 100ml. This permits the centrifuge to be used for a variety of micro and semi-micro work. You can easily install and lock on rotors to the centrifuge shaft by means of a drive pin and thumb screw. Shield positions in all rotors are clearly numbered for positive identification of tubes.

e. **Front-Panel Controls.** Front-panel controls include an illuminated power switch, run-brake switch, automatic timer, adjustable speed control, and tachometer. You can continuously adjust speed over the range of 500 revolutions per minute (rpm) (minimum) to a specific maximum, depending upon the rotor and shield configuration used.

f. **Additional Safety Features.** Additional safety features on the centrifuge include a transparent, shatter-proof, polycarbonate cover equipped with a positive latch. A latch interlock system prevents you from operating the centrifuge while the cover is open. Once the cover is closed and latched and the centrifuge is operating, a zero speed control switch prevents you from opening (unlatching) the cover until the rotor slows to less than 1 revolution per second. An external fuse, located on the back of the machine, prevents damage to the centrifuge in the event of external power surges or internal shorts.

1-3. OPERATING CONTROLS

Refer to figure 1-1 for an illustration of the location of the controls on the centrifuge.

Figure 1-1. Operating controls.

a. **Power Switch.** The illuminated power switch on the left side of the console applies power to the centrifuge. The switch remains lighted while in the ON position.

b. **Run/Brake Switch.** The run/brake switch on the right side of the console is spring-loaded to remain in the RUN position. In this position, with the power switch on and the timer set to the desired spinning time, the motor is actuated to begin the centrifuge cycle. When you manually hold down the switch in the BRAKE position, the switch actuates an electric brake which will bring the rotor to a gentle stop in less than 30 seconds. To actuate the brake, perform the following:

(1) Press and hold the switch down. The brake will be activated as long as the switch is held down.

(2) Release the switch as soon as the rotor comes to a stop.

NOTE: For delicate sedimentations, release the switch just before the rotor comes to a stop and let the rotor coast gently to a stop.

(3) DO NOT HOLD THE BRAKE SWITCH DOWN AFTER THE ROTOR HAS STOPPED. If you hold it down too long, the rotor will automatically begin accelerating in the opposite direction.

NOTE: Unless the timer runs out or is turned to "0," the rotor will regain speed when the switch is released.

c. **Speed Control.** A solid-state speed control provides smooth control over a wide range of rpm. With the timer set, the power switch in the ON position, and the centrifuge rotating at minimum speed, perform the following:

(1) Gradually turn the speed control knob clockwise from "0" until the desired speed is indicated on the tachometer.

(2) At the end of the centrifugation cycle, return the speed control knob counterclockwise to "0."

(3) You may select any speed from minimum ("0") to the maximum velocities indicated in figure 1-2 for each of the fourteen rotor/shield configurations.

NOTE: Before operating the centrifuge, the speed control should always be set at "0." Depending on the rotor configuration and load, the centrifuge will rotate at less than 500 rpm with the speed control set at "0."

Cat. No. 0261 4-place 15ml horizontal rotor with 4-0901 shields. TIP RADIUS-6.8 inches MAX SPEED-2690rpm RCF-1397	Cat. No. 0273 4-place horizontal rotor with 4 multiple carriers for 20 13x100mm tubes (0922) TIP RADIUS-6.0 inches MAX SPEED-2650rpm RCF-1197
Cat. No. 0263 4-place 50ml horizontal rotor with 4-0900 shields. TIP RADIUS-6.94 inches MAX SPEED-2560rpm RCF-1292	Cat. No. 0281 6-place 15ml angle rotor with 6-0901 shields. TIP RADIUS-6.37 inches MAX SPEED-2760rpm RCF-1378
Cat. No. 0265 8-place 15ml horizontal rotor with 8-0901 shields. TIP RADIUS-7.03 inches MAX SPEED-2340rpm RCF-1093	Cat. No. 0283 4-place 50ml angle rotor with 4-0900 shields. TIP RADIUS-6.49 inches MAX SPEED-2860rpm RCF-1508
Cat. No. 0267 4-place 100ml horizontal rotor with 4-0908 shields. TIP RADIUS-7.13 inches MAX SPEED-2450rpm RCF-1215	Cat. No. 0285 12-place 15ml angle rotor with 12-0902 shields. TIP RADIUS-5.75 inches MAX SPEED-2890rpm RCF-1364

Figure 1-2. Maximum angular velocities and relative centrifugal Forces for Dynac II Centrifuge rotors (Model 0103 at 120 volts alternating current (vac), 60 hertz (Hz) and Model 0106 at 220vac, 50 Hz).
(Continued)

Cat. No. 0269 & 0271 4-place horizontal rotor with 4 multiple carriers for 36 10x75mm tubes or 28 12x75mm tubes (0920 & 0921). TIP RADIUS-5.0 inches MAX SPEED-3600rpm RCF-1840	Cat. No. 0287 12-place 15ml horizontal rotor with 12-0901 shields. TIP RADIUS-6.37 inches MAX SPEED-2610rpm RCF-1232
Cat. No. 0289 24-place 15ml angle rotor with 24-0902 shields. TIP RADIUS-5.75 inches MAX SPEED-2760rpm RCF-1244	Cat. No. 0293 24-place angle rotor with 24-0904 shields. TIP RADIUS-5.0 inches MAX SPEED-3400rpm RCF-1641
Cat. No. 0291 24-place 15ml angle rotor with 24-0901 shields. TIP RADIUS-6.37 inches MAX SPEED-2500rpm RCF-1131	

Figure 1-2. Maximum angular velocities and relative centrifugal Forces for Dynac II Centrifuge rotors (Model 0103 at 120 volts alternating current (vac), 60 hertz (Hz) and Model 0106 at 220vac, 50 Hz). (Concluded)

d. **Timer.** Spinning time is controlled by a 30-minute timer with a hold position for continuous operation. Operating the timer automatically turns on the centrifuge, provided the power switch is on and the cover is securely latched.

(1) To set the timer, turn the knob clockwise to the desired setting. The centrifuge will now operate to the end of the timed cycle and then shut off automatically.

(2) For continuous operation, turn the knob clockwise, to the HOLD position. The centrifuge will now operate continuously until it is manually shut off. To shut off, turn the knob counterclockwise to "0."

e. **Tachometer.** The tachometer indicates the angular velocity of the centrifuge rotor in thousands of rpm. The meter scale is graduated from "0" to 4,000 rpm in increments of 100 rpm. When the centrifuge cycle is started, the tachometer needle may not immediately move off the "0" point on the meter scale until the rotor speed reaches approximately 500 rpm.

NOTE: The tachometer is accurate to within+5 percent over the range of 500 rpm to 4,000 rpm.

CAUTION: Never operate the centrifuge without a rotor installed. You could damage the tachometer.

f. **Cover Safety Latch Assembly.** The centrifuge cover is held closed by a lever-type lid latch which is spring-actuated to release when pressed. In addition, the latch assembly on the centrifuge bowl incorporates the following safety features:

(1) Safety switch. When the cover is closed and latched, an electrical interlock is engaged, and power is supplied to the motor. You cannot start the centrifuge while the cover is open.

(2) Zero speed switch. Once the centrifuge is running, a zero speed switch prevents the cover from being opened (unlatched). You cannot open the cover until the rotor slows to less than 1 revolution per second (50rpm).

(a) To lock the cover, press down on the latch and cover until you hear an audible click.

(b) To open the cover, wait until the rotor has stopped spinning and then press the latch as shown in figure 1-3.

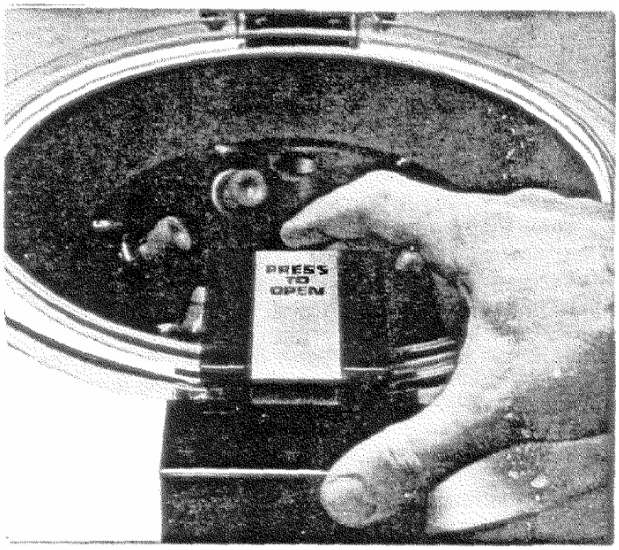


Figure 1-3. Cover latch.

1-4. LOAD BALANCING

For smooth centrifuge operation and extended equipment life, it is essential that you balance the loads as equally as possible. For best results, the use of a balance is recommended to obtain loads of equal weight. The angular distribution of material to be centrifuged is critical where loads are not of equal weight. If you cannot equalize the amount of fluid in the opposite tubes, fill the shield around the lighter tube with water until the loads are balanced.

NOTE: Never attempt to balance by adding weights, mercury, or shot to the bottom of a tube or shield.

1-5. SPEEDS AND RELATIVE CENTRIFUGAL FORCES

a. **Maximum Velocities.** Figure 1-2 lists the maximum angular velocities and relative centrifugal forces obtainable with each of fourteen interchangeable rotor and shield configurations. Tip radius for each configuration is also listed. The maximum velocities and centrifugal forces in figure 1-2 were derived by operating the Model 0103 Centrifuge at 120 vac, 60 Hz and Model 0106 Centrifuge at 220 vac, 50 Hz. These maximum velocities, however, can vary significantly with changes in line voltage and frequency, and with load, age and condition of the centrifuge.

b. **Speed Selection.** Many tests require centrifugation at an intermediate rpm between the minimum ("0") and maximum speed control settings. To obtain the desired speed, turn the speed control knob clockwise from "0" until the tachometer needle stabilizes at the required rpm.

NOTE: Always return the knob to the "0" position after completion of a cycle.

c. **Calculating RPM.** Certain tests call for centrifugation at a specified relative centrifugal force (rcf). Rcf is defined as the force acting on the sample being centrifuged relative to the force acting on the sample in the earth's gravitational field. The operator can calculate the correct tachometer speed (rpm in thousands) corresponding to the required rcf specified for a test, using the following formula:

$$\text{rpm (in thousands)} = \sqrt{\frac{rcf}{28.4R}}$$

Rpm in thousands (tachometer speed) equals the square root of rcf divided by 28.4R.

Where: Rcf equals the relative centrifugal force specified for the particular centrifugation procedure.

R equals tip radius of shield (in inches) obtained from Figure 1-2 for the rotor centrifugation being used.

1-6. SAFETY PRECAUTIONS

In order to obtain properly centrifuged specimens and to prevent damage to the machine, carefully observe the following basic operating precautions.

a. **Electrical.** Operate the Dynac II Centrifuge only from an ac power source approved for each model.

b. **Rotor Installation.** Never attempt to operate the centrifuge without first installing a complete rotor and shield assembly.

c. **Zero Speed Setting.** Before turning the centrifuge on, always turn the speed control knob to "0."

d. **Load Balancing.** For smooth operation and long service life, tubes must be placed in a balanced array.

e. **Timing and Speed.** For accurate results, follow the timing and speed specified for the particular centrifugation procedure.

f. **Cleanliness.** Keep the centrifuge clean and dust-free in accordance with maintenance and service instructions. Avoid spilling liquids into the centrifuge bowl. If the interior of the centrifuge contains dust, glass particles, or other foreign matter, it is possible for these contaminants to be stirred into the air and deposited into specimen tubes. Keep the centrifuge interior clean to prevent contamination of samples.

1-7. HAZARDS

Basic safety precautions must be observed when operating the centrifuge in order to avoid the hazards of electrical shock or other physical injury.

a. The Dynac II Centrifuge is not to be used in a Class I, Division 1, Group C hazardous location defined by the National Fire Protection Association, Bulletin No. 56A (Inhalation Anesthetics), as extending upward to a level of five feet above the floor where flammable anesthetics are used.

b. To avoid electrical shock, follow these procedures:

(1) Plug the power cord only into a grounded 3-wire receptacle.

(2) Never remove the grounding prong from the power plug.

(3) Always unplug the power cord before attempting to service the centrifuge.

(4) Immediately have a worn or damaged power cord or plug replaced by an authorized serviceman.

c. To avoid physical injury, never attempt to override the cover switch and lock while the rotor is spinning.

1-8. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE: Motors in both Models of the Dynac II Centrifuge incorporate permanently lubricated bearings. No lubrication is required for the life of the machine.

a. **Inspect Motor Brushes.** Inspect the motor brushes for wear every six months. Follow these procedures:

(1) Remove the line cord from the power outlet.

(2) Remove the rotor assembly and close and latch the centrifuge cover.

(3) Rest the centrifuge on the edge of the front console and cover.

(4) Remove the bottom cover and the drip pan plate.

(5) Locate the brush caps on the sides of the motor housing.

(6) Unscrew the brush caps and remove the spring and brush assemblies. Carefully note the orientation of the curved brush surface.

(7) Inspect the brushes and replace if worn to a length of 6.3mm (1/4 inch) or less.

(8) If the brush is not worn, return it to the same position that you found it.

b. **Clean the Centrifuge.**. To clean the centrifuge, follow these procedures.

(1) Wipe the interior and exterior with a damp cloth.

(2) Clean stains using a mild detergent.

(3) Clean the transparent cover with a mild detergent. Do not use carbon tetrachloride, chloroform, gasoline or acetone, or other chemicals such as aromatic hydrocarbons (benzene, scene, xylene) and strong alkalies (sodium and ammonium oxide). These can damage the cover.

Section II. PERFORM CALIBRATION/VERIFICATION

1-9. SPECIFICATIONS

Specifications for the centrifuge speed follow.

a. **Rated Speed.** The rated speed for Model 0103 (120 volts [v]) and Model 0106 (220v) is continuously adjustable from minimum speed. For maximum speeds, see figure 1-2 for speeds of fourteen different rotor/shield configurations.

b. **Electrical Specifications.**

(1) Model 0103: 120 volts alternating current (vac), 60 Hertz (Hz), 2.5 amperes (amps) and Model 0106: 220vac, 50Hz, 1.3amps UL approved.

(2) Tachometer Range: 0 to 4,000 rpm and accuracy: ±5 percent over 500 rpm to 4,000 rpm.

1-10. CALIBRATION/VERIFICATION PROCEDURES

a. **Required Tools.** To perform a speed check, an external tachometer, such as the Model 5205 ADAMS Photo Electric Tachometer, is recommended. Avoid mechanical-type tachometers that contact the rotor.

b. **Speed Checks.** The Dynac II Centrifuge is a variable speed machine. Maximum speeds that should be obtained with each rotor configuration are listed in Figure 1-2. These speeds can be used to check for proper operation of the centrifuge motor and tachometer.

(1) Check motor operation. Install a complete rotor and shield assembly. With the centrifuge operating at the maximum speed setting, the external tachometer reading should be within ±10 percent of the maximum speed listed in figure 1-2 for the rotor/shield configuration in use.

(2) Determine if supply voltage and frequency are correct. Such deviations will affect maximum obtainable operating speed. If supply voltage and frequency are correct, and the centrifuge motor speed or tachometer reading is outside the specified tolerance, you must correct the problem. If you cannot correct the problem, contact your nearest Clay Adams equipment dealer for service or call Clay Adams Technical Service Department.

(3) Check accuracy of the centrifuge tachometer. Use the external tachometer reading obtained above and operate the centrifuge at the maximum speed setting with the same rotor and shield assembly. The centrifuge tachometer reading should be within ±5 percent of the rpm reading obtained with the external tachometer. Troubleshooting an incorrect rpm reading is covered in Lesson 2, Isolate Malfunctions and Remove and Replace Defective Modules.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by selecting the response that best answers the question or best completes the statement.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For any exercise answered incorrectly, reread the material referenced after the solution.

1. For positive identification of tubes, shield positions in all rotors are:

   a. Notched.

   b. Lettered.

   c. Numbered.

   d. Color coded.

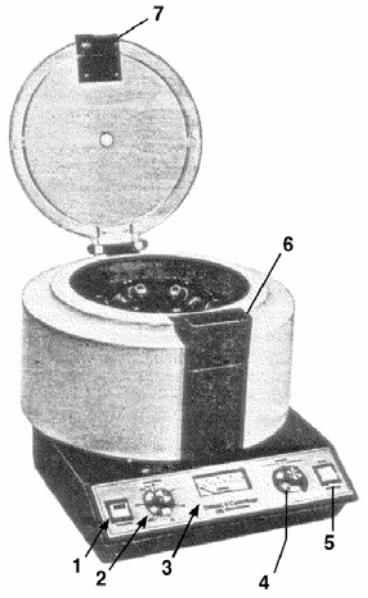
2. Refer to the figure below. Which number indicates the run/brake switch?

   a. 3.

   b. 4.

   c. 5.

   d. 6.



3. If you are using a 4-place 50 ml horizontal rotor with 4-0900 shields, what is the maximum speed?

   a. 2560 rpm.

   b. 2650 rpm.

   c. 2690 rpm.

   d. 2760 rpm.

4. What is the rcf if you are using an 8-place 15 ml horizontal rotor with 8-0901 shields?

   a. 1364.

   b. 1232.

   c. 1131.

   d. 1093.

5. You are inspecting the motor brushes for wear. After you locate the brush cap on the left side of the motor housing, what is your next step?

   a. Unscrew the brush cap and remove the spring and brush assembly.

   b. Remove the rotor assembly and close and latch the centrifuge cover.

   c. Rest the centrifuge on the edge of the front console and cover.

   d. Remove the bottom cover and drip pan plate.

6. You are reviewing the specifications for the centrifuge. What is the percentage of accuracy for the tachometer range over 500 rpm to 4,000 rpm?

   a. ±2 percent.

   b. ±5 percent.

   c. ±7 percent.

   d. ±9 percent.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1.

1. c (para 1-2d)
2. c (figure 1-1)
3. a (figure 1-2)
4. d (figure 1-2)
5. a (para 1-8a(6))
6. b (para 1-9b(2))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Isolate Malfunctions and Remove and Replace Defective Components.
TEXT ASSIGNMENT	Paragraphs 2-1 through 2-4.
LESSON OBJECTIVES	After completing this lesson, you should be able to:
	2-1. Identify the functions of the circuit.
	2-2. Identify troubleshooting techniques.
	2-3. Identify how to isolate malfunctions to component level.
	2-4. Identify how to remove and replace defective components.
SUGGESTION	After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

ISOLATE MALFUNCTIONS AND REMOVE AND REPLACE DEFECTIVE COMPONENTS

Section I. ISOLATE MALFUNCTIONS

2-1. CIRCUIT DESCRIPTION

In describing the circuit configuration, we will use the parallel method beginning with the black wire, hot side, and complete the circuit with the neutral (common) side. Refer to figure 2-1 for the Dynac II schematic.

a. **Armature Circuit.**

(1) With the power cord plugged into the wall outlet (receptacle), close the lid. When the cover latch snaps into place, it automatically closes the lid interlock switch, which is on the neutral side of the line.

NOTE: Reference is now on common at the power cord side of S-1.

(2) The 120vac will be on the black wire through fuse F-1 to one side of switch S-1. Close S-1 and continue on the white/tan wire to J2-5, to J3-7, red wire, to switch S-3, the timer switch. When time is selected, S-3 will close the 1-2-3 points. The 120 vac will now be at one side of the timer also. From S3-2, 120 vac will be on the black wire to the speed control through the speed control to J3-11.

NOTE: At this point, the speed control regulates the voltage.

(3) From J3-11 to J5-1 through the normally closed (spring loaded) S2, run/brake switch, to J5-8, to J1-6, to the brown wire, to one side of the armature.

NOTE: Reference on F1-2, 120v (hot side).

(4) For the neutral side, 120vac will be at S-1, white wire, through S-1, to the red wire, to the lid interlock switch, S-4.

NOTE: S-4 is a number assigned by the school for clarification. The mfg only lists it as lid interlock.

(5) When the lid is closed, S-4 is closed, and 120 vac will be on the black wire to J2-11, to J3-1, and jumped with a white/black wire to J3-2 through the pc board to J1-2. From J1-2, white wire, to the field windings. From the field windings, the voltage will be variable (depends on speed control setting) to J1-3. From J1-3, pc board, to J5-4, orange wire to S-2 (run/brake switch), through S-2, to J5-2, brown wire, pc board, to J1-5. From J1-5, yellow wire, to one side of the armature.

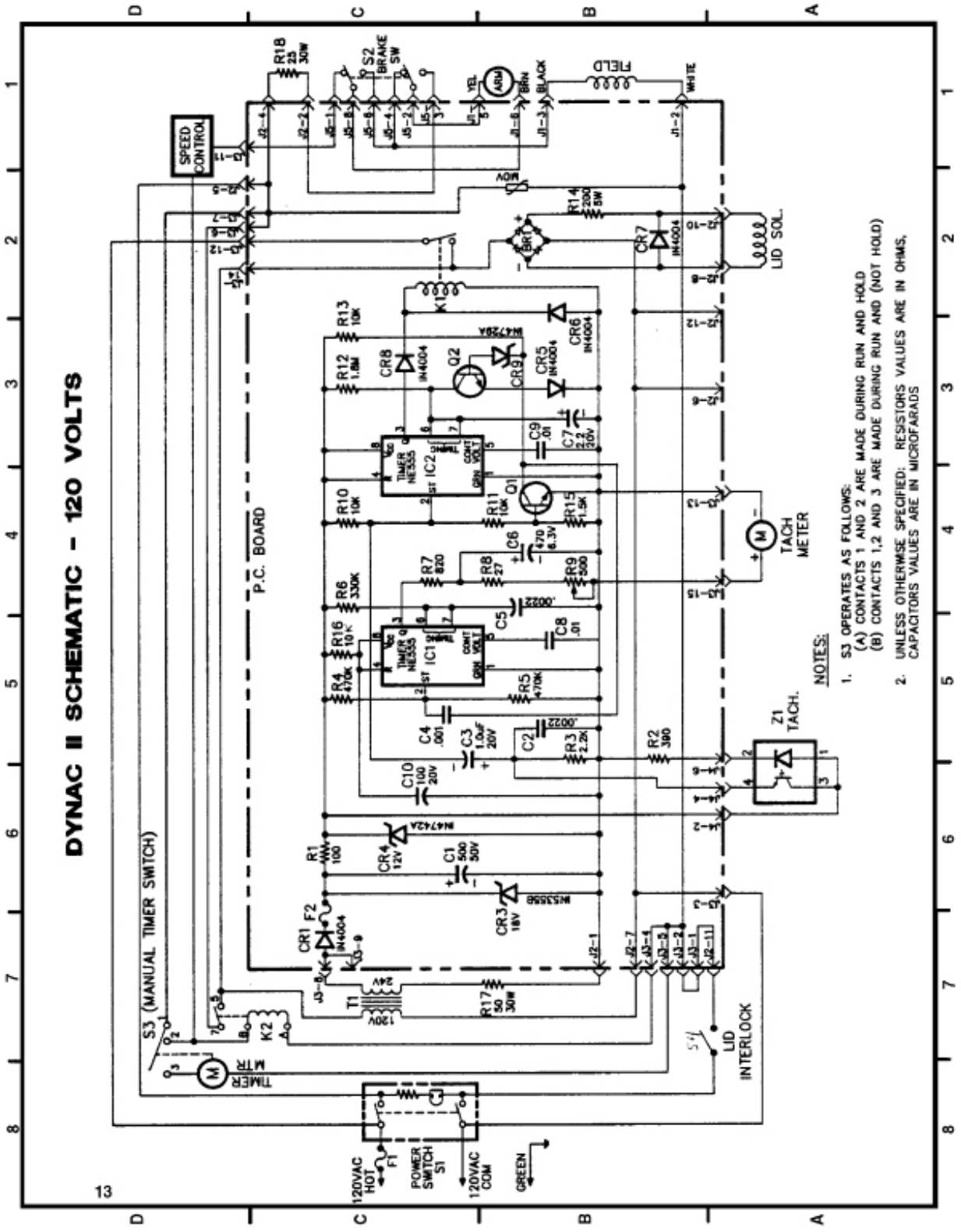


Figure 2-1. DYNAC II schematic--120 volts.

NOTE: Voltage is variable on both the hot and neutral sides due to action of the speed control pc circuit.

b. **Timer Circuit.** (Use the same reference as with the armature circuit.)

(1) The 120v is on the black wire to fuse F-1 and from F-1 to S-1. The lid is closed, closing the lid interlock switch. From S-1, through the white/tan wire, to J2-5, pc board to J3-7, red wire, to S3-1. Select time on the timer, closing S3-1 and S3-3 points. 120vac will be on the black wire at the timer motor.

NOTE: Change reference to F-1 (120vac, hot side).

(2) The common line is white wire to S-1. Close S-1 and 120vac will be on the red wire to S-4 and the black wire to J2-11, pc board, J3-1, jumped to J3-2, using a white/black wire. From J3-2 through the pc board, run to J3-5 and the white wire to the other side of the timer motor.

c. **Brake Circuit.**

NOTE: Reference lead at neutral (common lead).

CAUTION: Do not hold S-2 closed after armature comes to a complete stop as the armature will begin to accelerate in reverse.

(1) The path for voltage/current flow will be the black wire to the fuse, to S-1, the white and tan wire to J2-5, J2-4, through R-18, to J2-2, to J5-3. From J5-3, yellow wire, to S-2, brown wire, to J5-2, to J1-5, and yellow wire to the brush and to the motor.

NOTE: Reference at F-1 (120vac, hot side).

(2) The neutral side is as follows: white wire to S-1, and red wire to the lid interlock, black wire, to J2-11, to J3-1. The white/black wire to J3-2, to J1-2, and the white wire to the field windings. From the field winding, the black wire to Jl-3, J5-6, and purple wire to S-2. Red wire at S-2 to J5-8, J1-6, and the brown wire to the brush and to the motor.

d. **Tachometer Circuit.** The outputs from the pc board tachometer, tachometer pick-up pc board, and lid solenoid are as follows:

(1) Tachometer-J3-15 to J3-13, 0-57 millivolts direct current (vdc).

(2) Tachometer pc Board-Reference at J4-6. Test at J4-2 +1.2 vdc. Reference at J4-6. Test at J4-4 +0.6mvdc or -mvdc.

(3) Lid Solenoid-J2-8 and J2-10 -approximately 97vdc.

(4) The T1 secondary has approximately 24 vac across its windings. CR1 rectifies the ac and C1 is the filter for the +18vdc supply regulated by CR3. F2 protects T1 secondary. CR4 is a 12v zener diode which provides power for IC1, IC2, Q2, Q1 and K1. Z1 is a light emitting diode/transistor package. The positive +12v supply forward biases Z1 turning it on and charging C3.

(5) The Q1 is on at this time because of the +12v supply and the voltage divider network R10, R11 and R15. The collector of Q1 is low, and this low is felt to IC1 pin 2. IC1 pin 3 is also low at this time, and there is no signal to the tachometer. The arm attached to the armature motor turns as the armature turns. The arm will block the light being emitted by Z1, turning off Z1. C3 discharges. This places a low on the base of Q1, turning off Q1. A high will be felt from the collector of Q1 to IC1 pin 2.

(6) The high at IC1 pin 2 causes IC1 pin 3 to go high at this time. The high at IC1 pin 3 is felt through R7, R8, R9, and the tachometer causing the tachometer to read upscale. R9 is the tachometer adjust resistor. As the speed of the centrifuge increases, IC1 pin 3 goes more positive causing the tachometer to read further upscale.

e. **Lid Solenoid Circuit.**

(1) The Q1, Q2, IC2, and K1 make up a circuit that de-energizes the lid solenoid once the centrifuge drops below 50rpm. The same low felt on IC2 pin 2 is felt on the base of Q1 when Z1 is not conducting and C3 is discharging. Whenever IC2 pin 2 goes high, IC2 pin 3 goes high.

(2) This high energizes K1 coil. The K1's points are closed putting 120vac to BR1. The output of BR1 will energize the lid solenoid so that the operator cannot open the lid once 50rpm's have been reached.

(3) If the centrifuge times down or the speed control is set to zero, and the centrifuge drops below 50rpm, the following happens. As the speed decreases, fewer highs are felt to IC2 pin 2. Also at this time, the base of Q1 stays high longer, which keeps Q1 on longer. This keeps Q2 off longer. When Q2 is off, C7 is allowed to charge, putting a high on pins 6 and 7 of IC2. This high will cause IC2 3 to go low. K2 coil de-energizes and its points open. The 120vac is taken away from BR1. The lid solenoid de-energizes, and the operator can open the lid on top of the centrifuge.

2-2. TROUBLESHOOTING FOR MALFUNCTIONS

You use a troubleshooting guide to isolate the cause of malfunctions. You first identify the symptom, then check for the possible causes, and finally take the corrective action. Refer to the troubleshooting guide in figure 2-2.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Centrifuge fails to operate.	a) Power cord not in receptacle.	a) Plug cord into receptacle.
	b) Power switch not ON.	b) Activate power switch.
	c) Timer set to "0."	c) Set timer to desired spinning time.
	d) Cover not latched.	d) Close cover latch securely.
	e) External fuse blown.	e) Replace fuse.
	f) Motor brushes worn or defective.	f) Replace brushes.
	g) Defective internal parts.	g) Remove and replace.
2. Brake switch fails to decelerate rotor.	Brake system defective.	Remove and replace the defective component of the brake system.
3. Centrifuge vibrates excessively.	a) Unbalanced load.	a) Balance load.
	b) Rubber feet worn.	b) Replace feet.
4. Tachometer indicates zero speed or incorrect speed.	a) Centrifuge not rotating in excess of 500rpm.	a) Wait until speed accelerates above 500rpm.
	b) Defective tachometer, speed control or motor.	b) Remove and replace.
5. Centrifuge fails to achieve maximum speed specified for rotor configuration.	a) Line voltage incorrect.	a) Check power source with accurate monitor (authorized personnel only).
	b) Defective speed control, tachometer, or motor.	b) Remove and replace.

Figure 2-2. Troubleshooting guide.

Section II. REMOVE AND REPLACE DEFECTIVE COMPONENTS

2-3. REMOVAL AND REPLACEMENT PROCEDURES

Once you have isolated a defective component, you must remove and replace the component. Refer to figure 2-3 for an exploded view of components. Follow the procedures in the following paragraphs.

a. **Remove and Replace the External Fuse.** The external fuse is located in the back of the centrifuge. If you find that the external fuse is defective, replace it with a fuse of the following rating: Model 0103 -Type 3AG, 4 amp, 250 volt fuse, and Model 0106 -Type 3AG, 2.5 amp, 250 volt fuse. Always determine what caused the fuse to blow.

(1) Press the spring-load fuse holder to release the fuse.

(2) Install a new fuse in the holder and push the holder into the fuse receptacle until it locks into position.

b. **Remove and Replace the Motor Brushes.**

(1) Remove the line cord from the power outlet.

(2) Remove the rotor assembly and close and latch the centrifuge cover.

(3) Rest the centrifuge on the edge of the front console and cover.

(4) Remove the four screws and rubber feet which secure the bottom cover to the centrifuge base. Unloosen the cover clamp screw until the clamp is loose. Remove the bottom cover and drip pan plate.

(5) Locate the brush cap on the left side of the motor housing.

(6) Unscrew the brush cap and remove the spring and brush assembly carefully noting the orientation of the curved brush surface.

(7) Inspect the brush and replace if worn to a length of 6.3 mm (1/4 inch) or less.

NOTE: If the brush is not worn, replace it exactly as you found it.

(8) To install a new brush, insert the spring and brush assembly into the receptacle. Be sure the curved surface the brush is oriented to match the curved surface of the motor housing before insertion.

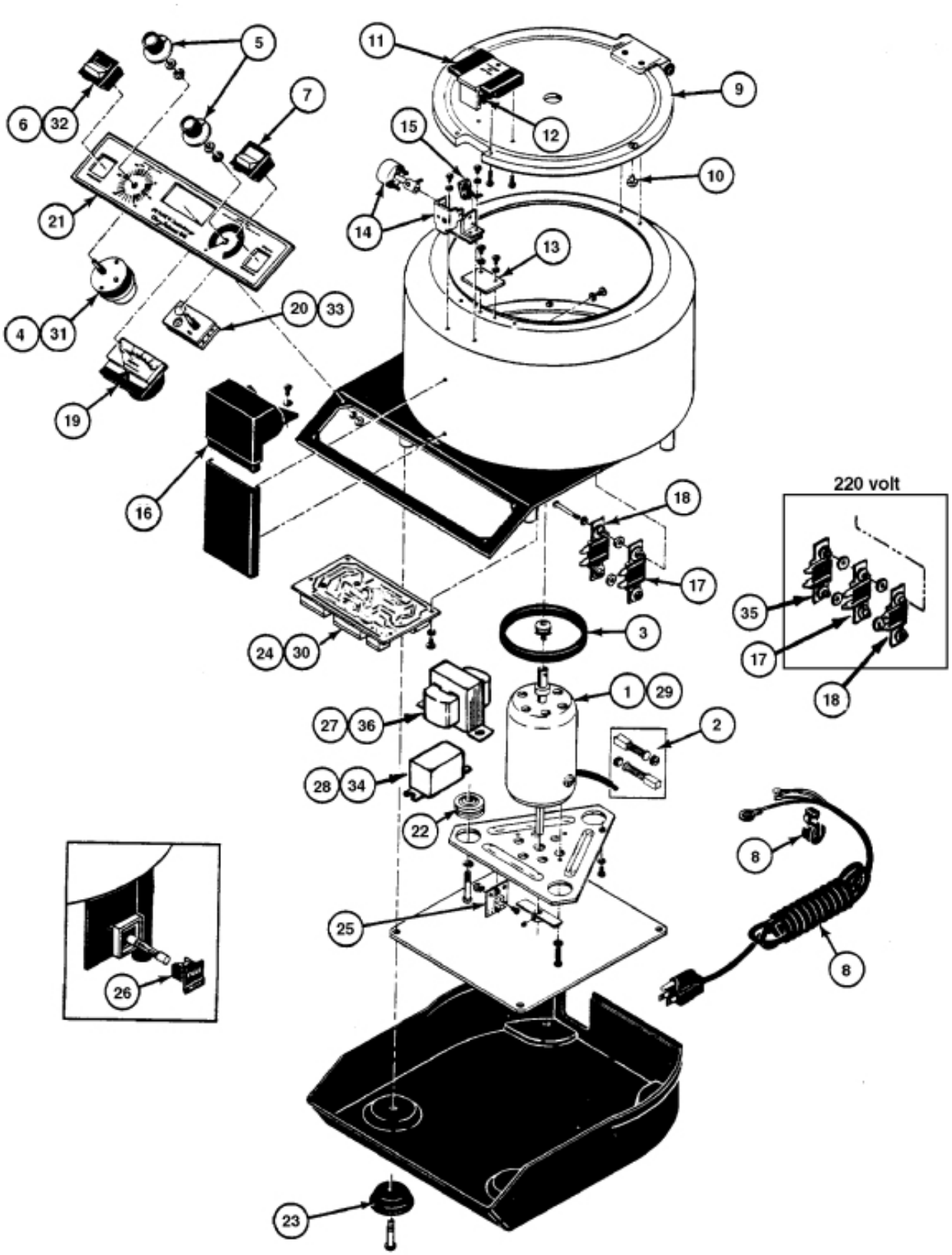


Figure 2-3. Exploded view of Dynac II centrifuge (continued).

ITEM NO	DESCRIPTION
	Motor Assembly (120 volt)
	Motor Brush Kit (set of 2)
	Gasket, Motor
	Timer Assembly (120 volt)
	Knob, Timer or Speed Control
	Power Switch (120 volt)
	Brake Switch
	Cordset Assembly
	Cover Assembly
	Bumpers, Lid (set of 2)
	Latch Assembly
	Lid Cushion
	Latch Plate
	Solenoid Assembly
	Safety Switch
	Cover, Solenoid
	Resistor, 50Ω, 30w
	Brake Resistor, 25Ω, 30w
	Meter Assembly
	Speed Control Assembly (120 volt)
	Front Panel
	Vibration Isolators (set of 3)
	Feet, Rubber (set of 4)
	P.C. Board Assembly (120 volt)
	Tachometer P.C. Board
26	Fuse Holder
27	Transformer P.C. Board
28	Relay K2 (120 volt)
29	Motor Assembly (220 volt)
30	P.C. Board (220 volt)
31	Timer Assembly (220 volt)
32	Power Switch (220 volt)
33	Speed Control Assembly (220 volt)
34	Relay K2 (220 volt)
35	Resistor, 1500Ω, 30w (220 volt)
36	Transformer (220 volt)

Figure 2-3. Exploded view of Dynac II centrifuge (concluded).

(9) Replace the brush cap and screw down tightly.

(10) Locate the brush cap on the right side of the motor.

NOTE: If the electrical leads on the right side of the motor interfere with the removal of the brush, disconnect the leads.

(11) Disconnect the leads from their pin terminals. Mark each lead for reconnection to the proper terminal.

(12) Remove the brush cap and brush assembly. Inspect and replace the brush if worn.

(13) Reconnect the wire leads.

(14) Reinstall the cover and drip pan plate as follows.

(a) Replace the drip pan plate.

(b) Slide the bottom cover on the top edges on either side of the back cutout underneath the wings of the cover clamp. Retighten the clamp and replace rubber feet and screws.

NOTE: Always run-in new brushes. The centrifuge may not operate properly until you operate the centrifuge for several hours with a rotor installed.

c. **Remove and Replace the Tachometer Meter Assembly.**

(1) Remove the bottom cover and drip pan.

(2) Remove and replace the tachometer meter assembly. (Part number 0103-610-000).

(3) Reassemble the unit.

d. **Remove and Replace the Brake Switch.**

(1) Remove the bottom cover and drip pan.

(2) Remove the brake switch. (Part number 0103-602-002).

(3) Replace the brake switch.

(4) Reassemble the unit.

e. **Install Rotors.** All rotors are installed in an identical manner, as follows.

(1) Remove the knurled retaining screw from the Centrifuge motor shaft.

(2) Place the rotor on the shaft so that the drive pin in the motor shaft engages the slot in the rotor.

(3) Push the rotor down until it seats.

(4) Replace knurled retaining screw on motor shaft and hand-tighten snugly.

(5) Insert the desired number of shields in the rotor in a balanced array.

2-4. OPERATIONAL CHECKOUT

Whenever you remove and replace a component, perform an operational checkout to ensure that the centrifuge operates properly. Perform the following procedures.

a. **Check the Speed Control.**

NOTE: Before operating the centrifuge, set the speed control to "0." Depending on the rotor configuration and load, the centrifuge will rotate at less than 500 rpm with the speed control at "0."

(1) Set the timer.

(2) Turn on the power.

(3) Rotate the centrifuge at minimum speed.

(4) Gradually turn the speed control knob clockwise from "0" until the tachometer indicates the desired speed.

(5) At the end of the centrifuge cycle, return the speed control knob counterclockwise to "0."

b. **Check the Timer.**

(1) Turn the knob clockwise to the desired setting.

(2) Ensure that the centrifuge operates to the end of the timed cycle.

c. **Check the Tachometer.** Ensure that the tachometer indicates rpm.

d. **Check the Cover Safety Latch Assembly.** Ensure that the cover locks properly.

e. **Check the Run/Brake Switch.**

(1) Manually hold down in the BRAKE position.

(2) Ensure that the rotor comes to a gentle stop in less than 30 seconds.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by selecting the response that best answers the question or best completes the statement.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For any exercise answered incorrectly, reread the material referenced after the solution.

1. You are identifying characteristics of the armature circuit, reference at F1. On the neutral side, 120 vac will be at S-1, common, incoming wire, through S-1, common, outgoing wire, to:

   a. The lid solenoid.

   b. The lid interlock.

   c. The Tachometer meter.

   d. The manual timer switch.

2. In the timer circuit, current goes from F-1 to:

   a. S-1.

   b. S-2.

   c. Speed control.

   d. Lid interlock switch.

3. In the brake circuit, the path for voltage/current flow is the black wire to the fuse to:

   a. S-1.

   b. S-2.

   c. S-3.

   d. Lid interlock switch.

4. For the tachometer pc board, reference at J4-6 and test at J4-4 for how many volts?

   a. +12mvdc.

   b. +9mvdc.

   c. +6mvdc.

   d. +3mvdc.

5. In the lid solenoid circuit, which of the following make up a circuit that de-energizes the lid solenoid once the centrifuge drops below 50 rpm?

   a. Q1, Q2, IC2, and K1.

   b. Q1 and IC1.

   c. Q1, Q2, and IC1.

   d. BR1, CR6, and S-3.

6. The centrifuge fails to operate. Which of the following is a possible cause? See figure 2-2.

   a. The cover is latched.

   b. The tachometer is not working.

   c. The load is unbalanced.

   d. The timer is set to "0."

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. b (para 2-1a(4))
2. a (para 2-1b(1))
3. a (para 2-1c(1))
4. c (para 2-1d(2))
5. a (para 2-1e(1))
6. d (figure 2-2)

End of Lesson 2