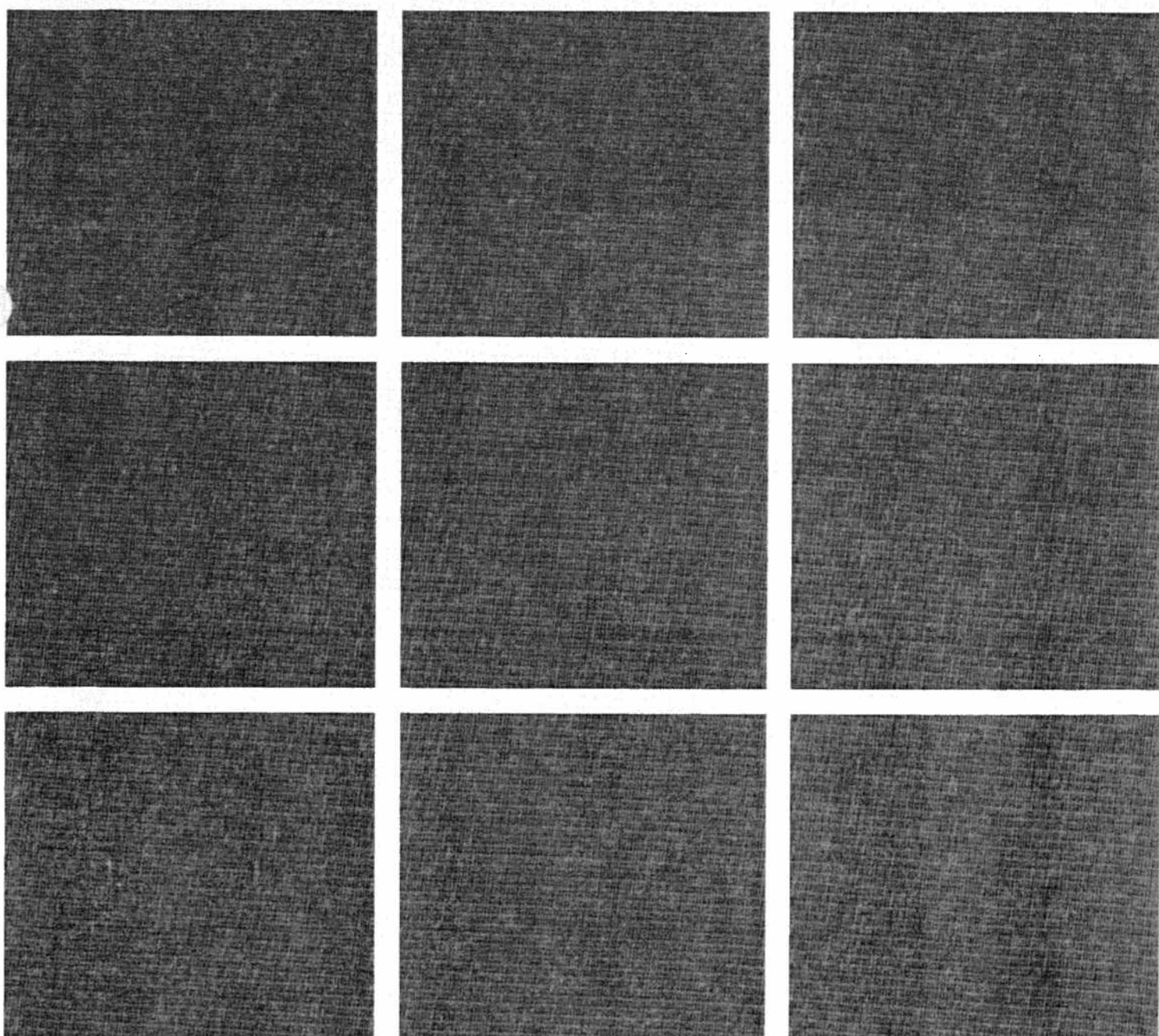


BECKMAN

J221-IM-6

J2-21 CENTRIFUGE

Instruction Manual



Safety

Reminder

This page summarizes mandatory information basic to the safe operation of the J2-21 centrifuge. It is strongly recommended that the user carefully read this entire manual before operating the instrument.

NEVER ATTEMPT TO OPEN the centrifuge door while the rotor is turning. In the event of a power failure, allow *at least* 20 minutes for the rotor to decelerate before overriding the door locking mechanism. (With loss of power the rotor will be decelerating without benefit of a brake.)

MAINTENANCE that requires the removal of instrument panels will involve exposure to electrical and mechanical hazards and should be performed only by qualified, trained personnel. **UNPLUG THE CENTRIFUGE** before removing panels, or turn off and lock out the main wall breaker if your instrument is hard wired to the wall.

FLAMMABLE LIQUID HAZARD. This centrifuge is not designed for use with flammable liquids. Be sure power to the centrifuge is off before using ethanol or any other flammable liquid in the vicinity of the centrifuge.

MISHAPS MAY GENERATE AEROSOLS. Hazardous materials must not be run in this centrifuge unless all necessary safety precautions are taken. The vacuum system exhausts continuously through filters that cannot be relied upon for complete trapping of airborne particles. The filter bottles that retain these particles do not require maintenance.

BECKMAN

J2-21

CENTRIFUGE

Instruction Manual

Mail in the product registration card supplied with
this manual when your instrument is installed.

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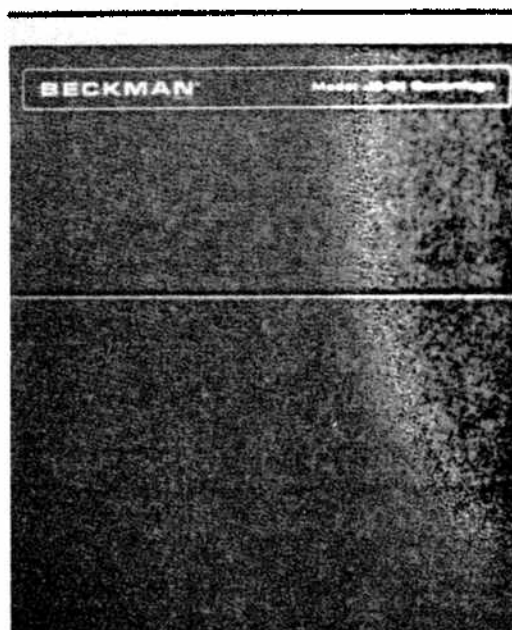
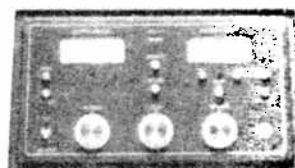
SPECIFICATIONS

CONTROL CHARACTERISTICS

Speed range	100 to 21 000 rpm
Speed control	RPM meter reading is within 200 rpm of setting on speed dial, and within 200 rpm of actual rotor speed; control range is 0 to 21 000 rpm.
Timer	Times up to 160 minutes (60-Hz instrument), 190 minutes (50-Hz instrument), or HOLD; graduated in 5-minute increments.
Temperature control	Within 2°C of set temperature using COMP dial; after calibration, within 1°C.
Temperature control range	0 to 40°C at full speed; as low as -30°C at reduced speed.
Ambient range	16 to 38°C

CENTRIFUGE SPECIFICATIONS

Rotor chamber diameter	371 mm (14.6 in.)
Vacuum	One-half atmosphere (green sector of gauge)
Maximum heat output during operation	2.05 kW (7000 Btu/h)



General Operation

The Beckman J2-21 is a refrigerated, general-purpose laboratory centrifuge designed for fast, efficient separation of large volumes of cells, bacteria, subcellular organelles, and viruses.

NOTE: If this is the first run on a new instrument, please be sure you have read the manual thoroughly and have fully completed the installation procedures, including the test run (see Chapter 3).

The J2-21 refrigerated centrifuge features:

- *solid-state circuitry*
- *long drive and brush life*
- *broad temperature range*
- *adjustable OVERTEMP shutdown protection*
- *easy maintenance and repair*
- *built-in speed calibration check*
- *wide choice of rotors, tubes, and adapters*
- *simple, quiet operation*
- *and the following safety features: chamber overheating protection, door locking system, heavy steel barrier around chamber, sealed lubrication, rotor overspeed protection (windage for low-speed rotors and internal electronics for high-speed rotors), rotor imbalance detection, and brush-wear warning.*

DRIVE UNIT

The sealed, prelubricated drive spindle is belt driven by a high-torque, dc motor. The motor to drive pulley ratio is 10:21 (i.e., 10 000 motor turns gives 21 000 rotor turns). The motor and drive spindle assembly are attached to a rubber-mounted driveplate, which reduces vibration and noise.

NOTE: *Some vibration may occur as the rotor passes through its Critical Speed Range (between approximately 600 and 800 rpm). This vibration is normal and is a side effect of the rotor's shifting to rotate about its center of mass. If abnormal vibration should occur, the imbalance detector will shut down the run.*

REFRIGERATION AND TEMPERATURE CONTROL SYSTEMS

The J2-21 refrigeration condenser is mounted in the lower rear of the instrument. The evaporator surrounds the rotor chamber. To achieve temperature control, the compressor cycles on and off.

When the power is on but a rotor is not running, chamber temperature (black needle indicator) can fall slightly below the set temperature (green bar on the meter). When a run has been started, chamber temperature rises rapidly to the set temperature. Though the temperature needle normally wavers during a run, the rotor's large mass keeps the sample temperature substantially constant.

Temperature sensing is done by a thermistor at the bottom of the chamber. A safeguard thermostat shuts down the drive system if chamber temperature exceeds 45° or if the black needle moves to the right of the setting of the red OVERTEMP bar on the temperature meter.

DOOR OPERATION

The instrument door is hinged and has a latch on the right side. Initial opening of the door is assisted by a built-in torsion bar. When you have the door about three quarters of the way open, a gas spring takes over and opens the door the rest of the way. The door will remain open without support. The rubber block on the inside of the door is provided as a hanger for a rotor windshield lid while the door is open.

The door latch locks when either the START button is pushed or the POWER switch is turned OFF. If the rotor is not turning, the door will unlock when power is restored. In the event of a power failure, you may wish access to the rotor before power can be restored. In this case, do the following:

WARNING

Turn POWER OFF before proceeding.

Allow at least 20 minutes for the rotor to coast to a stop. (With the power out, the brake will be inoperative.) To trip the door lock, insert a thin wire such as a straightened paper clip 4 cm *straight* through the hole below the chamber door handle. Push the wire ½ cm further in and, holding it there, pull the door latch lever forward and lift up on the handle. See Figure 1-1.

If the drive belt breaks during a run, the door will not open. When the belt has been replaced (see Chapter 3), the door will open normally.

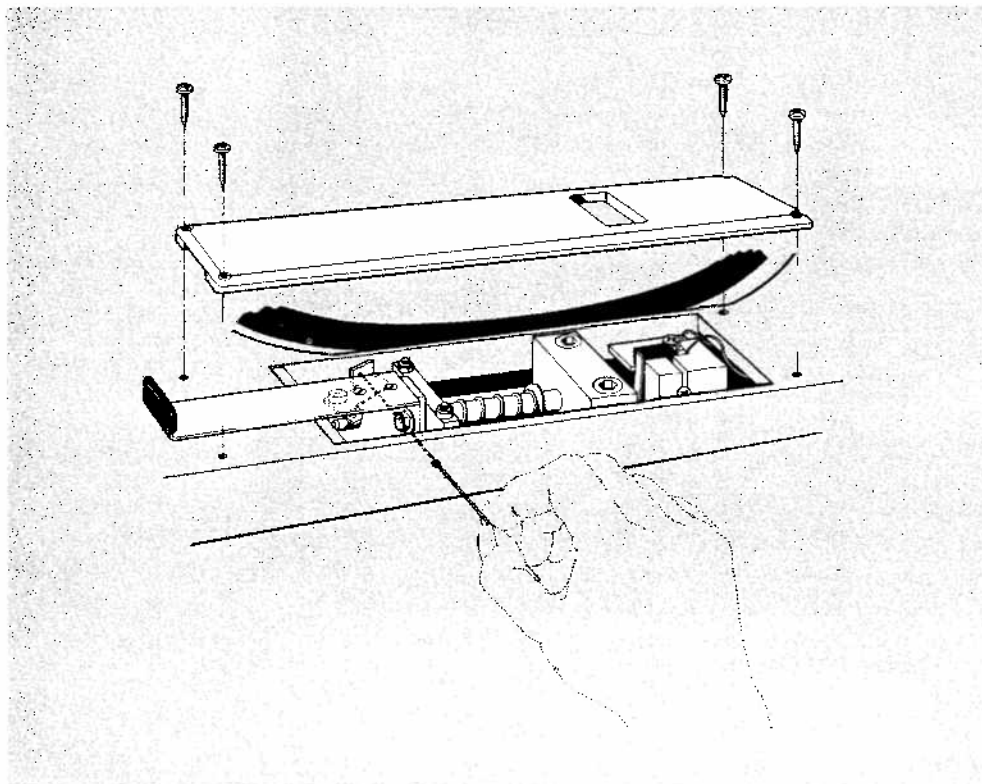


Figure 1-1. Tripping the Door Latch Manually

POWER SWITCH

The POWER switch is on the lower left side of the control panel (Figure 1-2). Turning the switch ON unlocks the chamber door if the drive spindle is stationary. Turning the switch OFF releases the door-latch locking pin. If the door is closed, turning the switch OFF will lock the door. If the door is open, it will be prevented from closing.

The power indicator light, the refrigeration system, and all electronics are activated by the POWER switch. The switch automatically trips OFF and shuts down the instrument if an internal short circuit occurs or if some condition causes excessive power consumption. If the switch trips OFF, reset to ON only once. If the switch trips OFF again, call your Beckman Field Service Representative.

SPEED SELECTOR

Each numbered increment on the speed dial represents 5000 rpm. If the indicator is turned to a slower speed during the run, the START light will go out and the STOP light will come on until the new speed is reached. (The rate of deceleration is controlled by the brake setting.) If ambient temperature is high and the desired run temperature is below 0°, run speed may need to be reduced to maintain the low temperature.

RPM METER

A convenient calibration check of the RPM meter is described in Chapter 3 (Test Run).

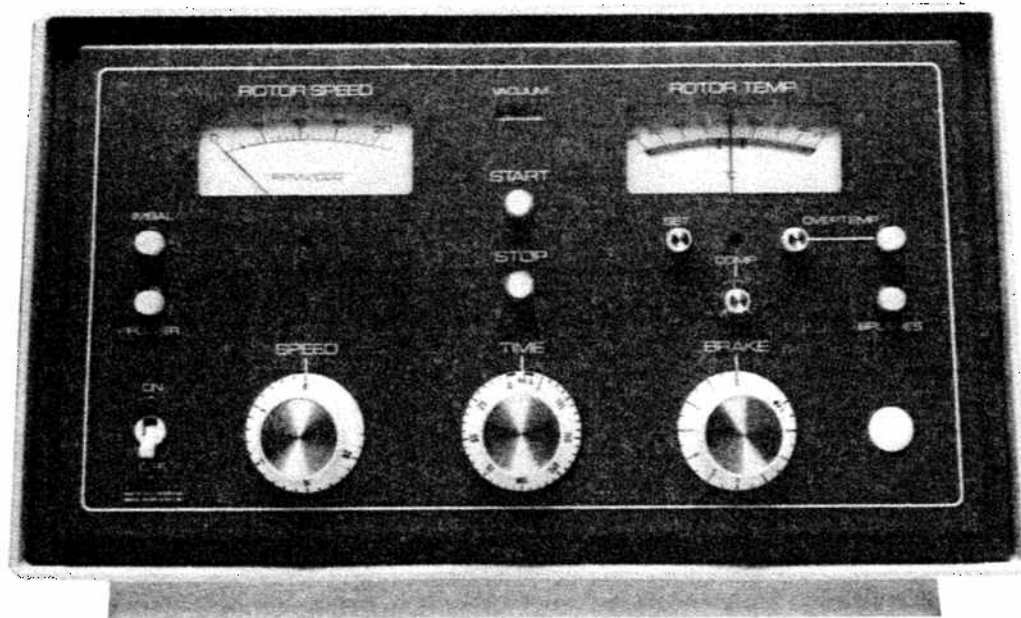


Figure 1-2. The Panel Controls

TIMER

The timer controls the drive and vacuum systems. Turning the timer on starts the vacuum pump, whether the instrument door is open or closed. Turning the timer off turns off the vacuum pump, shuts down the drive, and activates the brake.

Set the timer on HOLD for runs longer than 160 minutes (60-Hz instrument) or longer than 190 minutes on the 50-Hz instrument. At the end of instrument-timed runs, the timer turns off automatically. Turn the timer off manually to stop a HOLD run, or to prematurely shut down a timed run.

VACUUM GAUGE

The timer automatically turns on the vacuum system, lowering chamber pressure to about one half atmosphere. Drag on the rotor during a run is thereby reduced. Optimal vacuum conditions exist when the needle is in the green sector of the gauge. The pump evacuates the chamber via an opening in the center of the chamber door. The vacuum gauge should stabilize at operating pressures within one minute after the timer has been turned on and the chamber door closed.

BRAKE SELECTOR

The span between 0 and MAX on the brake dial represents a nonlinear series of braking rates, from no brake to full-powered brake. Incremental markings on the dial are provided only as reference points for repeat settings. The desired setting will vary with run speed and with rotor load, weight, and configuration. See Figure 2-2 for help in selecting a braking rate.

NOTE: Should a power failure occur, the brake does not engage to assist in slowing a rotor. Wait at least 20 minutes for the rotor to decelerate before overriding the door locking mechanism.

TEMPERATURE METER

Each minor increment on the temperature meter represents 2°C. The red bar is an overtemp indicator (set with the OVERTEMP knob), the green bar is set at the desired rotor temperature (use the SET knob), and the black needle indicates actual rotor temperature under stable conditions when the COMP dial has been properly set. It is normal for the black needle to waver slowly about the green bar; the relatively large mass of the rotor keeps the sample temperature steady. The position of the black needle is electronically corrected when the COMP dial is properly set (see Table 2-1). Occasionally the black needle will move rapidly when the operating mode is changed.

If you wish to verify the accuracy of sample temperature control, follow the temperature check procedure in the test run instructions (Chapter 3). Record new COMP dial settings, such as you may find, in Table 2-1. Recheck these settings occasionally during subsequent normal instrument use.

The red bar OVERTEMP indicator is the operator's insurance that his sample—should something go wrong during a run—will not be subjected to temperatures in excess of the setting of the red bar.

To start a run under high ambient temperature conditions, set the red bar at a reading well above ambient temperature and lower its setting as the chamber cools. If a run shuts down because the refrigeration system cannot maintain the desired rotor temperature, call your Beckman Field Service Representative.

COMP DIAL

The J2-21 centrifuge uses a variety of rotors, and each rotor has different cooling characteristics. To control a rotor's run temperature, first set the OVERTEMP indicator well above ambient temperature and lower its setting as the chamber cools. Then set the desired rotor temperature on the meter face with the SET knob. Finally, from Table 2-1, find the temperature compensation units needed to achieve that temperature and set them on the COMP dial. Temperature compensation units electrically correct the temperature reading of the black needle indicator and thereby affect the operating mode of the cooling system.

OVERTEMP FEATURE

When the OVERTEMP light is on, it means the run has shut down to prevent sample temperature from exceeding the setting of the red bar on the temperature meter. This OVERTEMP setting is what the operator considers to be the maximum allowable sample temperature. The run will shut down whenever the temperature indication of the black needle exceeds the setting of the red bar.

If the run has shut down only because the red bar was set too low, the run can be restarted immediately while the rotor is still turning. To restart, first turn the POWER switch OFF. Then reset the red bar to the right of the black needle and turn the POWER switch back ON.

If the desired OVERTEMP setting is below ambient temperature, the OVERTEMP bar will have to be set twice: first, *before the POWER switch is turned on*, set the OVERTEMP bar well above ambient temperature (i.e., usually above 26°C); second,

after the chamber and rotor have cooled and the black needle is indicating at least several degrees below the maximum allowable sample temperature, turn the OVERTEMP bar carefully down to the final OVERTEMP setting.

START BUTTON

With the timer on, pressing the START button will lock the chamber door and actuate the drive. The button lights up immediately as the rotor accelerates. The light stays on until the timer is turned off or the STOP button is pushed.

STOP BUTTON

When the STOP button is lit, the rotor is decelerating. The light goes out when the rotor stops. The STOP button will light up when

- it is pushed,
- or the timer is turned off manually or reaches zero,
- or a lower speed is selected, until that speed is reached.

Pushing the STOP button will activate the brake, but will not turn off the vacuum system. *Turning off the timer* is the best way to stop a run, since to open the chamber door there must be no residual vacuum.

IMBALANCE DETECTOR

If the imbalance detector shuts down a run, the imbalance light will come on and the rotor will decelerate with no brake. To restart the run, rearrange the load for better balance and start the centrifuge again. The detector light goes out automatically when the START button is pushed.

If the imbalance detector is repeatedly activated, check the following:

1. Is the rotor load balanced? (Check allowable imbalance listed in the specific rotor bulletin.)
2. Is the rotor properly seated on the drive hub?
3. Is the centrifuge level?

BRUSH LIGHT

Located at the far right of the control panel, the brush light goes on only when the drive motor brushes are in need of replacement. After the light comes on, a short run may be ended normally. However, *complete replacement of the drive motor will be necessary* if the centrifuge is operated for longer than 8 hours after the light has gone on. To change the worn-out brushes, see Chapter 3.

Run Procedure

STARTING A RUN

Use the following procedure to run the centrifuge.

1. Precool the rotor in a cold room, if desired, and load the sample (or see step 8 below).
2. Using the OVERTEMP knob, set the red bar of the temperature meter well above the ambient temperature (Figure 2-1).
3. Turn the POWER switch ON.
4. Adjust the green bar on the temperature meter to the desired run temperature, using the SET knob.
5. Select the COMP dial setting from the table below and set the COMP dial accordingly. (This setting will slightly alter the position of the black indicator needle when the timer is turned on.)



Figure 2-1. Panel Controls

Temperature Compensation Settings

Rotor and Speed (rpm)	Desired Sample Temperature (°C, green bar)						
	-20°	-10°	2°	5°	10°	20°	40°
JA-21							
21 000	N	N	-10	-10	-10	- 8	- 6
18 000	N	- 8	- 8	- 7	- 6	- 5	- 3
15 000	-6	- 6	- 5	- 4	- 4	- 3	N
10 000	-3	- 2	- 1	- 1	- 1	0	N
JV-20							
20 000	N	N	-max	-max	-max	-max	-max
18 000	N	N	-max	-max	-10	-10	- 9
15 000	N	N	- 7	- 7	- 6	- 5	- 4
10 000	N	N	- 2	- 2	- 1	0	0
JA-20.1							
20 000	N	N	-10	- 9	- 9	- 9	- 7
18 000	N	N	- 7	- 4	- 7	- 6	- 4
15 000	-7	- 5	- 4	- 4	- 4	- 3	N
10 000	-2	- 1	- 1	0	0	0	N
JA-20							
20 000	N	N	- 9	- 8	- 7	- 7	- 6
18 000	N	N	- 6	- 6	- 5	- 4	- 3
15 000	-5	- 4	- 4	- 4	- 3	- 2	- 1
10 000	-2	- 2	- 1	0	0	0	0
JA-18.1							
18 000	N	N	N	N	- 9	- 9	- 2
17 000	N	N	N	N	- 8	- 9	- 2
15 000	N	N	- 9	- 9	- 6	- 5	- 2
10 000	-5	- 5	- 4	- 4	- 4	- 3	0
8 000	-4	- 4	- 4	- 4	- 3	- 2	0
JA-18							
18 000	N	N	N	N	N	-10	- 7
17 000	N	N	N	N	- 9	- 8	- 6
16 000	N	N	-10	-10	- 9	- 7	- 5
12 000	N	- 6	- 6	- 6	- 5	- 4	- 3
8 000	-5	- 4	- 4	- 3	- 2	- 1	0
5 000	-4	- 3	- 2	- 2	- 1	0	0
JA-17							
17 000	N	N	- 7	- 7	- 7	- 4	- 2
15 000	N	- 5	- 4	- 4	- 4	- 3	- 1
12 000	-4	- 4	- 3	- 3	- 3	- 1	N
8 000	-1	- 1	0	0	0	0	N
JA-14							
14 000	N	N	- 7	- 7	- 7	- 5	- 4
12 000	N	- 6	- 5	- 5	- 4	- 3	- 2
10 000	-4	- 4	- 3	- 3	- 2	- 1	N
5 000	-1	0	0	0	0	0	N
JA-10							
10 000	N	- 3	- 2	- 1	0	+ 1	+ 2
8 000	-3	- 2	- 1	- 1	0	+ 1	+ 2
5 000	-2	0	0	0	0	+ 1	+ 2

COMP Dial Settings

N: indicates that the rotor cannot achieve the desired temperature at this speed; -max: turn the COMP dial clockwise as far as possible.

[Continued]

Rotor and Speed (rpm)	Desired Sample Temperature (°C, green bar)							
	-20°	-10°	2°	5°	10°	20°	40°	
JS-13.1								COMP Dial Settings
13 000	N	-10	-10	-10	-10	-10	- 9	
11 000	N	- 8	- 8	- 8	- 7	- 6	- 5	
8 000	-6	- 5	- 4	- 4	- 3	- 3	N	
5 000	-4	- 3	- 1	- 1	- 1	- 1	N	
JS-13								
13 000	N	-10	-10	-10	-10	-10	- 9	
11 000	N	- 8	- 8	- 8	- 7	- 6	- 5	
8 000	-6	- 5	- 4	- 4	- 3	- 3	N	
5 000	-4	- 3	- 1	- 1	- 1	- 1	N	
JS-7.5								
7 500	-4	- 3	+ 1	+ 1	+ 1	+ 2	+ 3	
5 000	-2	0	+ 3	+ 3	+ 3	+ 3	+ 4	
2 000	0	+ 2	+ 4	+ 4	+ 4	+ 4	+ 5	
JCF-Z								
20 000	N	N	-max	-max	-max	-max	-10	
18 000	N	N	-max	-max	-10	- 9	- 8	
15 000	N	N	-10	- 9	- 8	- 7	- 6	
10 000	N	N	- 6	- 6	- 5	- 4	- 3	
JE-68								
6 000	—	—	+ 6	+ 5	+ 6	+ 8	N	
2 000	—	—	+ 6	+ 5	+ 6	N	N	

N: indicates that the rotor cannot achieve the desired temperature at this speed; -max: turn the COMP dial clockwise as far as possible; —: setting has not been determined yet.

- Set the BRAKE dial. Figure 2-2 illustrates the relative braking effect of the dial settings versus deceleration time. The braking rates may be changed at any point during the run. Note that a *very high brake rate may cause sample stirring during deceleration*.

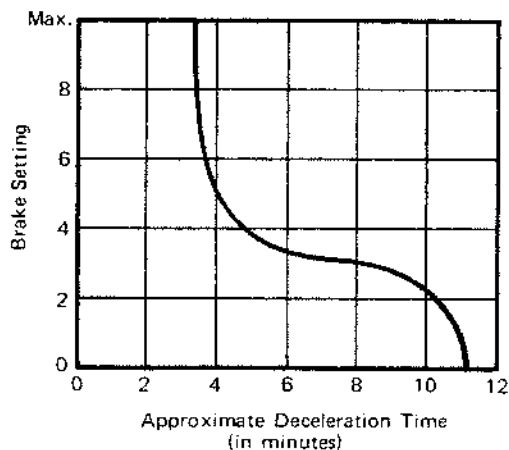


Figure 2-2. Brake Setting Versus Deceleration Time for a Typical Rotor

7. Install the rotor (refer to the specific rotor bulletin) and close the chamber door.
8. If the rotor was not precooled in a cold room, precool the rotor in the chamber now before the sample is loaded: set the SPEED dial at 1000 rpm, set the TIME dial on 20 minutes, and push the START button. After 20 minutes, when the STOP light has gone out, open the chamber door and load the sample into the rotor. Close the chamber door.
9. Reset the OVERTEMP knob (red bar) to the maximum allowable sample temperature.
10. Select and set the run speed (refer to the specific rotor bulletin).
11. Set the TIME dial. For runs longer than 160 minutes (60-Hz instrument) or longer than 190 minutes (50-Hz instrument), set the dial on HOLD. The timer can be reset at any point during the run by turning it clockwise or counterclockwise.
12. Push the START button.

STOPPING A RUN

1. Terminate the run either by allowing the timer to shut off automatically or by manually turning the timer to zero. (The STOP light will come on.)

NOTE: If the STOP button is pushed, the rotor will stop, but the vacuum system will continue to operate. The timer must be turned off to release the vacuum before you can open the chamber door.

2. Wait for the STOP light to go out, indicating full rotor stop, then press down slightly on the centrifuge door handle and lift the door open.

Remove the rotor following the instructions given in the specific rotor bulletin. *Rotors should not be stored in this centrifuge or they may stick on the drive hub.*

3. Turn POWER switch OFF when centrifuge is not in use to conserve energy and avoid unnecessary instrument wear. The chamber and rotors precool rapidly (20 minutes) in this centrifuge.

J2-21 RUN STEPS

1. Precool rotor in cold room and load sample (or see step 7 and footnote).
2. Set red bar of temperature meter well above ambient temperature, using the OVERTEMP knob.
3. Turn POWER switch ON.
4. Set green bar of temperature meter to desired rotor temperature, using SET knob.
5. Use Table 2-1 to select and set COMP dial.
6. Set brake rate on BRAKE dial.
7. Install rotor in centrifuge.*
8. Reset OVERTEMP knob to maximum allowable sample temperature.
9. Set run speed.
10. Set TIME dial.
11. Push START button.

DO's

If any unusual vibrations, sounds, or odors occur, TURN THE POWER SWITCH OFF until the cause is determined.

Turn the POWER switch off when not in use to conserve energy and to avoid excessive instrument wear.

Keep rotor and hub mating surfaces clean. Lightly lubricate the instrument drive hub with Spinkote to prevent its sticking on the driveshaft. Install rotors securely.

Lift rotors vertically to avoid bending the driveshaft.

Periodically defrost chamber and wipe up accumulated moisture; water in the chamber will prevent good temperature control.

If the brush light goes on, a qualified person must change the drive motor brushes as soon as possible.

Clean the condenser fins on the back of the instrument every few months (use a brush or a vacuum cleaner).

Use only Beckman-approved parts and accessories.

DON'T's

Do not operate instrument with metal panels removed: operator will be exposed to electrical shock and mechanical injury hazards.

Do not attempt maintenance without first referring to Chapter 3.

Do not operate instrument above 38°C (100°F) ambient temperature: premature component failure will result.

*Precool rotor and chamber (if not already done), and load sample.

Maintenance and Troubleshooting

This section contains instructions for centrifuge care that may be safely performed by qualified, trained personnel. Maintenance not covered in this manual should be carried out only by a Beckman Field Service Representative.

MAINTENANCE

Routine Maintenance	Recommended Frequency
1. Replace air filter	With dust and debris buildup (every one to three months)
2. Wipe and lubricate mating rotor and hub surfaces	Each time a rotor is installed
3. Inspect chamber door latch	In the event of spillage, clean as necessary
4. Clean and dry the centrifuge chamber	With spillage, or before moisture accumulates to a depth of 3 mm.

WARNING

Maintenance that requires the removal of instrument panels will involve exposure to electrical and mechanical hazards and should be performed only by qualified, trained personnel.

CLEANING

Cleaning the Refrigeration Condenser Fins (Air Intake)

Efficiency of the refrigeration cooling system may be seriously reduced by a buildup of dirt, dust, and blown papers on condenser fins. (The fins are on the rear of the instrument.) The fins should be cleaned with a brush or vacuum cleaner every one to three months.

Chamber Cleaning

The chamber of the J2-21 is stainless steel, and the vacuum seal around the chamber is silicone rubber. They may be cleaned with detergent solutions (rinse well) and disinfected with 70% ethanol. See publication IN-175.

WARNING

Be sure the power to the centrifuge is off before using ethanol or any other flammable liquid on or near the centrifuge.

Ice formed on the chamber wall during a run may be removed by allowing the ice to melt and then sponging the water up. Or turn the temperature up to 40°C and run a rotor at speed for 5 minutes. Air flow around the rotor will melt the ice. Remove the rotor from the chamber, then sponge up the water.

Surface Cleaning

The meter windows are polystyrene, the centrifuge lid is painted with urethane paint, and the rest of the centrifuge is painted with vinyl paint. All of these surfaces may be cleaned with a solution of mild, nonabrasive detergent. Seventy percent ethanol may be used to disinfect painted surfaces, but should not be used on the meter windows or the viewing port (polycarbonate) in the chamber door. See publication IN-175 for chemical resistances of materials.

WARNING

Be sure the power to the centrifuge is off before using ethanol or any other flammable liquid on or near the centrifuge.

SPECIAL CENTRIFUGE MAINTENANCE PROCEDURES

This section contains instructions for centrifuge maintenance that may be safely performed by qualified, trained personnel. Maintenance not covered in this manual should be carried out only by a Beckman Field Service Representative.

WARNING

Maintenance that requires the removal of instrument panels will involve exposure to electrical and mechanical hazards and should be performed only by qualified, trained personnel.

VACUUM SYSTEM

If the instrument does not achieve a good vacuum (within the green sector on the vacuum gauge) make sure the problem is not due to dirty vacuum-sealing surfaces in the chamber door. No other parts of the vacuum system require maintenance. However, you may occasionally check to be sure that

the vacuum pump filter bottles (Figure 3-1) are tightly screwed into their lids. The bottles require no maintenance.

WARNING

Ensure that the J2-21 is disconnected from the main power source: either **UNPLUG THE INSTRUMENT** or, if your centrifuge is hard wired to the wall, turn off and lock out the main wall circuit breaker.

If hazardous substances have been run in this centrifuge they will probably also be present in these bottles.

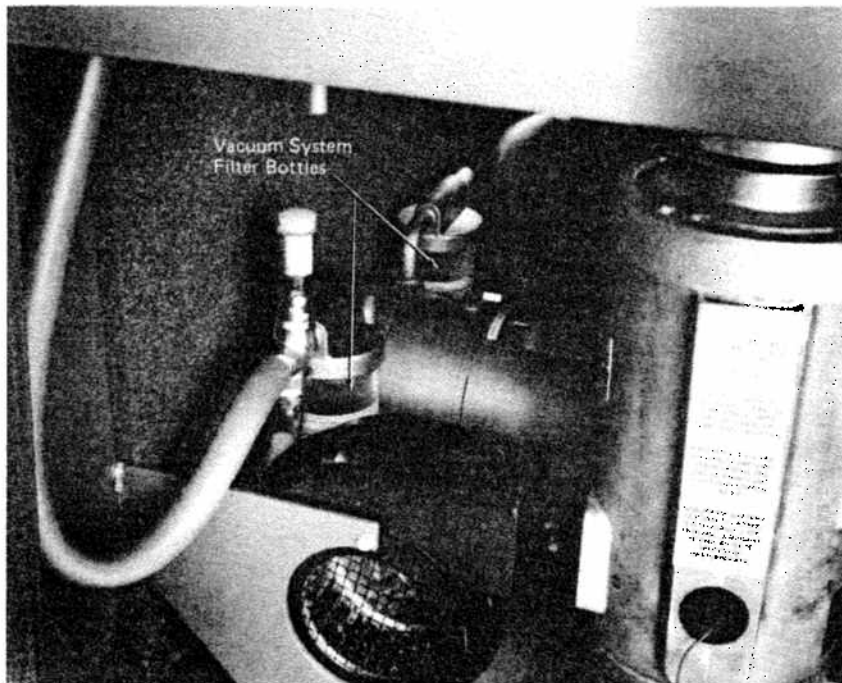


Figure 3-1. The Vacuum Bottles

To gain access to the filter bottles, first unplug the centrifuge. Then remove the front panel by unscrewing the two nuts under the bottom edge of the panel with a 12 mm (7/16 in.) wrench. The bottles are along the side of the centrifuge to the lower left. **DO NOT REMOVE THE BOTTLES FROM THE VACUUM SYSTEM.**

DRIVE BELT REPLACEMENT

WARNING

Ensure that the J2-21 is disconnected from the main power source: either **UNPLUG THE CENTRIFUGE** or, if your centrifuge is hard wired to the wall, turn off and lock out the main wall circuit breaker.

If the chamber door will not open after a run, or a run appears to accelerate unusually fast, the drive belt may be broken. Occasional inspection of the drive system may give you forewarning by revealing a worn belt.

WARNING

If you must retrieve your sample, wait at least 20 minutes before overriding the door latch mechanism. The rotor will be decelerating without a brake.

To replace a worn or broken belt:

1. Unplug the instrument.
2. Take off the front panel by unscrewing the two nuts under the bottom edge of the panel with a 12 mm (7/16 in.) wrench. VISUALLY CONFIRM THAT THE SPINDLE HAS STOPPED TURNING BEFORE PROCEEDING (Figure 3-2).
3. If the belt has broken, find and remove it from the instrument. If the belt is simply worn, push against the motor so that the motor swings to the rear and the spring (Figure 3-2) is extended. This slackens the belt, which then can be removed from the pulleys. Slowly release the motor, allowing the spring to contract and the motor to swing toward you.
4. To reinstall a belt, first fit it around the spindle pulley (Figure 3-2). Keep the serrated surface of the belt to the outside around the pulley. With your left hand hold the belt taut, stretching it toward the motor pulley. With your right hand push the motor back to extend the motor spring, then fit the belt (serrated side out, Figure 3-3) into the groove around the motor pulley. Gradually release the motor, and spring tension will tighten the belt.

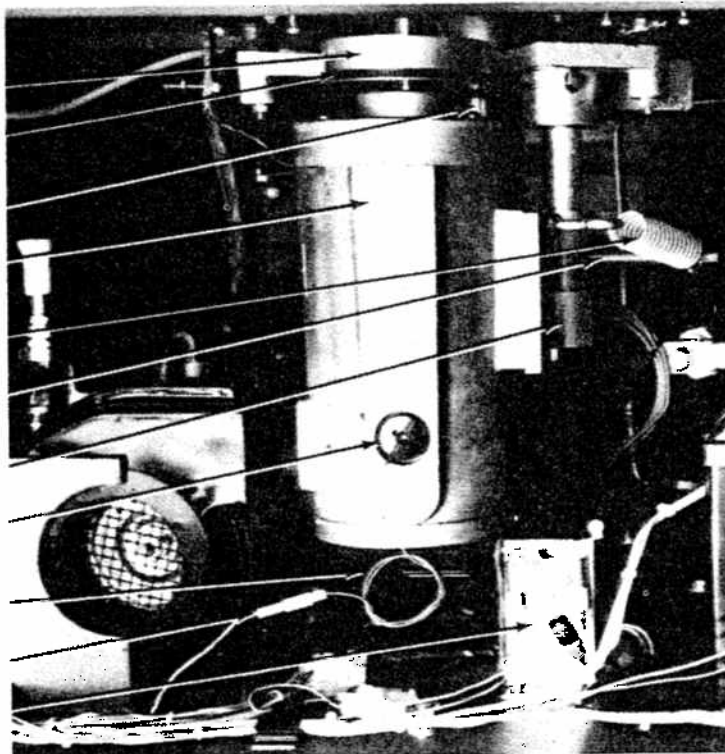


Figure 3-2. Drive System

5. Manually rotate the motor pulley three or four turns clockwise to be sure the belt is in the V-grooves and to be sure the belt is not twisted (it should be flat around the pulleys as shown in Figure 3-3). Install the front panel, plug in the instrument, and make a brief test run (accelerate to speed, then decelerate) to verify that the instrument functions normally. It is not necessary to use a rotor for this test run.

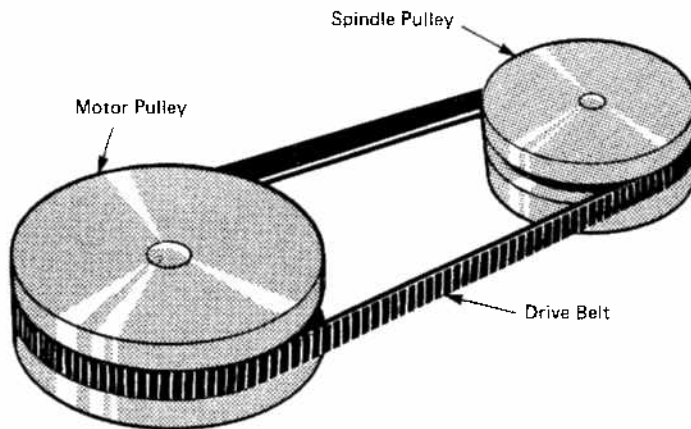


Figure 3-3. Drive Belt Properly Installed

DRIVE MOTOR BRUSH REPLACEMENT

WARNING

Ensure that the J2-21 is disconnected from the main power source: either **UNPLUG THE INSTRUMENT** or, if your instrument is hard wired to the wall, turn off and lock out the main wall breaker.

A brush warning light on the control panel signals the operator when the two drive-motor brushes need replacing. Both brushes, the wired brush and the unwired brush, must be replaced at the same time. It is not necessary to abort a run that will take less than eight hours of additional centrifuge time. However, Beckman recommends changing the brushes at the end of this run.

CAUTION

Complete replacement of the motor will be necessary if the centrifuge is operated for a significant time after the brush light has come on.

Unplug the instrument, remove the two nuts along the bottom edge of the front instrument panel and set the panel aside. Following Step 3 above, remove the drive belt. Then raise the motor (it weighs 11 kg, or 23 lb) with one hand and pull out the support rod (Figure 3-2). Grasp the motor mounting bracket and lower the motor gently to the floor. Then:

1. To replace the wired brush, disconnect the purple brush wire by grasping the two halves of the plastic connector (Figure 3-2) and pulling the halves

apart. **DON'T PULL ON THE WIRE.** Remove the brush from the motor by unscrewing the brush cap counterclockwise with the tool provided in the new brush kit (Supply List). Remove the old brush assembly (and wire) from the holder (Figure 3-4). The worn end of the wired brush will show copper if the brushes are worn out.

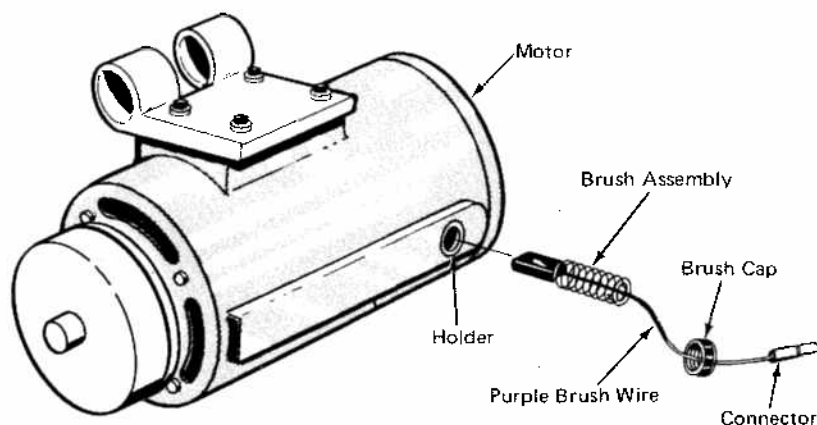


Figure 3-4. Removing the Wired-Brush Assembly for Replacement

2. Install the new wired-brush assembly and cap in the holder. Reassemble the brush-wire connector. Use the tool (Step 1) to tighten the cap firmly into the holder, ensuring good electrical contact. Be careful not to damage the wire.
3. The unwired brush is on the opposite side of the motor from the wired brush. Remove and replace the unwired-brush assembly and cap in the same manner as above.
4. Reverse the motor removal procedure to reinstall the motor. Make sure the support rod is pushed all the way in, or vibration could dislodge the motor.
5. To complete the installation, reinstall the drive belt (Steps 4 and 5 of DRIVE BELT REPLACEMENT above). Reinstall the front instrument panel. When power has been restored to the centrifuge and the POWER switch is turned ON, the brush indicator light should remain off.
6. *With no rotor in the centrifuge*, run the centrifuge at 15 000 rpm for as long as possible up to 8 hours (run at *least* 30 minutes) to make sure that the new brushes are properly seated. Failure to run-in the brushes will lead to very short brush life and the possibility of significant motor damage.

SPEED CONTROL CALIBRATION

A special feature of the J2-21 is the accessibility of the speed-control circuit board. Adjustment of the calibration circuit on this board allows a qualified, trained person to double-check and correct the RPM readout of a centrifuge. No other test equipment is required. However, the centrifuge may need to be moved, since the board is on the back of the control panel.

WARNING

This procedure involves exposure to electrical and mechanical hazards and should be performed only by qualified, trained personnel.

To calibrate, remove the four screws holding the black plastic cover on the back of the control panel. Set the cover aside. The speed control board (Figure 3-5) will be visible.

1. With the POWER switch ON, adjust the tachometer (RPM meter) to zero by turning the small screw just below the RPM meter face. Tap the panel gently as the screw is turned.
2. Push the RUN-CAL toggle switch in the upper right corner of the speed control board to the CAL position. This connects the power-line signal to the tachometer,* which should now read 15 100 rpm on a 60-Hz centrifuge, or 12 600 rpm on a 50-Hz centrifuge. If the meter reading is inaccurate, again tap the control panel just below the meter. If this does not correct the reading, adjust the potentiometer labeled R103 TACH with a screwdriver until the tachometer reads correctly (clockwise for a higher reading, counterclockwise for a lower reading).

Now switch the toggle back to RUN.

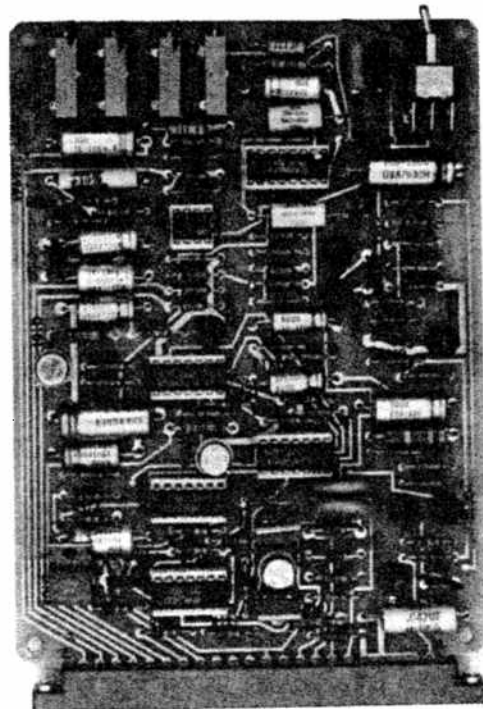


Figure 3-5. Speed Control Board

3. Set the speed dial for 1000 rpm and the timer on HOLD, then start the instrument. (The chamber door must be closed, but a rotor is not required.) The tachometer should control to within 200 rpm of the set speed. If it does not, adjust the R102 LO SP potentiometer on the board to correct the meter reading (clockwise for a higher reading, counterclockwise for a lower reading).
4. Turn the speed control dial to 15 000 rpm. Once the centrifuge has stabilized at 15 000 rpm, SLOWLY turn the dial up to 20 000 rpm. (If the instrument shuts down, you turned the dial too fast. To restart the high-speed calibration, simply turn the speed dial down and push the START button.) When the RPM meter has stabilized at 20 000 rpm, it should continue to read within 200 rpm of the set speed. If it does not, adjust the R101 HI SP potentiometer too.

*The calibration circuit converts the power-line frequency (60-Hz or 50-Hz) to pulses (two pulses per cycle) and substitutes these for the motor pulses normally sent to the tachometer. Since the drive spindle and tachometer turn and read out (respectively) 2.1 revolutions for every signal pulse and the meter readout is in rpm, the following conversion is accomplished:

$$\begin{aligned} 60 \text{ Hz} &= 60 \text{ cycle/s} = 120 \text{ pulse/s} \\ 120 \times 2.1 &= 252 \text{ revolution/s} = 15\,120 \text{ rpm} \\ 50 \text{ Hz} &= 50 \text{ cycle/s} = 100 \text{ pulse/s} \\ 100 \times 2.1 &= 210 \text{ revolution/s} = 12\,600 \text{ rpm} \end{aligned}$$

5. Repeat Steps 3 and 4 until both readouts are correct to within 200 rpm.
The speed control is now fully calibrated
6. Turn off the power and replace the rear housing cover.

CLEARING THE AIR INTAKE

The airflow bracket on the back of the centrifuge ensures that cooling air will be available to the centrifuge during operation. Efficiency of the refrigeration cooling system, however, may be seriously reduced by a buildup of dirt, dust, or blown papers on the intake. A filter bracket and a disposable filter are provided to keep the intake clean. Replace the filter as necessary. The first change of the filter is simply to turn it around so that the unexposed end is over the air intake. For the next change the filter is discarded and any commercially available filter (about 400 x 600 mm or 16 x 25 in.) that covers the intake may be substituted. The filter may require changing as often as once a month.

Operators who do not use the disposable filter should vacuum or brush the air intake clean every one to three months, depending on instrument use.

SYSTEM CHECK TEST RUN (Optional)

You will need a rotor, a thermometer, and a watch for the test run. Use your highest-speed J-21 series rotor. The systems to be checked are speed control, braking, and temperature control, in that order. See TROUBLE-SHOOTING if a system does not check out as normal.

1. Using the OVERTEMP knob, set the red bar of the temperature meter well above ambient temperature.
2. Turn the POWER switch ON. The power indicator light should come on immediately. The drive blower and cooling system will start.
3. Using the SET knob, set the green bar on the temperature meter to 2°C.
4. From Table 2-1, according to the highest rated speed for your rotor, select the COMP dial setting required to achieve a sample temperature of 2°. Set this on the COMP dial. (This will slightly alter the position of the black indicator needle.)
5. Set the SPEED dial to the maximum rated speed for the rotor being used.
6. Set the BRAKE in the MAX position.
7. Set the timer on HOLD.
8. Install the rotor and load it symmetrically with at least two tubes or bottles containing equal volumes of water. Then secure the rotor.
9. Close the chamber door by lowering it, then pushing down firmly. For safety, the rotor will not start until the door is closed. The door locks when the START button is pushed.
10. CHECK SPEED CONTROL CALIBRATION AND BRAKE CONTROL. Prepare to time the run, then push the START button and begin timing. Note that the START light should come on, and at speed the RPM meter should read within 200 rpm of the setting on the SPEED dial. Record the time required to accelerate to speed. The acceleration time should be approximately the same as that given in the rotor specifications in the rotor bulletin. The vacuum pump starts when the timer is turned on. Check that the vacuum meter readout is in the green sector of the meter. To check braking, turn the timer off and measure the length of time the STOP button is illuminated. This elapsed time should be approximately the same as the deceleration time given in the rotor specifications in the rotor bulletin.
11. CHECK TEMPERATURE CONTROL. Precool the rotor and chamber: set the SPEED dial to 2000 rpm, set the timer on 20 minutes, and push the START button. After 20 minutes, when the STOP light has gone out, reset the SPEED dial to the maximum rated rotor speed. Set the timer on 60 minutes and push the START button. After one hour, when the STOP light has again gone out, open the chamber door, precool the thermometer by immersing the bulb in one of the water-filled tubes, then record the temperature of the second tube. The temperature should be 2° ± 2°.

If any checks cannot be completed as described and the troubleshooting methods below do not correct the problem, call your Beckman Field Service Representative.

TROUBLESHOOTING

If the answer to a particular problem cannot be found here, customers should call their local Beckman Field Service Representative.

Observed Problem	Suggested Action
1. The run shuts down unexpectedly.	<ul style="list-style-type: none"> a) If the IMBALANCE light is on, rebalance the load, check rotor position on hub, or check the leveling of the instrument. b) If the OVERTEMP light is on and the black-needle temperature indicator is below 45°, the run can be restarted immediately even though the rotor is still turning: to restart, <i>first</i> turn the POWER switch OFF, <i>then</i> reset the red bar on the temperature meter to the right of the black needle; <i>finally</i>, turn the POWER switch back ON. Follow this order exactly. If you try to reset the overtemp bar before turning the power off, you will have to wait for the rotor to brake to a stop before restarting the run. c) If the OVERTEMP light is on and the black temperature needle is to the right of the red OVERTEMP bar or indicates about 45°C, call your Beckman Field Service Representative. d) If the SPEED dial is set fully counterclockwise, the run will shut down automatically. e) If the POWER switch is ON but the light is out, check the power supply to the instrument. f) If the POWER switch is OFF, reset to ON. If this causes it to switch OFF again, call your Beckman Field Service Representative. g) Possible low voltage. Have line voltage measured, with the instrument unplugged. Is the instrument wired for the measured line voltage?
2. RPM meter does not indicate (drive inoperable).	<ul style="list-style-type: none"> a) Is the instrument plugged in? Is the POWER switch (and light) ON? b) Is the timer properly set? (see Chapter 1) c) Is the OVERTEMP light on? If it is, see suggested action 1-b or 1-c above. d) If the chamber temperature is above 45°, you must let the instrument cool before using. e) Check hub movement by trying to rotate the drive hub by hand. If it does not turn smoothly, the drive spindle or motor is inoperable: call your Beckman Field Service Representative. f) UNPLUG THE CENTRIFUGE and check for worn-out drive brushes even though the brush light may not be lit.

[continued]

Observed Problem	Suggested Action
3. Chamber door will not open.	a) Note that the centrifuge must be plugged in, the POWER switch must be ON, and the timer must be OFF, before the centrifuge chamber door can be opened. To open the chamber door, first press down on the door handle (to release the latch pin, see Chapter 1), then lift the door open. b) If a run has shut down and the STOP light has gone out, see Figure 1-1 and the Door Operation section to gain access. Then UNPLUG THE CENTRIFUGE and check to see if the drive belt has broken.
4. Vibration at low speed.	a) Normal, in the Critical Speed Range. b) Check to be sure the rotor hold-down knob is tight. c) Check rotor load symmetry and balance, or instrument leveling.
5. Excessive fluctuations of rotor speed (during acceleration or at running speed).	UNPLUG THE CENTRIFUGE and check drive belt position and condition. Belt should be taut under spring load.
6. Rotor does not accelerate to set speed.	a) Check to be sure the VACUUM gauge reads in the green sector during a run. b) Tap RPM meter (to release needle if stuck). c) UNPLUG THE CENTRIFUGE and even though the brush light may not be lit, check for worn-out brushes (copper shows on the worn-out wired-brush surface). d) Wipe up any excess water in the chamber. e) Check the speed control calibration
7. Chamber is cold, but rotor is warm.	a) Make sure you used the right COMP dial setting (see Table 2-1). b) Check to be sure the VACUUM gauge reads in the green sector during a run.
8. Run timer shuts off early.	a) Was the timer properly set? (see Chapter 1) b) Is there an audible click just as the timer turns to zero? If not, call your Beckman Field Service Representative to reposition the knob.
9. Rotor is stuck on hub.	a) Wet rotor may have been placed on cold hub, and has frozen in place. Thaw apart at room temperature. b) Spinkote was not applied to centrifuge drive spindle before installation. Use the T-bar carrying handle (see Supply List) to remove rotor.
10. Brush indicator light is on.	UNPLUG THE CENTRIFUGE and replace brushes prior to further operation.
11. Burning smell from instrument.	a) Disconnect the instrument from the power source. b) Is the drive belt taut? c) Check hub movement by trying to rotate the drive hub by hand. If it does not turn smoothly, call your Beckman Field Service Representative.

SUPPLY LIST

ACCESSORIES NOT SHIPPED WITH CENTRIFUGE

Silicone Vacuum Grease	335148
Rotor Cleaning Kit	339558
Rotor T-bar Carrying and Removal Handle . . .	338896
Removal Handle Collar	338689
Tubes, Bottles, and Adapters	See Appendix
Zonal Key/Lock Switch	885106
Spinkote lubricant	306812

REPLACEMENT PARTS

Outside Stoppers for Chamber Ports	870068
Stoppers for Inside Chamber Ports	004422
Drive Brush Kit	334993
Drive Belt	878821
Fuse (0.25 ampere TD)	015101
Fuse (20 ampere)	878427
Lamp (START and STOP switches)	029726
Speed Control Board (338941); exchange . . .	329416

J2-21 CENTRIFUGE WARRANTY

Subject to the exceptions and upon the conditions specified below, Beckman agrees to correct, either by repair, or, at its election, by replacement, any defects of material or workmanship which develop within one (1) year after delivery of the Model J2-21 Centrifuge (the product), to the original Buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman discloses that such defect developed under normal and proper use.

Some components and accessories by their nature are not intended to and will not function for one (1) year. If any such component or accessory fails to give reasonable service for a reasonable period of time, Beckman will repair or, at its election, replace such component or accessory. What constitutes either reasonable service and a reasonable period of time shall be determined solely by Beckman.

Any product claimed to be defective must, if requested by Beckman, be returned to the factory, transportation charges prepaid, and will be returned to Buyer with the transportation charges collect unless the product is found to be defective in which case Beckman will pay all transportation charges.

Beckman makes no warranty concerning products or accessories not manufactured by it. In the event of failure of any such product or accessory, Beckman will give reasonable assistance to the Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

Beckman shall be released from all obligations under all warranties either expressed or implied, if the product covered hereby is repaired or modified by persons other than its own authorized service personnel, unless such repair by others is made with the written consent of Beckman, or unless such repair in the sole opinion of Beckman is minor, or unless such modification is merely the installation of a new Beckman plug-in component for such product.

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND THAT BECKMAN SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER ARISING OUT OF THE MANUFACTURE, USE, SALE, HANDLING, REPAIR, MAINTENANCE, OR REPLACEMENT OF THE PRODUCT.