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CIRCUIT BREAKER	Supplies main power to the instrument and protects against circuit overloads. The circuit breaker is rated at 30 amps 208 or 230 VAC and will trip open if a current in excess of its rating is drawn by the instrument.
TIMER	Controls the duration of time up to two (2) hours and automatically shuts down the centrifuge motor. Tests to be run in excess of two (2) hours require use of the timer Hold mode which will not automatically shut down the centrifuge motor.
OVERSPEED RELAY	This is a single-pole, single-throw (SPST) normally closed contact relay which will energize if the motor speed reaches 20,400 RP M. When energized the centrifuge motor will automatically shut down.
TACHOMETER INDICATOR	Visual indicator of the actual rotor speed.
SPEED CONTROL	Varies the speed of the motor from 0 RPM to maximum (depending on rotor being used). 115 VAC input is rectified to a 0 - 90 VDC output which is fed to the saturable reactor.
KSB RECEPTACLE	115 VAC is supplied to this receptacle for use with the KSB Automatic Safety Valve.
TACH TRIMMER	Varies the voltage from the tachometer generator to the tachometer indicator. It is used in conjunction with an external tachometer indicator during calibration.
MAIN PILOT LIGHT	When lit indicates power is on to the instrument.
HOLD PILOT LIGHT	The temperature in the evaporator chamber will be maintained at the preset value of the Blue temperature pointer with the rotor stationary.
RUN PILOT LIGHT	The temperature in the evaporator chamber will be maintained at the preset value of the Red run temperature pointer while the rotor is spinning.
CENTRIFUGE PILOT LIGHT	When on it indicates power has been applied to the speed control and motor.
COMPRESSOR PILOT LIGHT	This is the unmarked light on the control panel that indicates the state of the compressor. This light is controlled by the microswitches in the Partlow controller.
PARTLOW CONTROL	Temperature controller unit for the refrigeration system. Cycles the compressor on and off as required.

UPPER HART RELAY	Main circuit hold relay. Used to transfer temperature controller from Hold to Run modes. Energizes lower Hart Relay.
LOWER HART RELAY	When energized applies power in the centrifuge motor and when de-energized applies the DC brake.
COMPRESSOR RELAY	When energized by 115 VAC from the Partlow control, it will turn on the compressor.
STOP SWITCH	A normally-closed contact switch used to stop the centrifuge motor.
START SWITCH	Normally open contact momentary switch. When depressed supplies power to both Hart Relays, Partlow Control, etc.
TORQUE TRIMMER	Limits the instantaneous starting current to the motor to a safe valve.
80 MFD CAPACITOR	Used to smooth out the DC voltage in the speed control circuit.
BRAKE SWITCH	When in the ON position supplies 115 VAC to the Brake transformer.
BRAKE TRANSFORMER	A stepdown transformer from 115 VAC to 10-12 VAC.
BRAKE RECTIFIER	Used to convert 10-12 VAC to 8-10 VDC.
SATURABLE REACTOR	Controls the amount of current supplied to the centrifuge motor. A voltage of 0-90 VDC across the DC coil of the reactor, varies the current and voltage thru the reactor to the motor.
FAN RELAY	Allows for continuous operation of the condensing fan independent of the state of the compressor for better cooling.
CONDENSING FAN	Used to remove heat from the high pressure gas flowing thru the condensing coils.
COMPRESSOR	Pumps the Freon gas out of the evaporator into the compressor cylinder where it is compressed by the pistons. It is then delivered thru the discharge tube as a gas under pressure to the condensor where accumulated heat is released to the air.
TACH GENERATOR	An AC voltage generator (approximately 1.5 VAC/1,000 RPM) used in conjunction with the tach trimmer and tach indicator to show motor RPM. A permanent magnet rotating within a fixed coil of wire generates the AC voltage.

TEMPERATURE LIMIT SWITCH	This switch will open up shutting down the centrifuge motor if an overtemperature condition occurs.
MOTOR	A high torque motor with a full load speed of 20,000 RPM.
AUTO TRANSFORMER	A stepdown transformer used to reduce the 230 VAC input to 115 VAC for the control circuit.
CIRCUIT BREAKER (4 amps)	Protects the 115 VAC control line to the instrument.
BRAKE RESISTOR (cone 100 watt)	Provides a load across the motor armature during the braking cycle.
BRAKE RESISTOR (.2 ohm)	Utilized during braking at high RPM.
COMPRESSOR START RELAY	When de-energized the relay switches in the compressor motor start winding and automatically switches it out when the motor is at running speed.
COMPRESSOR OVERLOAD (klixon)	Will automatically shut off the compressor if a temperature in excess of 210°F is reached, or if an excessive current is being drawn by the compressor.
START CAPACITOR	An initial voltage boost to the compressor motor to overcome the high internal head pressures.
RUN CAPACITOR	Helps overcome the high torque on the compressor motor during the run cycle.
MOTOR BRUSH ALARM	When the motor brushes have worn to a length of 5/8" or shorter, the centrifuge pilot light will begin to flash indicating replacement of the motor brushes is required.

SERVICE MEMO NO. 201
JANUARY 25, 1971

SAFETY BULLETIN

SUBJECT: RC-2B, Serial No. 70600 and above
RC-3, Serial No. 71800 and above

The subject instruments have the new type control switch for turning on the centrifuge. This switch, however, does not turn off the entire instrument. With the switch in the OFF position, there is still 208 volts AC at the compressor terminals and at various points throughout the centrifuge. If the mercury relay sticks in the energized mode, the compressor will continue to operate even if the control switch is turned off.

Exercise care when working on these instruments since voltage is still present when the control switch is off.

GENERAL SPECIFICATIONS

SPECIFICATIONS

- Line Voltage

  208/230 VAC 60 Hz 25 AMPS (no buck/boost transformer required)

  220 VAC 50 Hz

- Current ratings and maximum speeds - SS-34 17,500 RPM
  9.5 - 10 AMPS

  GSA 9000 RPM

- Braking time - SS-34 17,000 RPM - 0 RPM Approx. 4 minutes

- Refrigeration system performance test - SS-34 1-hr run @ 17,000 RPM

  Refrigerant F12
  Ambient temperature +25°C
  Temperature run control set point -3°C
  Final tube temperature 0°C
  Condensing unit gauge readings
  High side 117 psi
  Suction side 0-2 psi
  Current draw 5.2 - 5.5 amps

- Maximum RPM

  SS-34 - 17,500 RPM

  SM-24 - 16,000 RPM

  GSA - 9,000 RPM

  HB-4 - 10,000 RPM

- Mechanical Dimensions

  See RC-2B next page

GENERAL SPECIFICATIONS

- Current Specifications
  - 30 amps or less. . . . . .Overall current draw during acceleration
  - 17 amps. . . . . .Maximum motor current draw during acceleration
  - 10 to 12 amps. . . . . .Compressor current draw after pressures have stabilized.
- Refrigeration
  - Refrigerant. . . . . .R502 Freon
  - System operating pressures at 25°C ambient. . . . . .190 - 225 psi high side
    9 - 12 psi low side

    Note: Operating at 20,000 rpm with SS-34 rotor.
- Heat Output during Operation
  - Average. . . . . .10,000 BTU/hr. (2.9 KW)
  - Maximum. . . . . .20,000 BTU/hr. (5.8 KW)

    Note: Heat output subject to rotor used and operating speed.
- Mechanical Dimensions
  - Height . . . . . .114 cm (45 inches)
  - Depth. . . . . 93 cm (32.5 inches)
  - Width. . . . . 76 cm (30.0 inches)
- Line Voltage

  208 VAC 60 Hz (boost transformer required)
  230 VAC 60 Hz (no buck/boost required)
  220 VAC 50 Hz (no buck/boost transformer required)
- Braking Time - SS-34 rotor

  20,000 → 0 RPM approx. 3 mins.
- Max. RPM

SS-34.	20,000	HB-4	13,000
GSA.	13,000	HS-4	7,000
SM-24.	20,000	GS-3	9,000
SE-12.	20,000		

RC-2B CHANGES

Start of RC-2B, Serial No. 64000

Cabinet No. 64267	Hart Relay (60607) replaced with Mercury Relay (61851) to control refrigeration system. All lower panels were replaced in the field at no charge to users. Some early units may still have Hart relay.
Cabinet No. 65500	Added Fan Relay to refrigeration electrical controls. This was done to keep condensing fan running continually to help cool compressor whenever the centrifuge drive is in operation.
Cabinet No. 67200	Motor Armature and field wire size has been changed. Motor nameplates on new units stamped 20443-11. Parts not interchangeable with earlier model RC-2B centrifuge motors.
Cabinet No. 68200	Replaced outlet cord to conform with approved standard configuration.
Cabinet No. 69550	Added brush warning control system to RC-2B Centrifuge. Pilot light will blink and circuit breaker, mounted on board below motor, will open when brushes are worn to their limit. Kit available for earlier units.
Cabinet No. 69585	Partlow control modified to cut centrifuge drive off whenever temperature rises 4-1/2°C above blue (hold) pointer setting. Partlow J 602.
Cabinet No. 69300	New condensing unit now being used. Tecumseh Model AH 2511 JS.

RC-2B ACCELERATION TIME (SECONDS)

208v 60Hz

PPM	SE-12	SS-34	HB-4	SM-24	GSA	HS-4	GS-3
1,000	1.3	2.9	2.7	3.3	7.6	13.3	21.4
2,000	2.9	5.9	6.1	6.8	18.2	28.0	43.3
3,000	4.3	9.3	9.8	10.7	28.9	44.0	65.3
4,000	5.7	12.6	13.8	14.4	42.9	61.3	88.7
5,000	7.2	15.7	18.2	18.5	35.9	80.0	114.0
6,000	8.5	19.0	22.6	22.7	72.4	102.7	141.3
7,000	10.0	22.5	27.7	26.7	88.4	176.7	173.3
8,000	11.5	25.7	33.0	30.7	105.9		212.7
9,000	12.9	28.9	39.3	34.8	124.4		296.0
10,000	14.4	32.3	46.6	38.8	146.2		
11,000	15.9	36.3	56.2	43.9	176.0		
12,000	17.5	40.2	70.7	49.0	216.9		
13,000	19.2	44.6	106.0	54.7	291.6		
14,000	20.8	49.1		61.1			
15,000	22.6	54.3		67.7			
16,000	24.6	60.3		75.5			
17,000	26.8	67.3		85.1			
18,000	29.3	75.8		98.0			
19,000	32.1	87.4		117.8			
20,000	47.6	134.6		177.1			

SORVALL® RCF CHART

Relative Centrifugal Forces (in g) for RC-2, RC-2B, RC-5, RC-5B Sorvall® Superspeed Centrifuge Rotors

The table below gives the maximum RCF in g for all currently available Sorvall® rotors for superspeed applications (up to 20,000 rpm). To find the average or minimum RCF, consult your rotor's instruction manual for the average or minimum radius, and use the formula given at the bottom of this page.

Speed, rpm	SS-34	SM-24 (inner row)	SM-24 (outer row)	SE-12	SV-288	TZ-28	SV-80	SA-600	GSA	HB-4	GS-3	HS-4 with 250-ml Bucket	RCF (g) for 2.54-cm (1-in) radius
500	30	25	31	26	25	27	28	36	41	46	42	48	7
1000	119	101	123	104	100	106	113	144	162	164	169	192	28
1500	268	228	278	234	226	239	255	325	366	371	300	432	64
2000	478	406	494	416	403	426	453	579	650	659	676	769	114
2500	746	635	772	651	629	665	709	904	1017	1031	1056	1202	177
3000	1075	914	1112	937	906	958	1021	1302	1464	1484	1521	1731	255
3500	1464	1245	1514	1276	1234	1304	1390	1773	1993	2021	2070	2356	348
4000	1912	1626	1978	1667	1612	1703	1815	2316	2603	2639	2704	3077	454
4500	2420	2058	2503	2110	2040	2155	2298	2931	3295	3340	3422	3895	575
5000	2987	2541	3091	2605	2518	2661	2837	3619	4068	4124	4225	4008	709
5500	3615	3074	3740	3152	3047	3219	3432	4379	4923	4990	5112	5818	858
6000	4302	3659	4451	3751	3627	3831	4085	5211	5858	5939	6084	6924	1021
6500	5049	4294	5224	4403	4256	4496	4794	6116	6876	6970	7140	8126	1199
7000	5856	4980	6058	5106	4936	5215	5560	7093	7974	8084	8281	9425	1391
7500	6722	5717	6955	5862	5667	5986	6383	8142	9154	9200	9506		1596
8000	7649	6505	7913	6669	6448	6811	7263	9264	10410	10550	10810		1816
8500	8635	7343	8933	7529	7279	7689	8199	10450	11750	11910	12210		2050
9000	9681	8233	10010	8441	8161	8620	9192	11720	13180	13360	13680		2299
9500	10780	9173	11150	9405	9092	9605	10240	13060	14680	14880			2561
10000	11950	10160	12360	10420	10070	10642	11340	14470	16270	16490			2838
10500	13170	11200	13630	11480	11100	11733	12510	15960	17940	18180			3129
11000	14460	12290	14960	12610	12190	12877	13730	17510	19690	19960			3434
11500	15800	13440	16350	13700	13320	14075	15000	19140	21520	21810			3753
12000	17210	14630	17800	15000	14500	15325	16340	20840	23430	23750			4087
12500	18670	15880	19320	16200	15740	16629	17700	22610	25420	25770			4434
13000	20190	17170	20890	17610	17020	17986	19170	24460	27500	27880			4796
13500	21780	18520	22530	18990	18360	19396	20680	26380					5172
14000	23420	19920	24230	20420	19740	20859	22240	28370					5561
14500	25120	21370	25990	21910	21180	22376	23860	30430					5967
15000	26890	22870	27820	23440	22660	23946	22553	32570					6386
15500	28710	24420	29700	25030	24200	25569	27260	34770					6818
16000	30590	26020	31650	26670	25790	27245	29050	37050					7265
16500	32530	27670	33660	28370	27430	28974	30890	39410					7726
17000	34540	29370	35730	30110	29110	30757	32790	41804					8202
17500	36600	31120	37860	31910	30850	32593	34750	44300					8689
18000	38720	32930	40060	33760	32640	34482	36760						9195
18500	40900	34780	42310	35660	34480	36424	38840						9713
19000	43140	36690	44630	37620	36370	38419	40960						10245
19500	45440	38650	47010	39620	38310	40468							10788
20000	47800	40650	49460	41680	40300	42570							11349

To calculate the RCF for a rotor not shown above, simply multiply the radius by the RCF value given for a 2.54-cm (1-in) radius at the desired speed. This is the last column of RCF values in the table above.

To calculate the most exact value of RCF at any speed for any given radius, use the RCF equation:

$RCF = 28.38R \left(\frac{rpm}{1000}\right)^2$ where R = radius in inches

$RCF = 11.17r \left(\frac{rpm}{1000}\right)^2$ where r = radius in centimeters

DUPONT COMPANY • BIOMEDICAL PRODUCTS DIVISION • WILMINGTON, DELAWARE 19898 • U.S.A.

Sorvall® Centrifuges

DUPONT

RC-2/2B/3/5

SPECIFICATIONS - SATURABLE REACTOR

Winding Resistance

Primary ≃ 0.5 Ω (Terminals 1 & 4)

Secondary ≃ 400 Ω (Terminals 2 & 3)

Voltage Across Control Winding (Terminals 2 & 3)

80 vdc	Accelerating
50 vdc	Controlling @ 17,000 RPM

RC-2

ENGINEERING GUIDE LINE

OPERATING LIFE OF BRUSHES AND COMMUTATOR OF W-2 MOTOR IN RC-2 @ 17000 w/34 ROTOR

1. Note that operating life in any single instance is hard to pin down. It will be spread over a range of hours and still be entirely normal. See explanation below. Within sensible statistical limits (80%) then

   (a) Brushes should last 75 to 150 hours with an average @ 100 hours.
   (b) Commutator should last between turnings through two sets of brushes. Provided brushes are properly replaced.

2. Explanation:

   (a) Some brushes will fall short of 75 hours and others exceed 150 hours -- about 10% on each end -- due to manufacturing problems (composition, fit, bearing runout, commutator quality etc.), application problems (dusty atmosphere, high humidity, improper edge preparation, etc.) and mysterious causes.
   (b) Proper replacement of a brush is not as straight forward as it may sound.

   The following points make considerable difference in performance and hence operating life.

      (1) Pigtail uncoiled so that spring is at maximum extension to insure adequate pressure for following commutator as brush wears.
      (2) Short edges of brush bevelled so that new brush will fit into existing commutator groove to make satisfactory contact. 1 or 2 even strokes with file.
      (3) Brush run-in adequately to prepare surface completely. This is very important. The brush comes as moulded -- nominally concave. To wear to commutator shape takes, say 1% of brush wear length, If brush is good for 75 hours min. @ speed, this means 0.75 hours run-in at speed. But since we don't want high current density in the picture at run-in, we must either remove the centering assembly and run at speed with no load (centering assembly requires rotor in place) or run with rotor at reduced load -- say 8000 RPM so that in current demand the motor is just "moseying along". Since surface velocities are directly proportional to RPM, the time for comparable run-in at 8000 RPM must be increased by 17,000/8,000 or 2-1/8. A proper run-in at 8,000 RPM must be increased by 17,000/8,000 or 2-1/8. A proper run-in time at 8,000 RPM, then is just about 2 hours.

A final word of advice, based on experience and logic, is that if brushes are changed properly early, say at 75 hours, one might get 3 brush changes between commutator turnings.

MINIMUM COMMUTATOR DIAMETER SPECIFICATION

The question of servicing drive motors returned to Sorvall for repair has arisen many times as to the minimum diameter the commutator can be resurfaced to still insure safe operation at operational speeds of the equipment. The list that follows is our servicing for motors.

INSTRUMENT	MINIMUM COMMUTATOR DIAMETER
RC-2	1.230 inches
RC-2B/5/5B/5C	1.500 inches

The mica insulation between commutator segments should be .020 - .030 below the turned diameter each time the commutator is resurfaced.

PRE-LOADING PROCEDURE

RC-2B & RC-5 MOTORS (RC-3600)

APPLICABLE TO: Assembly of RC-2B motor and RC-5 motor (RC-3600)

PURPOSE: Establish correct axial pre-load on bearings.

GENERAL: To obtain proper axial pre-load on bearings, loading spring (P/N - 61434) must be compressed from unload height of .125 to .062. In assembly this compression may require shims at upper end, depending on tolerance build-up of motor parts. No shims are ever used at lower (commutator) end.

PROCEDURE: (1) Assemble motor completely except for loading spring and upper end cap. Place motor in upright (operating position).

(2) Using depth gauge, measure depth "D" of outer race of bearing with respect to surface "A" of upper end bell (see sketch below).

(3) Subtract 0.262 from depth "D". Call the difference the "excess gap."

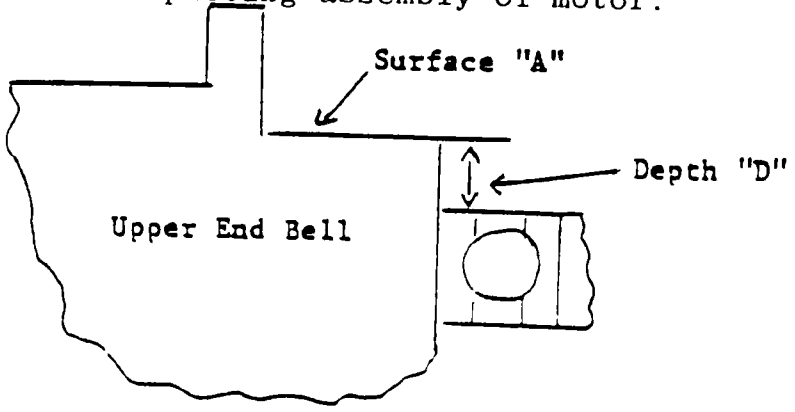
(4) Use minimum total number of shims with a combined thickness equal to or as close as possible to the excess gap. Available shims are:

RC-2483 = .008" thick *
RC-2509 = .020" thick
RC-2510 = .040" thick

* After parts in stock are used up, this shim will be .010" thick.

(5) It is possible (but with low probability) that the depth "D" will measure less than 0.262".

When this happens, use no shims. If this "negative gap" is more than 0.015" (i.e., if "D" measures 0.247 or less) notify Engineering Department before completing assembly of motor.



INSTRUCTION MANUAL

FOR THE

SORVALL RC2-B

AUTOMATIC SUPERSPEED

REFRIGERATED CENTRIFUGE

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Issue Date: 3/77

C A R D I N A L R U L E S O F O P E R A T I O N

for the

S O R V A L L

RC2-B AUTOMATIC SUPERSPEED REFRIGERATED CENTRIFUGE

Be certain the RC2-B has the correct power supply and is located in a well-ventilated area away from heat-producing apparatus.

Operate centrifuge motor ONLY when rotor is in position and properly fastened on the Tapered Spindle, otherwise, damage may result.

Keep the centrifuge clean and defrosted.

Keep the rotors clean and dry.

Pre-cool rotors before clamping on spindle.

Do not change or adjust factory-set controls of valves without authorization from *IVAN SORVALL, INC.* Warranty will be void if such settings are changed.

GENERAL DESCRIPTION

The RC2-B Automatic Superspeed Refrigerated Centrifuge has been designed to provide a maximum of convenience, reliability and versatility with a minimum of care and maintenance. Running on a pre-selected program, the RC2-B will automatically accelerate, run at the selected speed for the timed period, decelerate and stop, without further attention by the operator.

CENTRIFUGE SYSTEM

The RC2-B uses a *SORVALL* designed and manufactured motor with automatic programmed acceleration and braking. The motor is balanced to ensure smooth, quiet operation over its full speed range and to promote long life for the brushes and bearings. The patented *SORVALL-BLUM* "Gyro-Action" Self-Centering Drive, known for its smooth action, will accept a variety of *SORVALL* rotors.

ROTOR CHAMBER

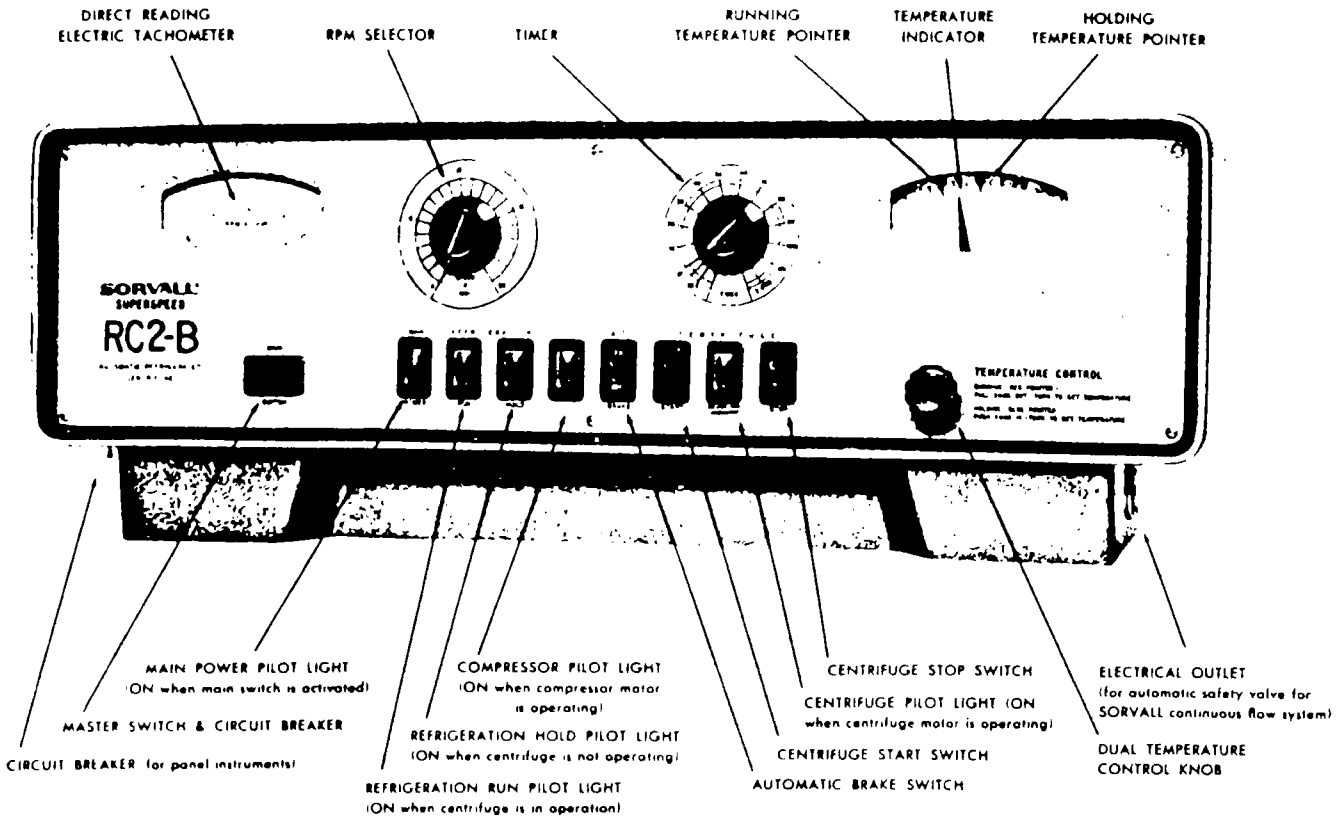
The completely smooth-walled stainless steel envelope-type evaporator rotor chamber eliminates exposed corrodable fin coils, facilitates drainage and permits easy cleaning. The chamber is equipped with a drainage outlet and a leakproof seal around the base of the drive assembly.

REFRIGERATION SYSTEM

Properly adjusted at the factory, and shipped with the valves open, the System, a low-temperature condensing unit consisting of a twin cylinder hermetically-sealed power assembly (motor and compressor), finned condenser and fan, is ready for operation and should require no further adjustment. It is designed to chill and maintain the chamber and its contents at the pre-set level, automatically maintaining rotor temperatures within ±1°C during acceleration, running, deceleration and non-operating cycles. It is suggested that the refrigeration system be left on continuously, making the instrument always ready for operation. Estimated cost for maintaining 0°C is 4 to 5 cents per day in most localities.

CABINET

Finished in corrosion-resistant gray enamel, except for the stainless steel top and front apron, the cabinet incorporates modern design with maximum accessibility. The lower front and side panels and the full back panel are easily removed for servicing.



CONTROL PANEL

Elevated for easy reading and use, the unitized panel is equipped with:

MAIN SWITCH: energizing all the power circuits, the switch is protected by a separate circuit breaker. This breaker is designed to take the momentary impulse of starting, but prolonged overload will activate it. A second circuit breaker protecting the control circuits is located under the control panel overhang on the left hand side.

SPEED SELECTOR: for pre-setting and adjusting speed using the Tachometer as a guide. The *SORVALL* Speed Selector features rapid acceleration to all speeds from 750 RPM to maximum, and will accurately maintain pre-set speed regardless of reasonable fluctuations in line voltage.

TEMPERATURE CONTROL: a Dual Control, with HOLD and RUN positions, described in detail in a following section.

TIMER: driven by a synchronous motor, has a timing range for 0 to 120 minutes. For centrifuge runs longer than the timing range, a built-in "Hold" position is provided.

START AND STOP SWITCHES: these are momentary-contact switches to control the centrifuge motor and will return to their original position when released.

PILOT LIGHTS: left to right indicate a) Main Power on; b) Refrigeration RUN [on when centrifuge is in operation]; c) Refrigeration HOLD [on when centrifuge is not in operation]; d) Compressor CYCLING in operation [this light will go on and off as the refrigeration unit cycles]; e) Centrifuge motor in operation [eventually this light will flash to indicate when Motor Brushes need replacing].

TACHOMETER: indicating actual motor (and rotor) rpm.

DYNAMIC BRAKE: activated [when in the "On" Position] only when the timing interval has expired or the centrifuge "Stop" Switch is pushed. The Dynamic Brake reduces deceleration time by about 50%. When in the "Off" Position, the rotor will "coast" to stop.

ELECTRICAL OUTLET: located under the Control Panel overhang on the right hand side, this outlet is for connecting the Automatic Safety Valve when used with the *SORVALL* "Szent-Gyorgyi & Blum" Continuous Flow System.

INLET AND OUTLET FACILITY

The tubes on the right hand side of the cabinet opening into the rotor chamber are the inlet and outlet facilities for the optional *SORVALL* "Szent-Gyorgyi & Blum" Continuous Flow System. The screw caps on the outside and rubber plugs on the inside protect the connecting tubes from dirt and foreign materials; to create a dead air space to minimize heat leakage and condensation, they should be in place at all times, except, of course, when using the Continuous Flow System.

CHAMBER DRAIN

The drain, used when defrosting the chamber, is sealed during normal operations by a rubber plug within the chamber and a screw cap plug on the outside outlet at the lower right side of the cabinet. The plugs should be in place at all times except when defrosting and cleaning the chamber.

NOISE SUPPRESSION

Included in the RC2-B design is the *SORVALL* "Noisuppressor" which reduces the motor noise level considerably. Non-flammable, sound-absorbing materials are used in this special design, and require no particular care or maintenance.

SAFETY FEATURES

Some features are: protective guard within the cabinet; safety electrical interlocks to limit overspeed (20,000 RPM) and to prevent centrifuge operation at temperatures more than

5°C higher than blue pointer setting; refrigeration system overload relay built into motor; controls whose settings may be changed, intentionally or accidentally, without harm to the centrifuge; elevated Control Panel, easy to reach and read, yet virtually eliminating accidental damage by spillage or dropping of other objects; circuit breakers, described in Control Panel section, protect the individual circuitry of the RC2-B, and are re-settable should a prolonged overload throw either breakers; electrical lock-out prevents operation of motor and damage to armature when motor brushes are too worn.

INITIAL INSTALLATION PROCEDURE

When the RC2-B has been unpacked and removed from its bottom platform, the following details and instructions SHOULD BE READ AND FOLLOWED during the initial installation to insure the proper operation of the instrument.

ELECTRICAL REQUIREMENTS

The RC2-B has been ordered with specific power specifications, and must be connected to the correct supply for proper performance. The nameplate on the back panel of the Centrifuge cabinet will show one of the following classifications:

208 volts, AC, 60 Hz, single phase, 30 amps.*
230 volts, AC, 60 Hz, single phase, 30 amps.*
220 volts, AC, 50 Hz, single phase, 30 amps.*

*Because of the power requirements of this unit (start required 30 amperes at 230 volts; nominal running 25 amperes), it cannot always be used in an existing line circuit. Some electrical wiring codes require that an individual permanent line be installed by a licensed electrician.

The RC2-B is equipped with a three-wire cord with three-prong cap including ground connection to fit Hubbell Receptacle No. 9330 or equivalent. This cord may be changed to meet particular local code requirements: the GREEN wire is the ground, and is connected to the instrument frame.

LOCATION

The positioning of the instrument should be carefully considered. Free air circulation is important for proper functioning. Areas near heat, i.e., heating pipes, radiators, etc. should be avoided; the cooler, more air-swept the location, the better.

Four to six inches minimum clearance from walls and cabinets on all sides should be maintained to allow adequate air circulation. Close grouping of centrifuges or other heat-producing laboratory equipment should especially be avoided, since one will act

as a heat source for another.

Once the instrument has been placed, the LOCKING STABILIZERS, in the front, should be lowered to prevent the unit from moving on its casters. The RC2-B should be leveled for best performance.

OPERATING PROCEDURE

To fully realize the "built-in" convenience and reliability incorporated in the RC2-B, the following procedure should be followed during routine operations.

IMPORTANT

OPERATE CENTRIFUGE MOTOR ONLY WHEN ROTOR IS IN POSITION AND PROPERLY SECURED ON THE TAPERED SPINDLE: OTHERWISE DAMAGE MAY RESULT.

1) Check that Rotor has balanced load, and that it is secured on the Tapered Spindle. (Refer to section "Mounting of Rotors" for specific instructions).
2) Activate Main Switch.
3) Pre-set desired temperature.
4) Pre-set desired time, or use "Hold" position.
5) Pre-set desired speed.
6) Activate "START" Switch

The RC2-B so set up and started, will accelerate to the programmed speed, run for the selected time interval, and then automatically decelerate and stop. In case of power interruption during a run, re-activate the "START" Switch.

At the expiration of the pre-set time period, the RC2-B will automatically stop. If it becomes necessary to stop the motor before the timed period is completed, or if the "HOLD" provision of the timer is being used, simply activate the "STOP" Switch. This, like the "START" Switch, is a momentary-contact type unit, and will return to its original position when released.

Dynamic braking has been included in the circuitry of the RC2-B. Deceleration time from top operating speed is reduced 30 to 50% depending on rotor being used, when the brake is applied. The brake is more effective at higher speeds, and no appreciable advantage is gained for speeds below 3,000 RPM. The switch can be turned on or off at any time during the operating cycle, and with no damage to the circuitry or mechanism of the unit, as the brake will be activated only when the time has expired or the centrifuge "STOP" Switch has been pushed.

After the completion of a run, the braking switch should be placed in the "OFF" position to eliminate the small continuous braking excitation of the centrifuge drive.

Temperature control in the RC2-B is entirely automatic, by pre-setting. This is accomplished by the use of a dual control; one facility is called "HOLDING"; the other "RUNNING".

The dual control feature is necessary because of the variable heat input, due to different size, mass and speeds of the rotors. Thus, one control facility must be available to compensate for this input, while the other must be calibrated in absolute terms of "HOLD" while the unit is at rest.

Instructions to pre-set desired temperatures are noted on the control panel face near the temperature control knob. The blue or "HOLD" pointer is adjusted by pushing in on the control knob and turning; the actual desired temperature is pre-set here. The red or "RUN" pointer is adjusted by pulling on the control knob and turning; this is the one into which a compensating factor must be set.

Note that the temperature indicating needle does not show the temperature of the rotor but indicates the temperature of the air in the rotor chamber. It will vary some 2°C during the centrifuge "RUN" cycle causing a few tenths of a degree corresponding change in rotor temperature. In the "HOLD" condition, the temperature variation will approach 10° with a corresponding rotor temperature change of ±1°C. Actual rotor temperature is found from the chart (page 9) for any given speed and rotor.

Example: For 0°C of the rotor contents of the SS-34 Rotor, at a speed of 15,000 RPM, the "RUN" control (red pointer) must be set at -1½°C. This control is sensitive within ±1°C and for all practical purposes, holds the temperature of the rotor and contents constant during a run. The "HOLD" control (blue pointer) is to be set at the desired 0°C.

To bring the rotor temperature down to the desired level prior to a run, spinning the rotor at low speed (1,000 to 3,000 RPM) for several minutes will hasten cooling because of the increased air circulation.

The Pilot Lights on the control panel describe the functions which are taking place. For the Refrigeration System there are three lights - Run, Hold and Cycle. The first two show which of the control circuits is in operation and the third will turn on and off as the refrigeration system cycles.

When the centrifuging cycle is finished and the rotor starts to decelerate, or the power to the centrifuge motor has been shut off, intentionally or unintentionally, the temperature control will automatically switch to the "HOLD" control which has been pre-set to the temperature desired within the rotor. This temperature will be maintained until the refrigeration system is purposely shut down.

Ambient temperature is understandably a factor insofar as the obtainable temperatures are concerned. The higher the ambient temperature, the higher will be the lowest chamber temperature obtainable, (linear proportionality).

The RC2-B can be pre-set and operated at temperatures from -20°C to +20°C, depending on speed, time duration and rotor used.

ROTOR SPEED/TEMPERATURE DIFFERENTIAL TABLES

The following tables are an approximate guide, indicating the "RUN" Control temperature setting required to maintain +2°C Rotor Temperature.

SS-34 and SM-24 Rotors
For +2°C Rotor Temperature

At RPM	Set "RUN" Temp. Control at:
2,000	+ 3 1/2°
4,000	+ 3 1/2°
6,000	+ 3 1/2°
8,000	+ 3 1/2°
10,000	+ 2 1/2°
12,000	+ 1 1/2°
14,000	+ 1/2°
16,000	- 1/2°
18,000	- 1 1/2°
20,000	- 3 °

SE-12 and SU Rotors
For +2°C Rotor Temperature

At RPM	Set "RUN" Temp. Control at:
2,000	+ 3 1/2°
4,000	+ 3 1/2°
6,000	+ 3 1/2°
8,000	+ 3 1/2°
10,000	+ 2 1/2°
12,000	+ 1/2°
14,000	- 1/2°
16,000	- 1 1/2°
18,000	- 2 1/2°
20,000	- 3 °

GSA Rotor For +2°C Rotor Temperature At RPM	Set "RUN" Temp. Control at:
2,000	+ 3 1/2°
4,000	+ 3 1/2°
6,000	+ 2 °
8,000	+ 1 °
10,000	0 °
12,000	- 1 °
13,000*	- 2 °

* Recommended Top Speed

HB-4 Rotor For +2°C Rotor Temperature At RPM	Set "RUN" Temp. Control at:
2,000	+ 3 1/2°
4,000	+ 3 1/2°
6,000	+ 2 °
8,000	+ 1 1/2°
10,000	0 °
12,000	- 1 1/2°
13,000*	- 2 °

* Recommended Top Speed

To maintain higher or lower Rotor Temperatures, adjust the table accordingly; i.e. to maintain 0°C in the SS-34 Rotor, subtract 2° from each temperature setting: for 0°C at 10,000 RPM, set "RUN" Control at + 1/2°C/for + 4°C at 10,000 RPM, set "RUN" Control at + 4 1/2°C.

MOUNTING OF ROTORS

Because of the increased torque and high speed capability of the RC2-B, the Tapered Spindle is equipped with Drive Pins, which serve a dual purpose; first, and primarily, the pins make a more positive contact with the rotor, allowing higher torque for faster acceleration and deceleration times; secondly, the pins are a safety feature: only rotors which are equipped with matching adapters may be used; this is purposely done to preclude the use of an old rotor which may be seriously pitted or beyond the recommended retirement age.

SS-34, SM-24, SE-12 and GSA Rotors

These rotors are equipped with double locking screws on the cover; the larger hand screw seals the cover to the rotor; the small hand screw secures the rotor to the Tapered Spindle. It is important that each screw be tightened separately -- FIRST THE LARGER SCREW, THEN THE SMALLER.

GS-3, HB-4, HS-4 and SU Rotors

These rotors have only a single hand screw which secures the rotor to the Tapered Spindle.

TAPERED SPINDLE and ROTOR CENTER HOLE

These areas must be kept free of foreign materials, nicks, and scratches. The surfaces

should be wiped clean before each seating operation. Rotor sticking, scratching, and possible corrosion will thereby be minimized.

PRE-RUN ROTOR TEMPERATURE

When the evaporator temperature is below room temperature, unless a pre-chilled rotor is used, allow time for the rotor to cool to the lower temperature BEFORE CLAMPING TIGHTLY IN PLACE. This will preclude sticking of the rotor to the shaft; the longitudinal motion of the rotor with respect to the spindle may wedge the rotor on the spindle as it contracts with the decreasing temperature.

When mounting in the centrifuge, first make sure the Rotor and Tapered Spindle are clean, then place the rotor on the spindle carefully engaging the drive pins, and FIRMLY TIGHTEN BOTH HAND SCREWS, first the larger, then the smaller.

ROTOR CARE

It is VERY IMPORTANT that the rotor be properly secured to the spindle and the load be in balance within 3 to 5 grams maximum before the centrifuge is started. Generally, visual measuring of tube contents will prove to be within these ranges.

When utilizing less than the full capacity of the rotor, make sure the load is distributed evenly in opposing compartments. DO NOT ATTEMPT TO OPERATE with a load in non-opposing compartments; such a load will not be in balance and may damage the Gyro-Action Drive.

The basic rules of Rotor Care are as follows:

1. Keep the rotor clean and dry when not in use.
2. Do not subject the rotor to temperatures in excess of 110°C.
3. Use hot water and mild soap or detergent for all washing.
4. Remove Stainless Steel Cups and Tubes from aluminum alloy rotors when not in use
5. Wash preferably with distilled water as a rinse, and dry the rotor after each use in which there has been spillage.
6. In the event of tube breakage, wash and dry rotor or cup, making sure all fragments are removed.
7. Avoid scratching or nicking the anodized surfaces.

The proper use of rotors involves another fact which must be considered along with cleanliness. Rotors are designed to withstand normal expected repetitive stresses with a "normal" load es-

tablished for each rotor based upon a specific gravity of the specimen of 1.3.

If a greater load is run, the maximum speed should be derated to maintain the design factor of safety.

CARE AND MAINTENANCE

While the RC2-B has been designed tominimize maintenance, there are basic steps of proper care which should be followed to ensure long and satisfactory service.

CLEANING

ROTOR CHAMBER

The ROTOR CHAMBER should be defrosted periodically to obtain the most efficient cooling. The coating of frost which forms on the inner walls is, in effect, an insulation between the chamber and the refrigerant. With a rotor mounted and the chamber door open, defrost by running the centrifuge for two or three minutes with the Temperature Control set above 0°C, until the frost liquifies. Remove the bottom Drain Plug and the external plug and allow the water to drain from the chamber. Any remaining moisture in the chamber may be wiped up with a sponge or cloth. The entire procedure can take less than five minutes, and will barely affect the rotor temperature at all. Replace the Drain Plug and external plug and re-set the temperature control to the desired level.

TAPERED SPINDLE

Inside the rotor chamber, the TAPERED SPINDLE should be kept clean to minimize the possibilities of rotor sticking. Wipe with a soft cloth before each rotor mounting; the smooth surface is essential for proper operation; when necessary, repolish with #400 emery cloth to restore its original finish.

CABINET

While it is especially important for the rotor chamber, the entire instrument should be kept clean. The stainless steel and enameled CABINET PANELS may be easily cleaned with commercially available products. Polish may then be applied to protect the stainless steel surfaces; a good quality wax is suggested for the enameled surfaces.

LUBRICATION

All components are pre-lubricated and require no lubrication maintenance; the refrigeration unit is hermetically sealed and the ball bearings in the Gyro-Action Drive Assembly and the centrifuge motor have sealed-in lubrication.

TUBES, BOTTLES AND ADAPTERS

A variety of tubes, adapters and accessories are available for use with the various *SORVALL* rotors. Consult the current Catalog and Price List for detailed information.

WARRANTY

The *SORVALL* Centrifuges and Rotors furnished by *IVAN SORVALL, INC.* are warranted to be free from defects in material and workmanship for a period of one (1) year, under normal use.

This Warranty is limited to the replacement without charge at the factory (f.o.b. Assembly Plant, Newtown, Connecticut) of any part or parts determined by *IVAN SORVALL, INC.* to have been defective and not subjected to accident, alteration, abuse, misuse or wear through normal usages. *IVAN SORVALL, INC.* should be notified immediately upon discovery of any defects. All transportation charges shall be assumed by the customer.

No Warranty other than the above is given nor shall be implied. *IVAN SORVALL, INC.* accepts no contingent liability and shall in no event be liable for consequential damages.

In line with our policy of Progressive Research, we reserve the right to change or revise any part or parts without being obligated to make corresponding changes, improvements, additions or replacements in any centrifuge or rotor previously sold or shipped.

SERVICE

The RC2-B has been designed to allow adequate access to its component parts should servicing be required.

Components are removable, and may be replaced with temporary loan components, should it be necessary to return the original component to the factory for repair. Should such repairs be required, instructions for removal of the component shall be forwarded by the Service Department.

When correspondence is necessary regarding replacement parts or repairs, it is important to include the Serial Number of the cabinet, found on the plate at the lower right hand corner of

the bottom frame in the front of the instrument. The Console Control Panel Serial Number is located on the right hand side, inside the back panel. The lower Control Panel Serial Number is on a plate at its center. The Refrigeration Compressor Serial Number is on the right front corner of the mounting plate.

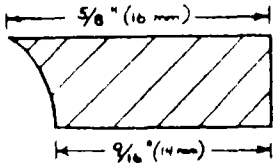
MOTOR BRUSH REPLACEMENT

To eliminate periodic motor brush inspection, a Brush-Wear Indicator warns when the brushes have worn down to minimum operating length. When the light flashes, the brushes will still have about eight hours' operational life; however, to prevent damage to the motor commutator, a lock-out system is included. When the indicator light starts flashing, this is the last run that can be made: after motor turns off, it will not re-start when the "START" Switch is activated. In an emergency, another run can be made as follows: remove the front panel, push in both red re-set buttons on the circuit breakers located on the base plate, replace front panel, activate the "START" Switch.

To replace the brushes, the motor must be removed from the centrifuge as follows:

1. Remove the lower front Self-Locking Access Panel and switch off the circuit breaker at the left.
2. Open the hatch on the bottom of the silencer by pulling the trap door down.
3. Disconnect the motor electrical cable from the junction box located to the left of the silencer, and let the cable and plug rest below the hatch.
4. Remove the rubber seal around the centering assembly in the Rotor Chamber.
5. Remove the four socket head screws from the centering assembly outer ring (use 5/32" Allen Wrench).
6. Lift the motor assembly out of the evaporator, using the Gyro-Action Drive as a handle, taking care not to foul the cable or plug against the hatch.
7. Lift up the brush springs and withdraw the brushes from their holders.
8. If the brush length is less than 9/16 inch (see illustration), the brushes must be replaced. If the brushes are badly pitted or worn unevenly, or if the commutator is badly grooved, the armature may have to be replaced. If the armature needs replacement, contact the Service Department, *IVAN SORVALL, INC.*, Newtown, Connecticut (or in locations outside the U.S., an authorized *SORVALL* distributor).

Minimum Length Of Brush

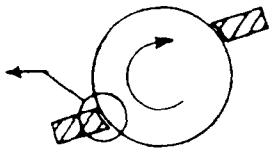


If the brush length is equal to or less than that shown, replace both brushes

9. To replace brushes, simply loosen the brush wire connectors and remove the old brushes. Be sure to insert the new brushes into the holders so that the bevelled ends match the curvature of the commutator (see illustration).

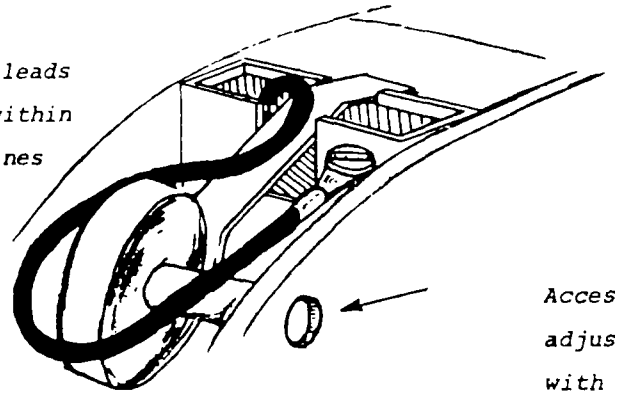
PROPER INSERTION OF BRUSHES

Be sure bevelled end of each brush matches curvature of commutator



10. Position the brush lead along the top of the brush to the brush spring and from there out along the spring in a flat, easy curve to the terminal screw. Keep the brush leads flat and well within the outer confines of the motor. If the lead is brought out directly over the top of the brush holder, the brush will "hang up" after a short period of operation.

Keep the brush leads flat and well within the outer confines of the motor



Access hole to adjust brush tension with Allen Wrench

11. To reassemble, reverse the above procedure. Make sure when replacing the motor that the guide pin of the centering assembly is in line with the guide hole. Also make sure when closing the trap door that the cable fits properly through the notched opening provided at the edge of the trap door.

INSTRUCTIONS FOR REMOVING SELF-LOCKING FRONT PANEL

The lower front panel of the RC2-B is equipped with a safety catch which automatically locks the panel as when it is snapped in place. To remove this panel, follow the procedure described below.

REMOVAL

1. Insert screwdriver through 1/4" diameter hole near bottom center of the panel.

2. Catch lip of locking clip with tip of screwdriver. Using the bottom edge of the hole as a pivoting point, depress the screwdriver handle and pull the lower edge of the front panel toward you.

3. Panel may now be removed by pulling lower edges forward and down.

INSTALLATION

1. To replace panel, insert upper edge first, pushing it up as far as it will go, then swing lower edge into position. Press both lower corners into place. Panel will automatically lock in position.

TROUBLE SHOOTING CHART

CENTRIFUGE MOTOR AND CONTROL SYSTEM

PROBLEM	CAUSE	SOLUTION
1. No power	a. Circuit Breaker open	a. Re-set breaker; if circuit breaks again have wiring checked for short circuits
	b. House Line Circuit Breaker open	b. Check/House Circuit Breaker Reset
2. Centrifuge Motor does not operate	a. Worn brushes	a. Replace Brushes
	b. No "click" noise when "Start" button is activated	b. Check both Hart Relays
	c. Variable Resistor open in D.C. Power Supply	c. Check for continuity, replace if defective
	d. Defective motor (forewarned by rapid brush wear and excessive arcing)	d. Overhaul or replace motor (contact Ivan Sorvall, Inc., Service Department or, outside the U.S., an authorized SORVALL distributor)
	e. Defective Speed Control	e. Replace Speed Control, exchange units available from SORVALL
3. Slow Braking Time (Auto Brake ON) exceeds 4½ min. with SS-34 Rotor from 20,000 RPM to 0 RPM (loaded 8 tubes full)	a. Motor Relay not functioning	a. Check Relay on control panel. Replace if faulty.
	b. Brake Resistor (cone shape) loose in socket	b. Check and tighten Brake Resistor in socket, ean contacts in socket and bottom of resistor
	c. Motor Brush Tension too light	c. Check Brush Tension 22 oz. and readjust
4. Fast Braking Time (Auto Brake ON) less than 3 min. with SS-34 Rotor from 20,000 RPM to 0 RPM (loaded 8 tubes full)	a. Motor Relay not functioning	a. Check Relay on control panel. Replace if faulty.
5. Motor operates but Rotor does not move	a. Broken lower coupling in Gyro-Action Drive	a. Remove and replace lower coupling
6. Instruments on Control Panel do not operate	a. Short in instrument circuit	a. Re-set circuit breaker (located under left side overhang of control panel)
		b Check wiring
7. Rotor stuck on Tapered Spindle	a. Rotor not pre-cooled before tightening on spindle	a. and b. Use Carrying Handle supplied with rotor as an extractor, screw it in so its end can bear against spindle and exert a parting force. As an alternative, use a correct size ¼-20 L.H. bolt. After removal, clean both spindle and center hole; re-polish spindle with crocus cloth or No. 400 Emery paper.
	b. Dirt or spillage on tapered spindle or on Rotor Center Hole	
8. Rapid Motor Brush wear	a. Brush Spring tension too great	a. With motor removed, adjust brush springs by loosening Spring Post with Allen Wrench and rotate until tension, checked with scale, is 22 oz. (± 2 oz.) or 625 gr. (± 55 gr.). Re-tighten Post and re-check tension
	b. Worn Commutator	b. Return motor to Ivan Sorvall, Inc., Service Department for servicing (outside the U.S., get in touch with authorized SORVALL distributor).

CIRCUIT BREAKER	Supplies main power to the instrument and protects against circuit overloads. The circuit breaker is rated at 30 amps 208 or 230 VAC and will trip open if a current in excess of its rating is drawn by the instrument.
TIMER	Controls the duration of time up to two (2) hours and automatically shuts down the centrifuge motor. Tests to be run in excess of two (2) hours require use of the timer Hold mode which will not automatically shut down the centrifuge motor.
OVERSPEED RELAY	This is a single-pole, single-throw (SPST) normally closed contact relay which will energize if the motor speed reaches 20,400 RP M. When energized the centrifuge motor will automatically shut down.
TACHOMETER INDICATOR	Visual indicator of the actual rotor speed.
SPEED CONTROL	Varies the speed of the motor from 0 RPM to maximum (depending on rotor being used). 115 VAC input is rectified to a 0 - 90 VDC output which is fed to the saturable reactor.
KSB RECEPTACLE	115 VAC is supplied to this receptacle for use with the KSB Automatic Safety Valve.
TACH TRIMMER	Varies the voltage from the tachometer generator to the tachometer indicator. It is used in conjunction with an external tachometer indicator during calibration.
MAIN PILOT LIGHT	When lit indicates power is on to the instrument.
HOLD PILOT LIGHT	The temperature in the evaporator chamber will be maintained at the preset value of the Blue temperature pointer with the rotor stationary.
RUN PILOT LIGHT	The temperature in the evaporator chamber will be maintained at the preset value of the Red run temperature pointer while the rotor is spinning.
CENTRIFUGE PILOT LIGHT	When on it indicates power has been applied to the speed control and motor.
COMPRESSOR PILOT LIGHT	This is the unmarked light on the control panel that indicates the state of the compressor. This light is controlled by the microswitches in the Partlow controller.
PARTLOW CONTROL	Temperature controller unit for the refrigeration system. Cycles the compressor on and off as required.

UPPER HART RELAY	Main circuit hold relay. Used to transfer temperature controller from Hold to Run modes. Energizes lower Hart Relay.
LOWER HART RELAY	When energized applies power in the centrifuge motor and when de-energized applies the DC brake.
COMPRESSOR RELAY	When energized by 115 VAC from the Partlow control, it will turn on the compressor.
STOP SWITCH	A normally-closed contact switch used to stop the centrifuge motor.
START SWITCH	Normally open contact momentary switch. When depressed supplies power to both Hart Relays, Partlow Control, etc.
TORQUE TRIMMER	Limits the instantaneous starting current to the motor to a safe valve.
80 MFD CAPACITOR	Used to smooth out the DC voltage in the speed control circuit.
BRAKE SWITCH	When in the ON position supplies 115 VAC to the Brake transformer.
BRAKE TRANSFORMER	A stepdown transformer from 115 VAC to 10-12 VAC.
BRAKE RECTIFIER	Used to convert 10-12 VAC to 8-10 VDC.
SATURABLE REACTOR	Controls the amount of current supplied to the centrifuge motor. A voltage of 0-90 VDC across the DC coil of the reactor, varies the current and voltage thru the reactor to the motor.
FAN RELAY	Allows for continuous operation of the condensing fan independent of the state of the compressor for better cooling.
CONDENSING FAN	Used to remove heat from the high pressure gas flowing thru the condensing coils.
COMPRESSOR	Pumps the Freon gas out of the evaporator into the compressor cylinder where it is compressed by the pistons. It is then delivered thru the discharge tube as a gas under pressure to the condensor where accumulated heat is released to the air.
TACH GENERATOR	An AC voltage generator (approximately 1.5 VAC/1,000 RPM) used in conjunction with the tach trimmer and tach indicator to show motor RPM. A permanent magnet rotating within a fixed coil of wire generates the AC voltage.

TEMPERATURE LIMIT SWITCH	This switch will open up shutting down the centrifuge motor if an overtemperature condition occurs.
MOTOR	A high torque motor with a full load speed of 20,000 RPM.
AUTO TRANSFORMER	A stepdown transformer used to reduce the 230 VAC input to 115 VAC for the control circuit.
CIRCUIT BREAKER (4 amps)	Protects the 115 VAC control line to the instrument.
BRAKE RESISTOR (cone 100 watt)	Provides a load across the motor armature during the braking cycle.
BRAKE RESISTOR (.2 ohm)	Utilized during braking at high RPM.
COMPRESSOR START RELAY	When de-energized the relay switches in the compressor motor start winding and automatically switches it out when the motor is at running speed.
COMPRESSOR OVERLOAD (klixon)	Will automatically shut off the compressor if a temperature in excess of 210°F is reached, or if an excessive current is being drawn by the compressor.
START CAPACITOR	An initial voltage boost to the compressor motor to overcome the high internal head pressures.
RUN CAPACITOR	Helps overcome the high torque on the compressor motor during the run cycle.
MOTOR BRUSH ALARM	When the motor brushes have worn to a length of 5/8" or shorter, the centrifuge pilot light will begin to flash indicating replacement of the motor brushes is required.

INSTRUCTIONS

FOR

INSTALLATION AND OPERATION

OF THE

SORVALL® MANUAL RATE CONTROLLER, PN 49060

ON THE

SORVALL® RC-2, RC2-B, AND SS-3 SUPERSPEED CENTRIFUGES

CONTENTS

WARNING

Because of high voltages in this unit, untrained personnel must not attempt to install, test, or repair any electrical circuits in either the manual rate controller or the centrifuge on which it is installed.

WARNING

Unplug centrifuge power cord before attempting to install, test, or repair the manual rate controller.

PN 49721-2

DUPONT COMPANY • INSTRUMENT PRODUCTS • BIOMEDICAL DIVISION • NEWTOWN, CONNECTICUT 06470

DuPont Instruments

DUPONT

SECTION 1 DESCRIPTION

1-1 SCOPE

These instructions provide descriptive, installation and operational data for the Sorvall Manual Rate Controller, PN 49060, on the Sorvall RC-2, RC2-B and SS-3 Superspeed Centrifuges.

1-2 PURPOSE

The Manual Rate Controller is designed to provide controlled acceleration and deceleration during the speed range of 0-1,000 rpm, a range which is important in the operating cycle of the SZ-14 Reorienting Density Gradient Zonal Rotor and the SS-90 Vertical Rotor.

1-3 DESCRIPTION

The Manual Rate Controller contains a 120 vac variable transformer; a half-wave rectifier diode; a rate control knob and two double-pole, double-throw switches; a RATE switch to determine the operating mode of either "Normal" (controller is off) or ZONAL (controller is ON); and a Compressor Fan Switch which turns off the compressor and fan during the critical acceleration and deceleration phases to prevent untimely vibrations from disturbing the rotor contents.

The controller may be installed on any RC-2, RC2-B or SS-3 Centrifuge which is equipped with speed control, PN 21798. If the centrifuge does not have speed control, PN 21798, one must be installed before the controller can be installed. The controller is <u>not</u> required on <u>all</u> SS-4 Centrifuges or early model RC-2 and SS-3 Centrifuges which utilize a variable transformer speed control.

1-4 PARTS

The Manual Rate Controller Kit, Pn 49060, contains the following items.

Part No.	Description	Quantity
49050	Manual Rate Controller with attached wiring harness	1
61544	Ty-wraps	12
61703	Male/Male in-line connectors	2
61522 & 60998	Female spade terminals (spares - not required for installation unless needed	6 each
60978	In-line splice (blue)	3
61010	Y adapter (1/4 in)	2
62418	Y adapter (3/16 in)	2
21895	Plug/Switch Assy	1
21953	Varistor Assy	1

SECTION 2 INSTALLATION

2-1 EQUIPMENT REQUIRED

The following equipment is required to install the controller:

Cutting shears
Standard slotted screwdriver
Phillips head screwdriver
Wire cutter and crimping tool
Electric hand drill
Twist drill, 0.16 cm (1/16 in)
Twist drill, 0.32 cm (1/8 in)
Twist drill, 0.64 cm (1/4 in)
Greenlee knockout punch, 1.27 cm (1/2 in), if available
Metal files

2-2 INSTALLATION

NOTE

- Read these instructions through to the end before proceeding
- Only installation steps a through g and m through o apply to the SS-3 Centrifuge. All steps a through o apply to RC-2 and RC-2B Centrifuges.

To install the controller on the centrifuge:

a. Unplug instrument.

b. Remove the back cover of the centrifuge control console, the front panel and the upper rear panel (RC-2 and RC-2B) or the bottom panel (SS-3).

c. Cut out slot for rate controller harness and grommet assembly in console rear cover for RC-2 and RC-2B or in the base panel for SS-3 as shown in figure 1. Remove all burrs and sharp edges.

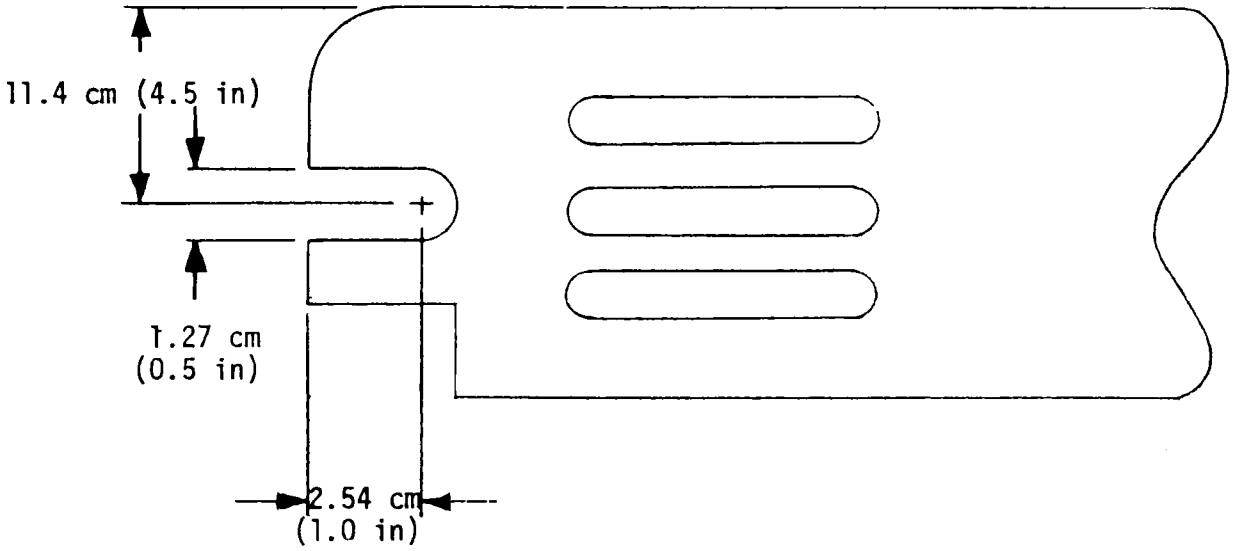
d. If the instrument has a door interlock, the plug/switch assembly must be installed by the appropriate method which follows:

(1) On RC-2 or RC-2B centrifuges, disconnect the wires to the socket for the KSB Automatic safety valve, located on the lower right side of the control console. Remove socket by loosening the two screws on the outside of the console, then remove and discard escutcheon plate and socket assembly. Cut wire leads to this plug at their point of origin. Install plug/switch assembly into this available opening.

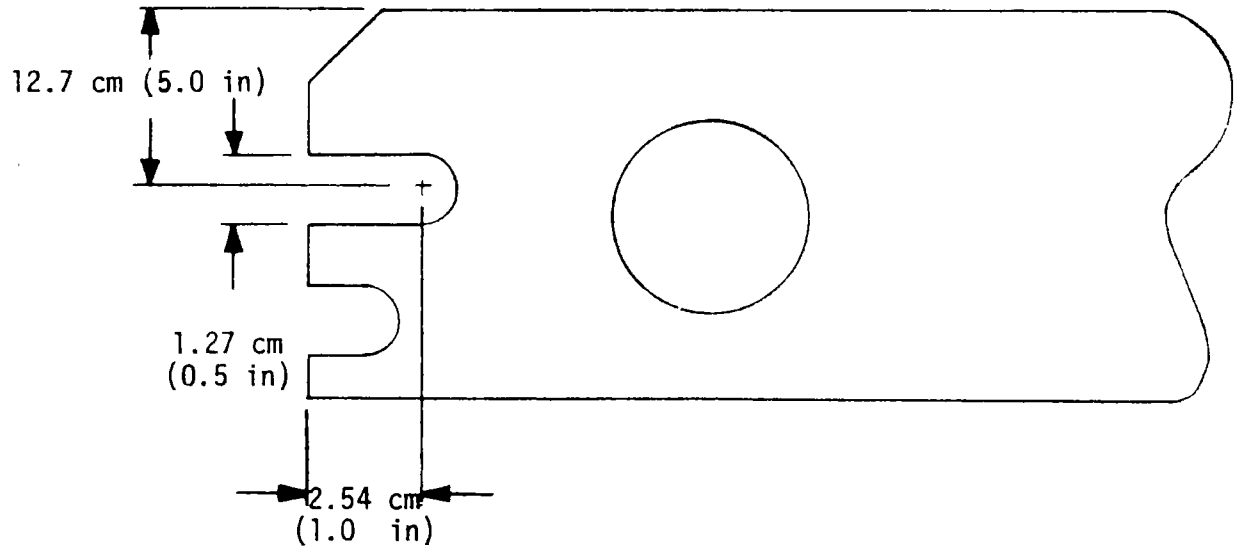
(2) Customer option on RC-2 or RC-2B Centrifuges, drill .64 cm (1/4 in) hole in console panel (refer to figure 2 for location and dimension) and remove all chips. Remove plug from plug/switch assembly and install switch. It may be necessary to discard one lock nut on switch assembly.

FIGURE 1

RC-2, RC2-B, RC-3: CONSOLE REAR COVER REWORK FOR HARNESS AND GROMMET



SS-3 BASE PANEL CUTOUT FOR HARNESS AND GROMMET



NOTE

Prior to drilling 0.64 cm (1/4 in) hole, first remove adjacent switch or light assembly on console and make certain that the total metal thickness for this hole location does not exceed 0.64 cm (1/4 in) total.

e. Place controller in position as follows:

(1) RC-2, RC2-B: Place controller on the top right side of centrifuge control console.

(2) SS-3: Remove base mounting bracket from controller by removal of attachment hardware.

(a) Open rate controller assembly by removing metal screws.

(b) Remove nut and machine screw.

(c) Discard mounting bracket and resecure capacitor.

(d) Close rate controller assembly. Place controller on table top along the left side of the instrument base.

f. Disconnect the female Amp plug *from the speed control, and connect this plug to the male Amp plug of the Rate Controller harness. Then connect the female Amp plug from the Rate Controller harness into the male Amp plug of the speed control.

NOTE

Match bevel sides with female and male connector.

g. If this is an SS-3 installation, connect the green harness wire to ground. Cut the remaining unused 4-wire leads of the controller's five wire harness (blue, pink, yellow, white) where they exit from the harness jacket. Cut flush. No insulation is necessary.

(IF THIS INSTALLATION IS ON THE SS-3 CENTRIFUGE, GO TO STEP m.)

h. The conductors in the 5-wire harness of the controller must be connected to the compressor and fan. There are two pair of wires--the white and pink pair and the yellow and blue pair.

*Part of short adapter harness, PN 21830 on older RC instruments, part of regular harness on newer instruments.

NOTE

RC-2, and some older RC-2B models (those without a fan relay) are wired so that the fan is switched by the compressor relay; use only the yellow and blue pair on these instruments (Refer to Figure 3):

i. Locate a blue wire on the left side of the lower control panel where it attaches to the compressor relay. Disconnect* this wire and attach to the blue wire from the harness cable, using one of the male/male in-line connectors.

j. Connect the yellow wire from the harness cable to the terminal on the compressor relay which formerly held the blue wire. Connect the green wire to ground. The white and pink wires are not utilized when a fan relay is not incorporated. Cut this pair of wires where they exit from the harness jacket. Cut flush. No insulation is necessary.

NOTE

Discard tab if not needed.

k. Later RC-2B models have the condensor fan wired to run continuously in the run mode. The compressor wires are wired as described in Step h with additional connections to the fan relay as follows:

(1) Locate the fan relay on the lower control panel. Disconnect the yellow wire from this relay and attach to the pink wire from the harness cable using one of the male/male in-line connectors.

(2) Connect the white wire from the harness cable to the terminal on the fan relay which formerly held the yellow wire.

(3) Connect the green harness conductor to chassis ground.

l. Wire the plug/switch assembly as follows:

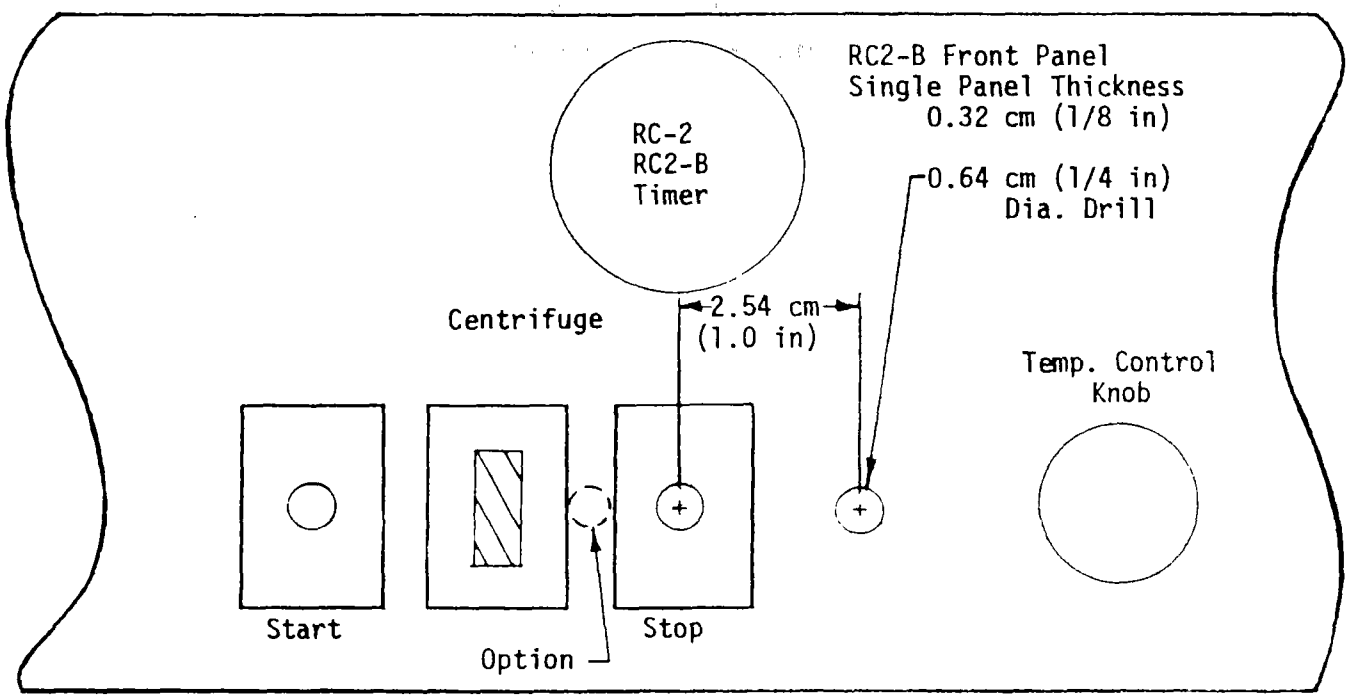
(1) Using a Y adapter, PN 61010, (1/4 in), attach white wire to the lower terminal (wire #21 brown) of the main indicator light on RC-2 and RC-2B centrifuges.

(2) Using the second Y adapter, PN 62418 (3/16 in), attach the white wire to the interlock solenoid terminal (wire #109) located on the left side of the console (from the rear).

*Some RC-2's utilized a Hart relay for the compressor relay. It will be necessary to cut the control wire and splice with blue in-line splicers.

NOTE: This control wire is soldered to relay base terminals.

Figure 2



Option Position selected is where a total panel thickness (combination console and panel) will not exceed 0.64 cm (1/4 in) whereas, elsewhere a total of .95 cm (3/8 in) will be encountered on older instruments.

m. Installation of Varistor Assy PN 21953.
Refer to figure 4 for Steps 1-3.

(1) Remove insulated terminal cover on top of saturable reactor by removing two hex nuts.

(2) Loosen the two center top screws and attach the Varistor to center terminals. Tighten screws.

(3) Install and secure insulated terminal cover for saturable reactor.

n. Make sure all connectors are tight and tape all exposed unused connectors. Dress all loose wires with ty-wraps. This completes the installation.

NOTE

On final dressing or wires, make certain that the new harness leads are free from brake cone resistor and compressor relay on most all RC's and SS-3.

o. Install rear panels and front panel on the RC's and base panel for SS-3.

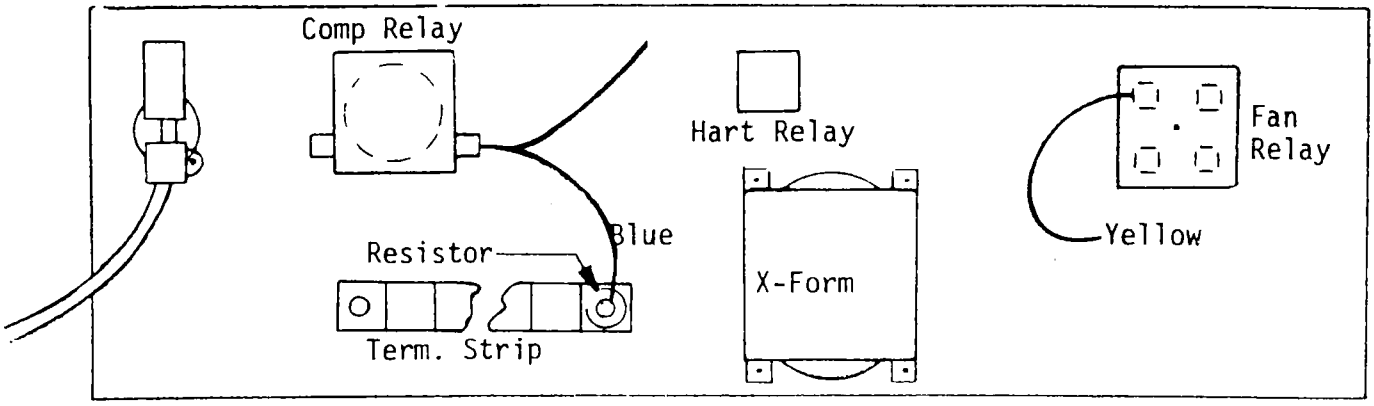
NOTE

Install harness grommet assembly into slot provided when installing the console rear panel on RC's and base panel for SS-3.

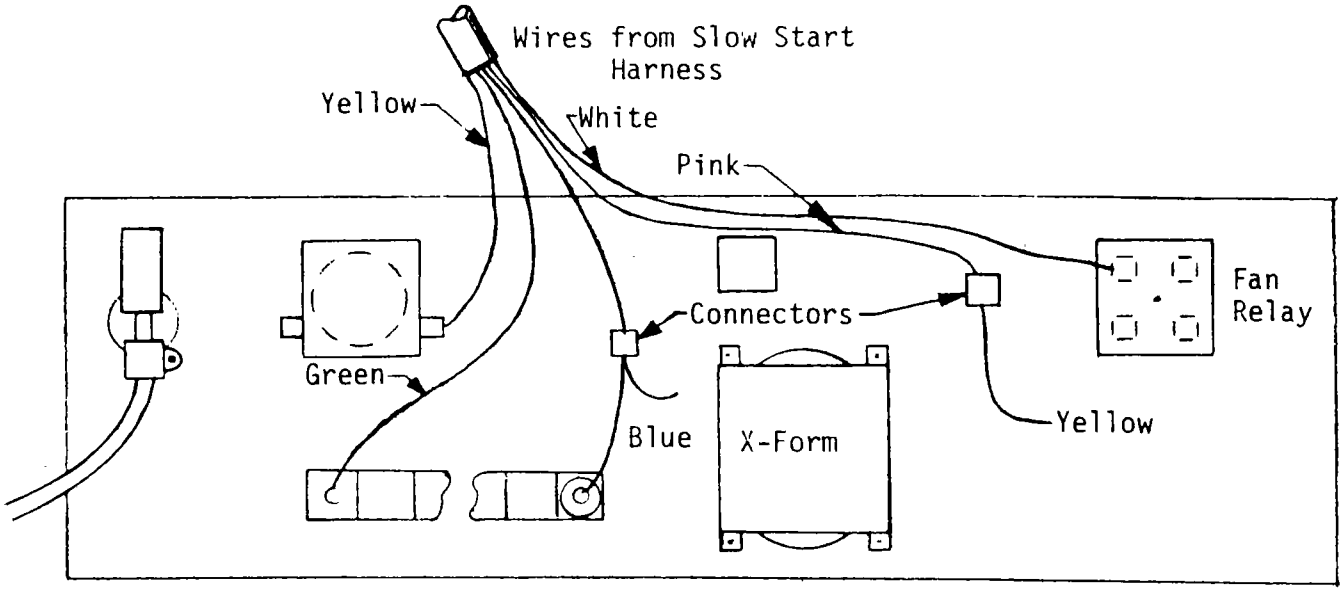
The overall schematic for the new speed control installation is shown in Figure 4.

FIGURE 3

Typical Installation - Normal Configuration



Lower Control Panel



Lower Control Panel

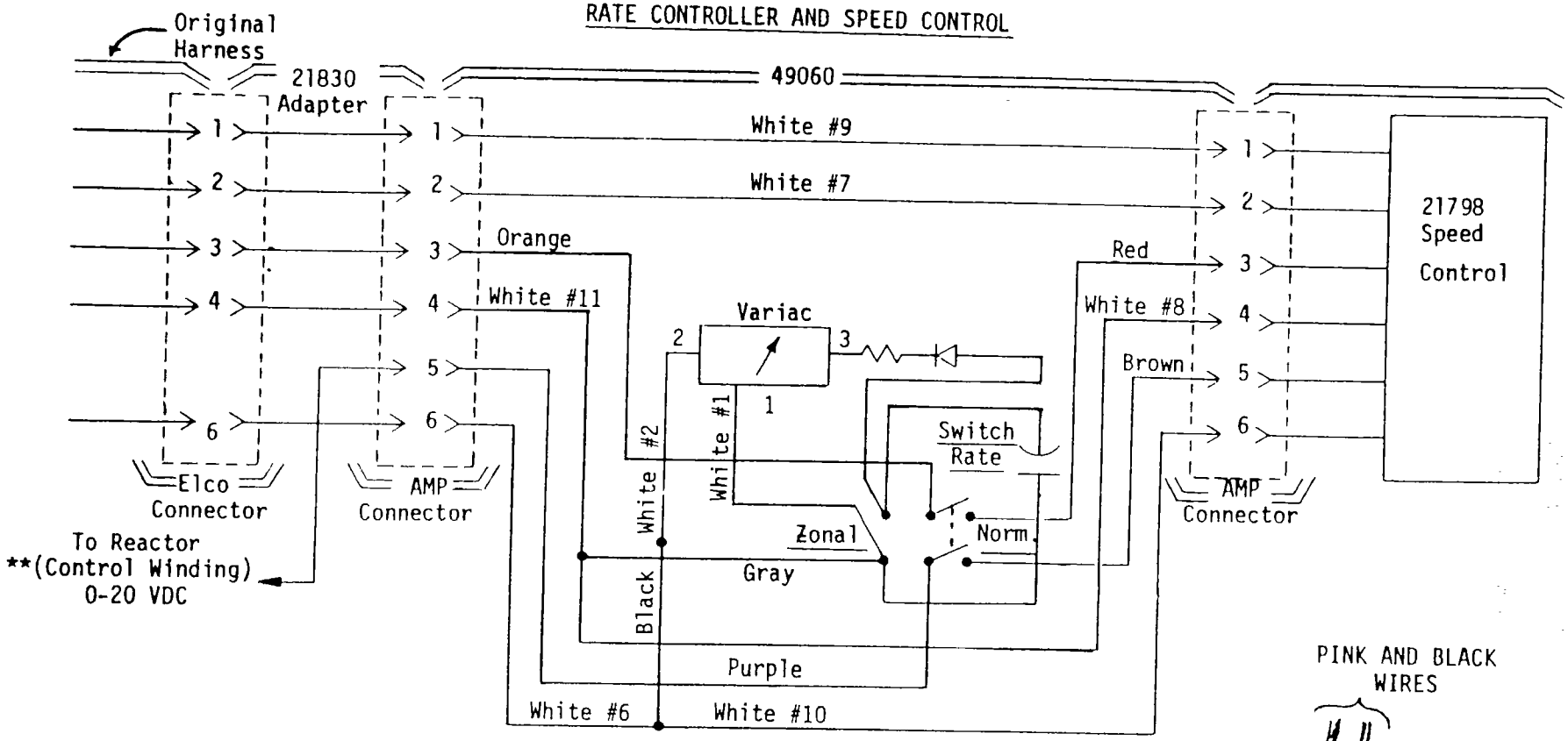
Note:

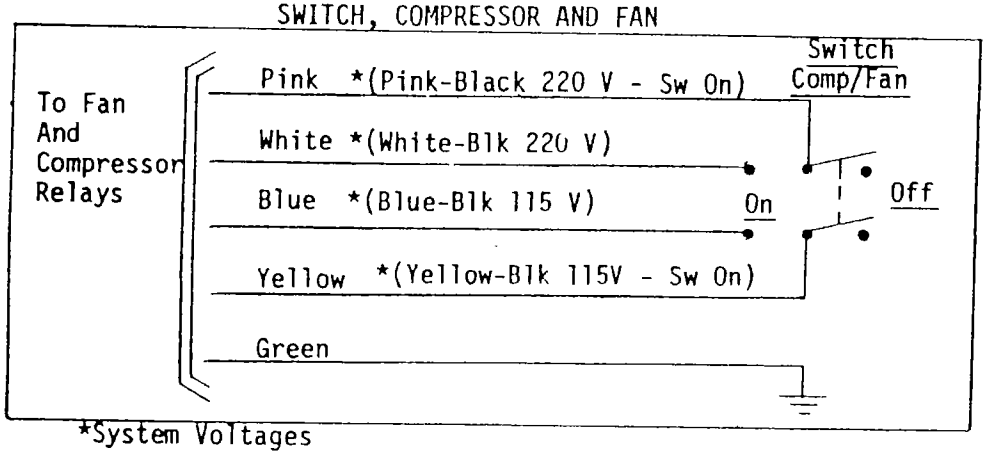
1. Location and relationship of compressor relays varies from serial numbers and models, but generally speaking, relays will be located on lower electrical panel, left side.

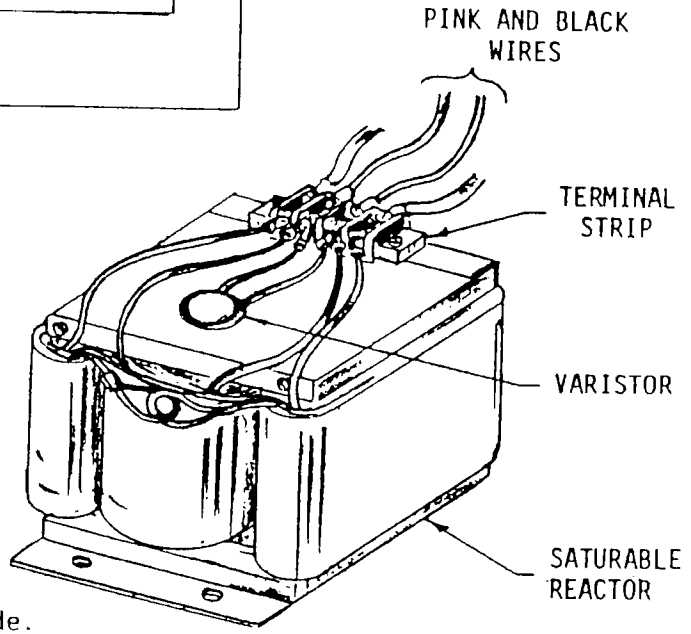
2. In most centrifuges, the 115 Volt control wire will be blue.

3. Original and replacement compressor relays will vary in type and shape.

FIGURE 4
OVERALL SCHEMATIC
RATE CONTROLLER AND SPEED CONTROL







*System Voltages
**Use lower right terminal strip pink and blk. (0-20 VDC) in Zonal mode.

SECTION 3 OPERATION

3-1 GENERAL

These instructions describe how the PN 49060 Manual Rate Controller may be used to allow a "soft" acceleration and deceleration of any rotor and to disable the refrigeration unit as desired.

Use of the controller is described as fitted to the RC2-B Centrifuge, but is typical for all models. Exceptions will be noted where necessary.

Applications data for a specific rotor may contain information as to how this Controller is to be used.

3-2 CONTROLS

a. Comp/Fan Switch

This toggle switch operates independently of the rate switch and disables the refrigeration system when in the OFF position to prevent untimely vibrations from disturbing the rotor contents during the critical acceleration and deceleration phases.

NOTE

This control is inoperative on the SS-3.

b. Rate Switch

When in the ZONAL position, this toggle switch bypasses the instrument speed control and places the centrifuge under rate control.

c. Rate Control Knob

This control determines the amount of acceleration when the controller is on. Turning the knob clockwise increases acceleration. Turning the knob counterclockwise decreases acceleration.

3-3 CALIBRATION OF RATE CONTROLLER PRIOR TO "LIVE" RUN

a. Turn instrument power on.

b. Mount rotor.

c. Set the rate switch to ZONAL and the rate control knob to 0.

d. Press Centrifuge "ON" button. A drive impulse will occur which will tend to turn the rotor through several degrees. This is normal.

e. Gradually advance rotary control until rotor begins to turn smoothly at minimum "speed." Record the value on the logging dial. The Rate Controller is now calibrated for the particular rotor in use.

f. Depress STOP button. Remove rotor when at rest. Set rate control to 0.

3-4 OPERATION

Use the controller during the acceleration and deceleration phases of a typical rate controlled run as follows:

a. Acceleration

(1) Set switches and gauges:

Power - On
Rotor - Dismounted
Rate Switch - Zonal
Rate Control Knob-Zero
Centrifuge "Speed" Control - Desired Run "Speed"

(2) Press "START" button. This step allows drive impulse to dissipate before mounting loaded rotor. Comp/Fan Control may now be used, if desired, to prevent compressor start/stop shake from disturbing rotor contents.

(3) Mount rotor.

(4) Advance rate control knob. At the logging value recorded in Step 3-3,e the rotor will begin to turn smoothly. Continue to advance control slowly as rotor accelerates to revolutions of approximately 800/min.

WARNING

Close door prior to completing operations instructions.

(5) Select Normal Mode. Rotor will accelerate to "speed" setting of "Speed" Control as set in step (1) above.

b. Deceleration

(1) Reset rate control knob to minimum smooth "speed" setting (Step 3-3e).

(2) Move rate switch to ZONAL. Centrifuge will remain in normal mode until "START" button is depressed in a later step.

(3) Press "OFF" button. Rotor will decelerate under braking. When rotor "speed" is below critical, press "START" switch. Rotor now decelerates under rate control taking approximately 6 minutes to stop. During deceleration, watch the centrifuge tachometer; if the rotor does not decelerate, turn the rate control knob counterclockwise about 2°. If deceleration is too rapid, turn the rate control knob clockwise approximately 2°. As soon as the rotor stops, immediately press "STOP" switch.

INSTRUCTIONS

FOR

FIELD MODIFICATION

OF THE

SORVALL® MANUAL RATE CONTROLLER

FOR USE WITH

"SPEED" CONTROL KITS PN 12217 AND 12219

ON THE

SORVALL® RC-2, RC2-B, AND SS-3 SUPERSPEED CENTRIFUGES

CONTENTS

WARNING

Because of high voltages in this unit, untrained personnel must not attempt to install, test, or repair any electrical circuits in either the manual rate controller or the centrifuge on which it is installed.

WARNING

Unplug centrifuge power cord before attempting to install, test, or repair the manual rate controller.

PN 49439-0

DUPONT COMPANY • INSTRUMENT PRODUCTS • BIOMEDICAL DIVISION • NEWTOWN, CONNECTICUT 06470

DuPont Instruments

DUPONT

1 Equipment Required

Electric hand drill

Drill .48 cm (.187 in) diameter

Screw driver

Wire cutter and crimper

Phillips head screw driver

2 Parts Supplied

Part Number	Description	Quantity
49438	Harness assy	1
21953	Varistor assy	1
61544	Ty wrap	18
61949	Ring terminal	4
910637	Capacitor	1
64459	Sleeving	15.24 cm (6 in.)
60964	Machine Screw	2
61518	Ty wrap	2
60171	Washer	2
60184	Hex Nut	2

3 "Speed" Control Replacement

a. Place Circuit Breaker switch in OFF position.

b. Remove power cord from wall receptacle.

c. Remove the following panels from the unit: console rear panel, upper rear panel and lower front panel.

d. Disconnect the rate controller from the "speed" control circuitry by separating the three plugs and disconnecting associated wires at their termination points. These will be replaced with new harness assembly PN 49438.

e. Disconnect the 12-pin Molex connector and discard that harness assembly.

f. Remove defective "speed" control as follows:

1. Remove knob.

2. Disconnect harness from "speed" control.

3. Loosen and remove retaining nut on "speed" control shaft.

g. Install "speed" control kit as per instructions:

PN 12217 - RC-2 and RC2-B

PN 12219 - SS-3

h. Functionally check and calibrate the new "speed" control as per instructions:

PN 05286 - RC-2 and RC2-B

PN 05285 - SS-3

4. The following steps will alter rate controller circuitry to allow rate controller PN 49050 to become compatible with new "speed" control PN 21798.

a. Remove rate controller from console top and place it on centrifuge top. Leave harness attached to instrument console. Place a work pad (such as cardboard) on the instrument top to prevent scratching and marring of stainless steel surfaces.

b. Remove the four metal screws on the rear side of controller and separate the box assembly.

c. Drill two (2) 0.48 cm (0.187 in) diameter holes in controller box as per instructions in figure 1.

d. Mount capacitor PN 910637 as per figure 1, utilizing hardware described and enclosed in the kit.

e. Route the capacitor wires to determine proper length:

- The + wire is attached to the lower terminal on the rate switch. A white wire #1 is also secured to this lug.

- The - wire is attached to the upper terminal on the rate switch. A white wire #5 is also secured to this lug.

f. Slip sleeving over each capacitor lead, 0.95 cm (3/8 in) shorter than the lead wire.

g. Crimp ring Terminal PN 61949 on each lead.

h. Locate gray wire from the harness which is spliced jointly with a black wire, also from the harness. Sever gray wire as close as possible to the in-line splicer (refer to figure 2) and strip end of wire 0.95 cm (3/8 in).

i. Remove #1 wire (white) coming from the power stat, secured to the lower terminal on the rate switch. Clip terminal end and discard terminal.

j. Strip insulation back 0.95 cm (3/8 in) from white wire #1.

k. Join the white wire #1 to the gray wire from step h and crimp onto ring terminal PN 61949.

l. Attach and secure + wire from capacitor along with gray and white wire (step k) to the lower lug on the rate switch.

m. Attach and secure - wire from the capacitor to the upper terminal on rate switch along white wire #5.

n. Reassemble the rate controller assembly and mount on top of console.

5. Harness Installation (PN 49438)

a. Unplug the AMP connector (short adapter harness, PN 21830) from the "speed" control and insert the 6-pin male plug of the Rate Controller connecting cable in its place. Then connect the 6-pin female plug of the Rate Controller cable to the AMP plug which was just removed from the "speed" control and connect the 12-pin Molex connectors.

NOTE

Match bevel sides with female and male connector.

b. If this is an SS-3 installation, connect the #111 harness wire to ground. Cut the remaining unused 4-wire leads (#107, #108, #109, and #110) of the controller's 5-wire harness where they exit from the harness jacket. Cut flush. No insulation is necessary.

(IF THIS INSTALLATION IS ON THE SS-3 CENTRIFUGE, GO TO STEP g.)

c. The conductors in the 5-wire harness of the controller must be connected to the compressor and fan from which original harness wires were removed. There are two pairs of wires--#109 and #110; #107 and #108 (see figure 3).

NOTE

RC-2, and some older RC2-B models (those without a fan relay) are wired so that the fan is switched by the compressor relay; use only wires #107 and #108 on these instruments (refer to figure 3).

d. Locate a blue wire on the left side of the lower control panel where it attaches to the compressor relay. Disconnect this wire and attach it to wire #107 from the harness cable, using one of the male/male in-line connectors.

e. Connect wire #108 from the harness cable to the terminal on the compressor relay which formerly held the blue wire. Connect wire #111 to ground. Wires #109 and #110 are not utilized when a fan relay is not incorporated. Cut this pair of wires where they exit from the harness jacket. Cut flush. No insulation is necessary.

NOTE

Discard tab if not needed.

f. Later RC2-B models have the condenser fan wired to run continuously in the run mode. The compressor wires are wired as described in step e with additional connections to the fan relay as follows:

   1. Locate the fan relay on the lower control panel. Disconnect the yellow wire from this relay and attach to wire #110 from the harness cable using one of the male/male in-line connectors.

   2. Connect wire #109 from the harness cable to the terminal on the fan relay which formerly held the yellow wire.

g. Install Varistor Assembly PN 21953 as follows:

   1. Remove the insulated terminal cover on top of the saturable reactor (figure 4).

   2. Loosen the two center tap screws and attach the varistor assembly to the center terminals.

   3. Tighten center tap screws.

   4. Install and secure the insulated terminal cover for the saturable reactor.

h. Make certain all connections are tight and tape all exposed unused connectors. Dress all wires and harness neatly using enclosed ty-wraps.

NOTE

On final dressing of wires, make certain that the new harness leads are free from the brake cone resistor and compressor relay found on most RC and SS-3 units.

i. Functionally check "speed" control and rate controller rework and installation.

j. Install all panels and level instrument. Connect power cord.

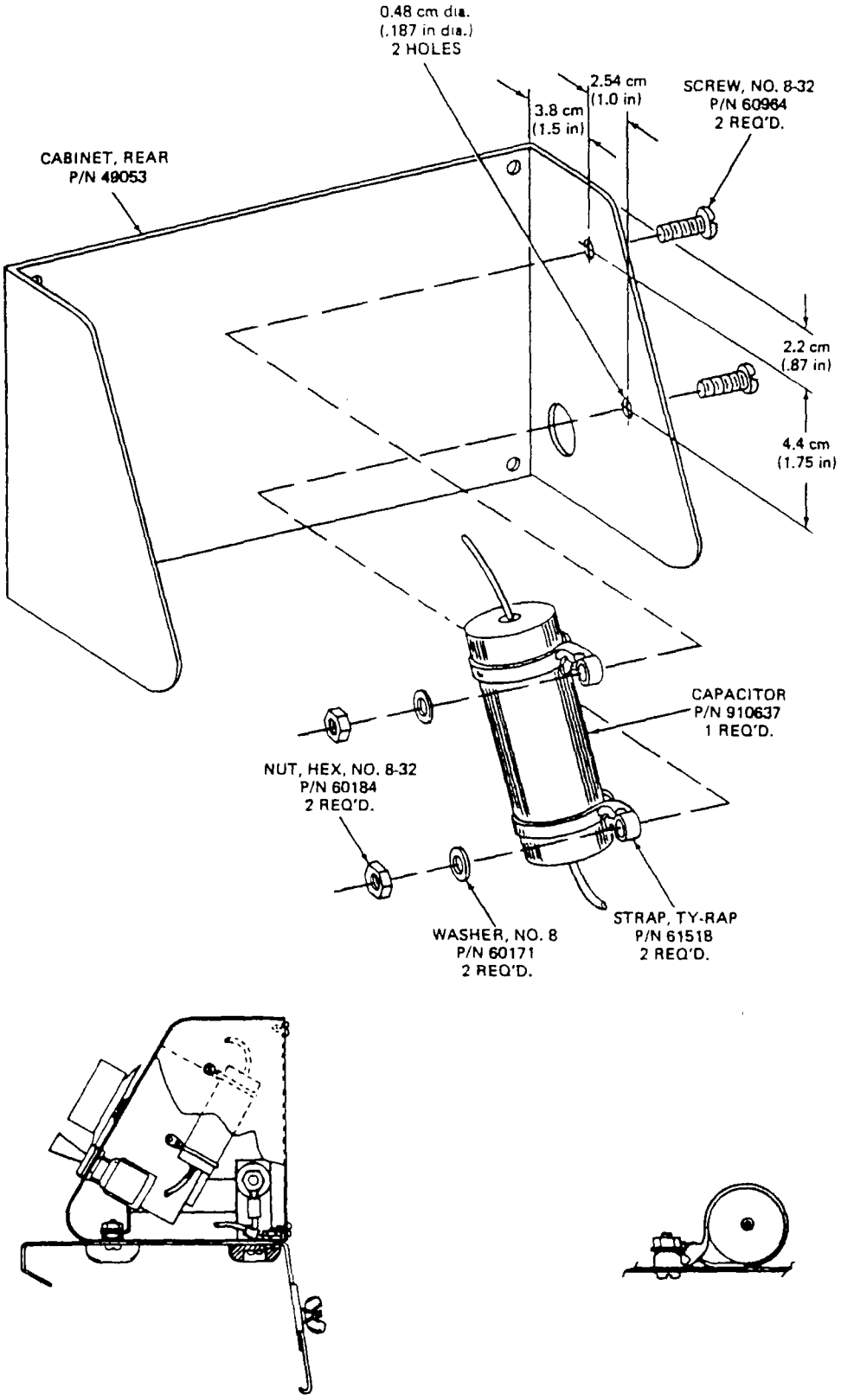


FIGURE 1

CAPACITOR MOUNTING

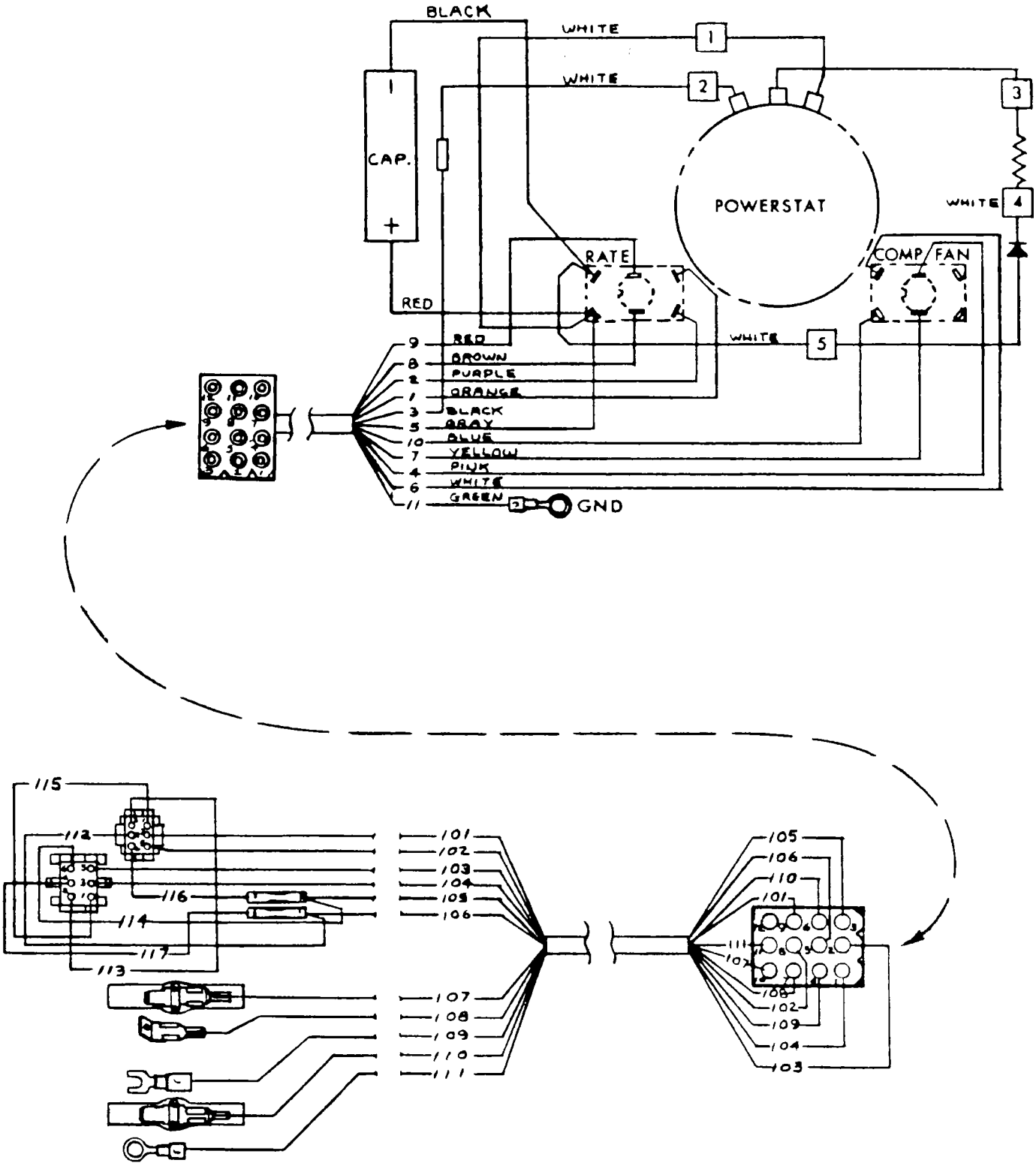
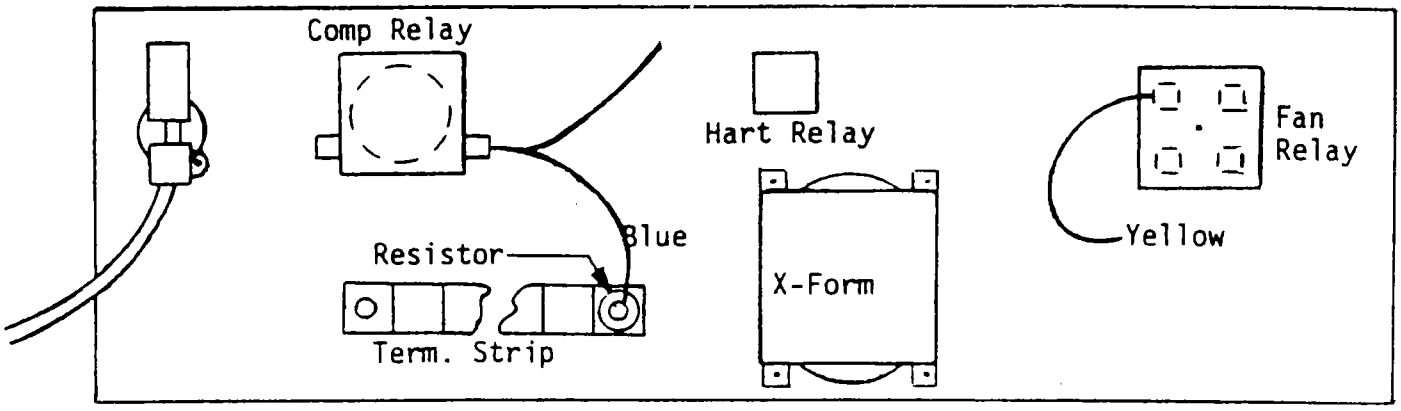


FIGURE 2

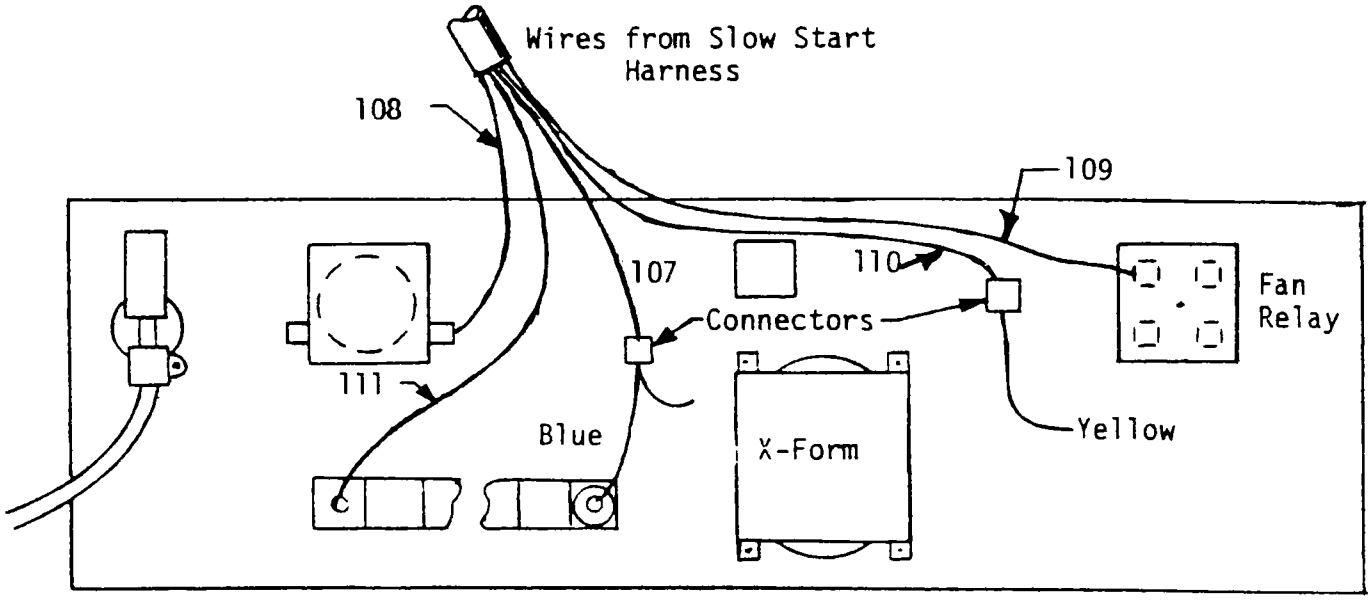
WIRING DIAGRAM

FIGURE 3

Typical Installation - Normal Configuration



Lower Control Panel



Lower Control Panel

Note:

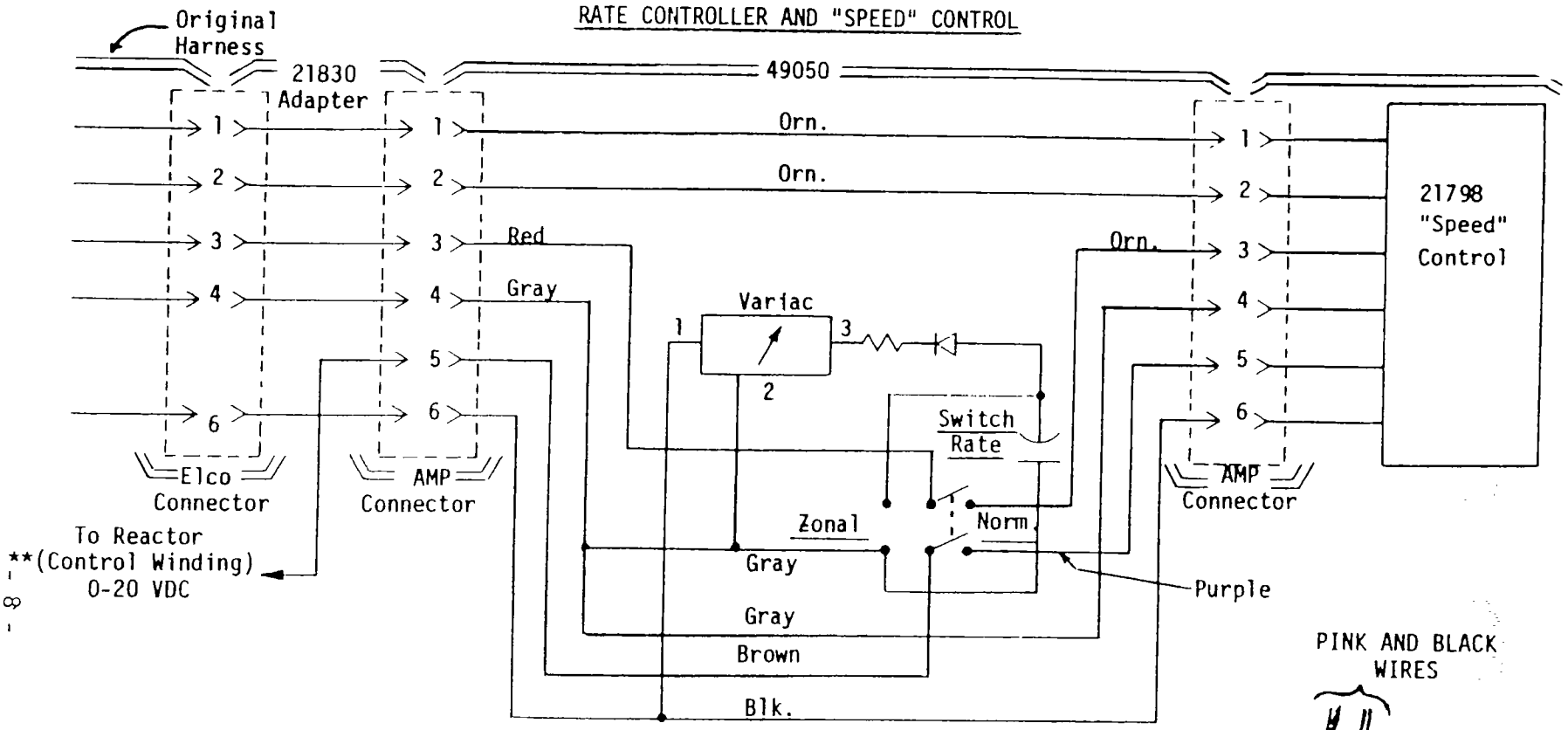
1. Location and relationship of compressor relays varies from serial numbers and models, but generally speaking, relays will be located on lower electrical panel, left side.

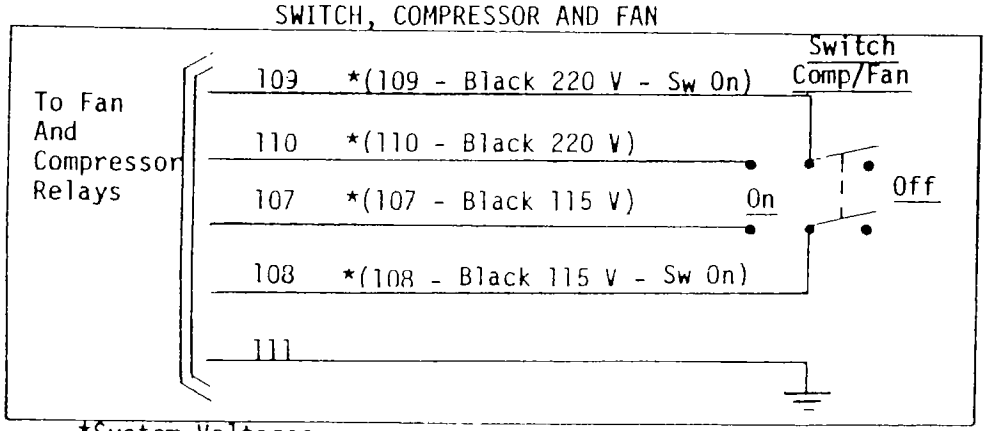
2. In most centrifuges, the 115 Volt control wire will be blue.

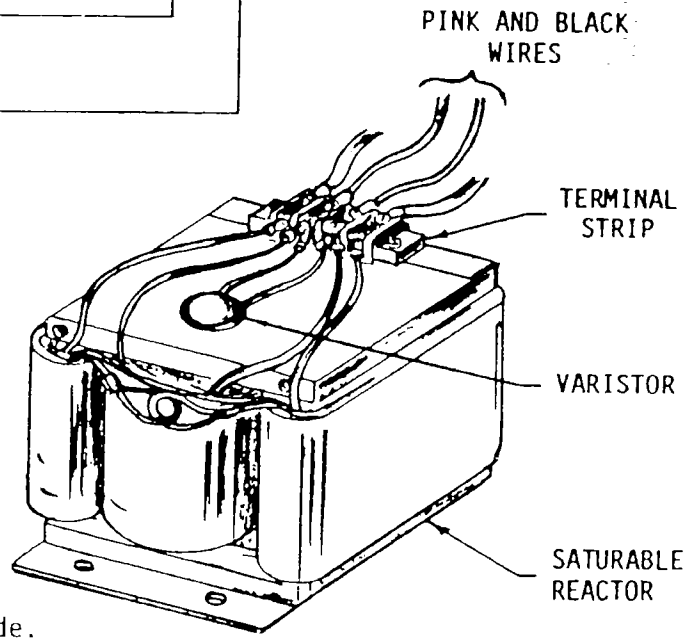
3. Original and replacement compressor relays will vary in type and shape.

FIGURE 4
OVERALL SCHEMATIC

RATE CONTROLLER AND "SPEED" CONTROL







*System Voltages

**Use lower right terminal strip pink and blk. (0-20 VDC) in Zonal mode.