IEC MODEL HN-SII

GENERAL-PURPOSE CENTRIFUGE

IM201

INSTRUCTION MANUAL

MAY 1987

Catalog No. 2355

60 HZ
120VAC

Catalog No. 2356

50 HZ
240 VAC

Bench Model

WARNING

DO NOT ATTEMPT TO OPERATE THIS CENTRIFUGE BEFORE THOROUGHLY READING THE OPERATORS SECTION OF THIS MANUAL.

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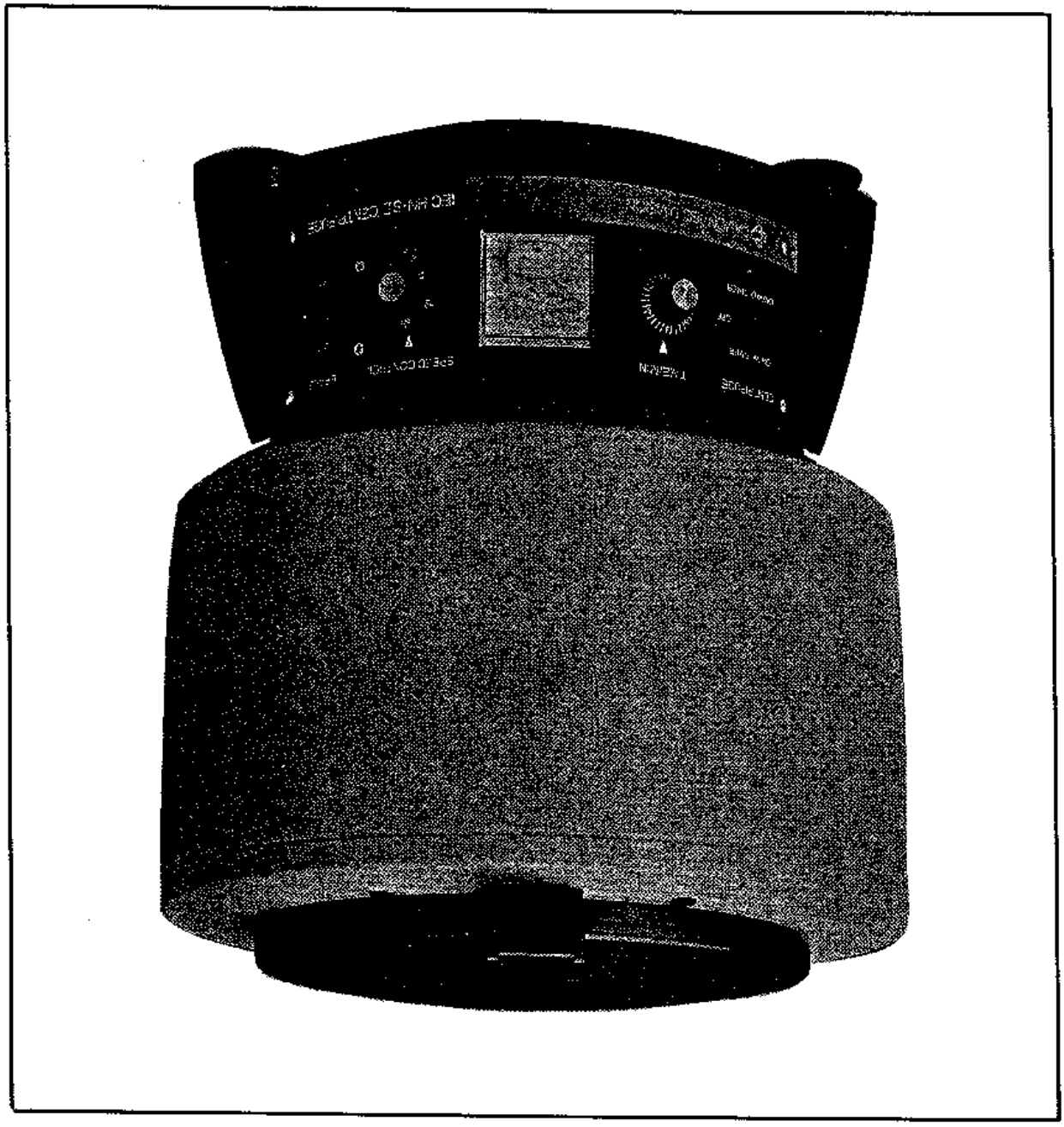

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1.0 GENERAL DESCRIPTION

1.1 Purpose of Manual

This manual provides installation, operating and servicing instructions for the Model **HN-SII** Centrifuge manufactured by the IEC Division of Damon Corporation. The **HN-SII** is a general purpose bench top centrifuge designed for use in the medical, industrial, and scientific laboratory to perform separations by centrifugal force. It is listed as a device in accordance with HEW and FDA regulations governing distribution and use of such products.

The HN-SII is designed for 115 VAC, 60 Hz (Catalog No. 2355), or 230 VAC, 50 Hz operation (Catalog No. 2356).

1.2 Description of Centrifuge

The IEC **HN-SII** Centrifuge combines the economy and space-saving conveniences of bench type centrifuges with many of the performance advantages of larger cabinet models. This versatile unit accepts oil and Babcock testing accessories, a hematocrit rotor, multiple carriers, and more than 50 general purpose laboratory rotor and accessory combinations, with capacities of up to 100 ml bottles. The **HN-SII** provides a maximum speed of 4,900 rpm, maximum relative centrifugal force (RCF) of 2,750 x g, and maximum volume of 684 ml (see Speed/Force Table for accessories). The Hemato-kit™ Rotor (Cat. No. 930) provides 6200 x g at 7800 RPM. It is widely accepted for the most routine applications of clinical and industrial laboratories as well as the more varied, esoteric procedures of research centers.

A solid-state stepless speed control system includes a direct-readout electric tachometer for continuous indication of speed. The system provides automatic acceleration to selected speed, accurate and repeatable to within ± 2% at rated voltage.

The **HN-SII** employs a rugged, series-wound high torque motor. Two permanently sealed self-lubricating ball bearings assure smooth, quiet, and dependable operation.

A 60-minute electric timer automatically shuts the centrifuge off at any pre-determined time between 2 and 60 minutes. A continuous-operation mode is provided for longer runs. The **HN-SII** features an electric brake that can be used to reduce coast time by approximately 50%.

The instrument panel is located at the base of the machine to provide easy access to all controls. The solid, steel construction of the guard bowl and cover contributes to quiet operation, reliability, and operator safety. Three rubber feet mounted on the base absorb sound and vibration, and increase stability. Brushes are accessible for replacement.

1.3 Specifications

Table 1-1 provides a quick-reference listing of the major specifications.

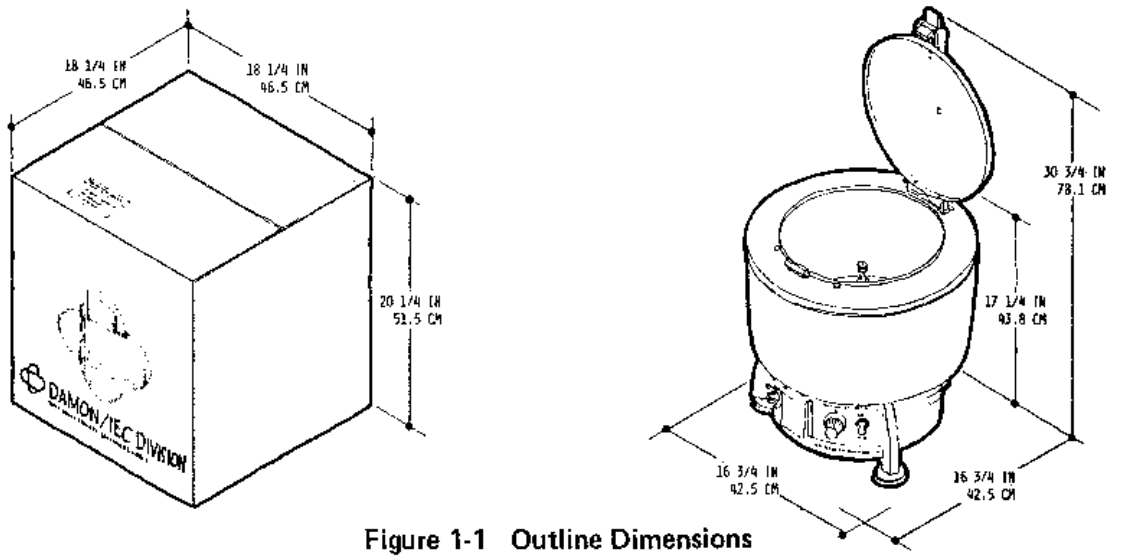


Figure 1-1 Outline Dimensions

TABLE 1 - 1

SPECIFICATIONS

SPEED, ATTAINABLE:	ANGLE	– 4900 RPM W/803 ROTOR, 356 SHIELDS
	HORIZONTAL	– 4150 RPM W/215 ROTOR, 366 TRUNNION RINGS, 369 MULTIPLE CARRIERS
	HEMATO-KIT™	– 7800 RPM W/930 ROTOR ALL AT 120 VAC, 60 Hz
	(See Speed/Force Table for complete accessories and ranges.)	
RCF, ATTAINABLE:	ANGLE	– 2750 x g W/803 ROTOR, 356 SHIELDS
	HORIZONTAL	– 2250 x g W/215 ROTOR, 325 TRUNNION RINGS, 320 SHIELDS, MISCELLANEOUS ADAPTERS
	HEMATO-KIT™	– 6200 x g W/930 ROTOR, ALL AT 120 VAC, 60 Hz
	(See Speed/Force, Table 3-3, for complete accessories and ranges.)	
VOLUME, MAXIMUM:	HORIZONTAL	– 19ml x 36 = 684ml
	ANGLE	– 19ml x 24 = 456ml
TUBE CAPACITY, MAXIMUM:	HORIZONTAL	– 48 TUBES (5ml ea.)
	ANGLE	– 24 TUBES (19ml ea.)
TIMER:	RANGE	– 2 to 60 MINUTES
	TYPE	– ELECTRIC
TACHOMETER RANGE		– 0-9000 RPM
ACCURACY & REPEATABILITY		– ± 2% of FULL SCALE
TACHOMETER GRADUATIONS		– 500 RPM INCREMENTS
CENTRIFUGE MOTOR		– 1/7 HP RATING AT 4000 RPM, 120 VAC, 60 Hz, 3.3 AMP. MAX.
BRAKE RATE		– APPROX. 1/2 of COAST TIME
HEIGHT WITH COVER OPEN		– 78.1 cm (30¾")
HEIGHT WITH COVER CLOSED		– 43.8 cm (17¼")
WIDTH		– 42.5 cm (16¾")
DEPTH		– 42.5 cm (16¾")
INSIDE DIAMETER OF GUARD BOWL		– 41.9 cm (16½")
POWER, NOMINAL		– 115±10% VAC, 60 Hz 3.3 AMPS (CAT. NO. 2355) 230±10% VAC, 50 Hz 1.7 AMPS (CAT. NO. 2356)
POWER CONSUMPTION		– 150 WATTS OPERATING
HEAT PRODUCED		– 520 BTU/HR. OPERATING
NET WEIGHT		– 24.3 Kg (53.5 lbs.)
SHIPPING WEIGHT		– 27.3 Kg (60.1 lbs.)

1.4 Warranty

Damon/IEC Division warrants that it will repair or replace, free of charge to an Authorized Dealer of Damon/IEC Division any instrument which fails within one (1) year after delivery to the original customer because of defective material or workmanship, provided it does not fail under the exceptions and conditions specified in the warranty given with the instrument. Such exceptions and conditions include, but are not limited to, failure of parts due to natural wear, accident, neglect or operation in a manner not prescribed in the operating instructions supplied with the instrument. The foregoing expresses Damon/IEC Division's sole warranty with respect to the instrument. THIS WARRANTY IS MADE IN LIEU OF ANY AND ALL OTHER WARRANTIES AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED AND EXCLUDED. Damon/IEC Division and its Authorized Dealers will not be liable for consequential damages, loss or expense arising from the improper use of the instrument. Damon/IEC Division will not honor any other warranty given by the Authorized Dealer which is different from the warranty given by Damon/IEC Division. This warranty is not assignable and is operative only in favor of the original customer to whom this warranty is delivered.

DEALER OBLIGATION UNDER WARRANTY

1. Any instrument having a retail value of over $1000 will be installed by an Authorized Factory-Trained Dealer Serviceperson and the customer will be instructed in its use by a dealer representative.
2. Customers requesting service for an instrument during the period covered by warranty should receive a response, within a 48-hour period, from the Authorized Dealer who sold the instrument. If this obligation is not met and the customer so advises Damon/IEC Division, such Authorized Dealer will be notified of, and responsible for, the action taken, and expense incurred, by Damon/IEC Division in satisfying the customer.

DISCLAIMERS AND EXCLUSIONS

The Installation, Operation and Service Manual supplied with this instrument includes a service trouble-shooting chart. However, you are under no obligation to locate or remedy any service problem. You hereby release and forever discharge Damon/IEC Division, its successors, assigns, subsidaries, affiliates, officers, agents, and employees from any and all claims, demands and liabilities in law or in equity, of any nature, based upon, arising out of, or resulting from locating, remedying or attempting to locate or remedy any service problem. Should service be required, contact the dealer from whom you purchased this instrument to obtain service by factory-trained personnel.
The information included in this Installation, Operation and Service Manual is believed adequate for the operation and intended use of this instrument. If the instrument is to be used for any purpose exceeding or deviating from the capabilities specified herein, then written confirmation of acceptability for such purpose should be obtained from Damon/IEC Division. Failure to do so will affect the warranty, and Damon/IEC Division will not guarantee any results nor assume any obligation or liability arising from such unconfirmed action.

1.5 Ordering Information and Factory Returns

To obtain service and/or replacement parts under warranty, you should contact the authorized Damon/IEC Division dealer from whom you purchased your machine, or write directly to Damon/IEC Division, 300 Second Avenue, Needham Hgts., Massachusetts 02194, Attention: Service Manager. Your correspondence must include the model and serial number of your machine, the date of its delivery, and the name of the dealer from whom you purchased it. Damon/IEC Division can not accept goods returned without proper authorization. A "Returned Goods Authorization" must be obtained through a dealer and accompany the prepaid return shipment.
To obtain service and/or replacement parts not under warranty, or to order additional accessories, you may contact any authorized Damon/IEC dealer.

NOTE: In the event you wish to return the machine or any part, you must comply with the following:

1. If the machine or any part has been exposed or used to process potential pathogenic or radioactive material, you are required to decontaminate the machine or part being returned to insure there is no radioactivity or harmful bacteria present and to advise us accordingly.

2. Decontaminate the machine or any part that may have accumulated blood or any other chemical deposits by using standard laboratory procedures. Should this machine or any part be received in a condition we consider to be a potential biological hazard to our personnel, it will be returned to you unrepaired, at your expense, along with a report of our findings.

1.6 Registration of Instrument

For registration purposes please fill out the Warranty Registration/Installation Report form supplied with the instrument. Return the completed form to Damon/IEC Division.

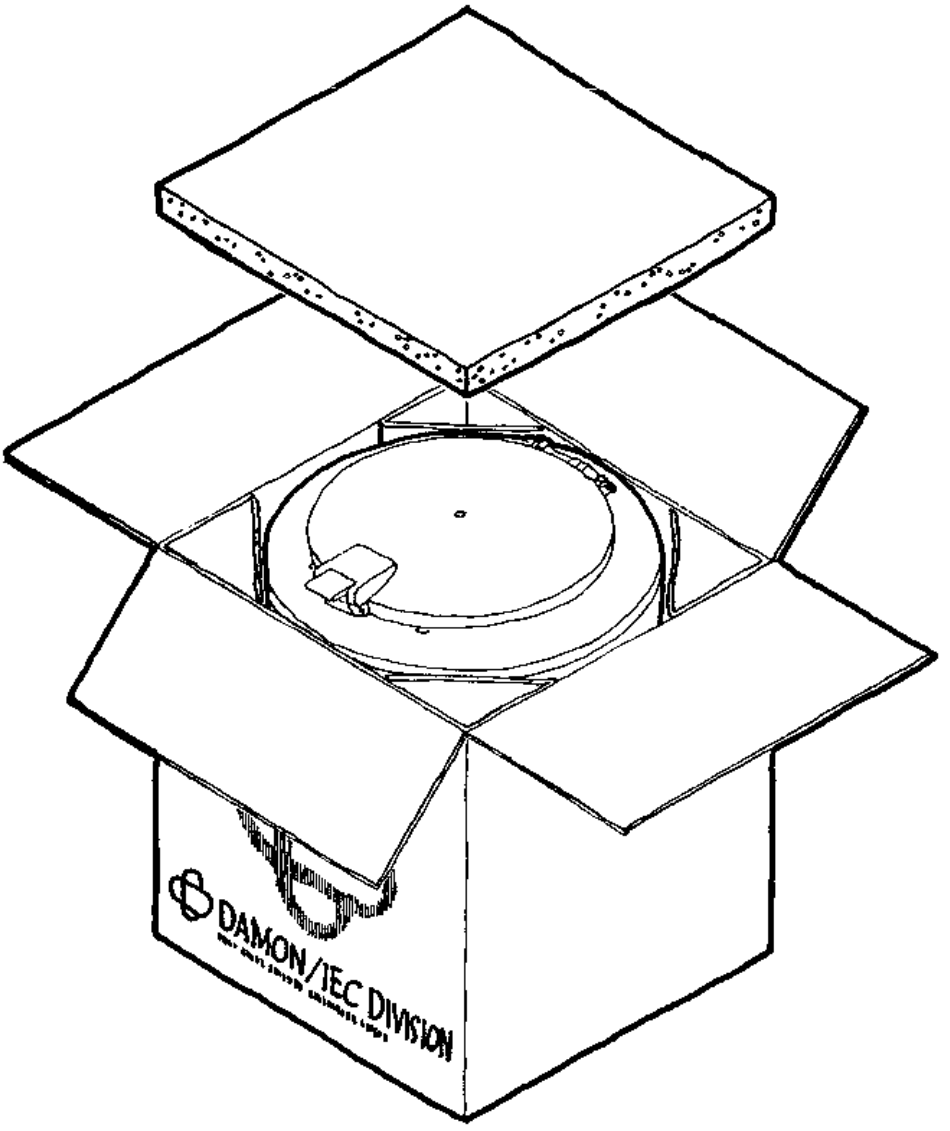


Figure 2-1 Unpacking

2.0 INSTALLATION

2.1 General

The **HN-SII** Centrifuge is shipped in a special carton designed to protect the machine from shipping hazards. Installation of the centrifuge includes an initial inspection of the carton before acceptance from the shipper, moving the carton to the operating location or incoming inspection area, unpacking, preliminary checkout, and installation for use.

2.2 Receiving Inspection

Before signing the delivery receipt and accepting the shipment, inspect the shipping carton for any signs of mishandling, such as broken or dented sides. Damage to the carton must be noted and a written statement made on the delivery receipt before signing, describing the nature of the damage. A normal or undamaged carton does not necessarily ensure that the contents have not been damaged during shipping. If mishandling or damage is suspected, contact the office of the carrier so that a representative may witness the unpacking. The centrifuge and other contents of the carton should be carefully examined as the unpacking proceeds. Any damage discovered which can be attributed to mishandling or shipping damage should be documented and a signed inspection report should be furnished to the shipping company. Damon/IEC Division is not responsible for damage incurred in transit.

2.3 Unpacking the HN-SII Centrifuge

Unpack the centrifuge at the intended operating location or at a convenient area for inspection. Keep all shipping documents. Open the top of the carton and remove all accessible packing material and shipping supports. Remove centrifuge from carton by reaching inside carton, grasping lower curvature of guard bowl, and lifting out the centrifuge. Avoid grasping Tachometer meter (below lower curvature; located beneath cover latch). Save the carton and shipping material for possible re-location.

2.4 Line Voltage Check

The line voltage supply must be within six feet of the **HN-SII** centrifuge as a standard three wire grounded single phase circuit. It must be easily accessible to allow a rapid disconnect in case of an emergency, and as a protective precaution during machine maintenance. Check the line voltage and frequency requirements of the machine, shown on the data plate at the rear of the machine. Use an AC voltmeter to measure the voltage available at the power socket, and check with your power company as to line frequency.

Proceed as follows:

1. 115 VAC, 60 Hz machine (Catalog No. 2355): Line voltage must be between 103 VAC and 127 VAC. If outside these limits, an external voltage step-up or step-down transformer will be required.

2. 230 VAC, 50 Hz machine (Catalog No. 2356): Line voltage must be between 206 VAC and 254 VAC. If outside these limits, an external voltage step-up or step-down transformer will be required. Line frequency must not be below 48 Hz.

If the line voltage and frequency are suitable for your **HN-SII**, you are ready to proceed to the installation checkout. Note that fluctuations in line voltage or frequency will slightly alter the machine's performance with respect to the values listed in the Speed and Force Tables of this Manual.

2.5 Installation Checkout

Perform the installation checkout procedures as listed below. Refer to Section 3.0, OPERATION, and Figure 3-1 as needed. In case of improper machine operation at any of these checkout steps, or in case of no operation, consult your authorized Damon/IEC dealer, or see the trouble shooting chart in this Manual. See also the warranty in paragraph 1.4.

1. Check that the centrifuge is on a firm, non-resonant surface.

2. Lift the cover, and remove all materials from inside the chamber.

3. Install a rotor on the shaft, and tighten the knurled nut finger-tight (see paragraph 3.5.1).

4. Close the cover and latch tightly.

> *WARNING: Never open the cover while centrifuge is in operation.*

5. Set the Power Switch (S2) to OFF (center position).

6. Set the Speed Control knob to OFF.

7. Insert the power plug into the power socket.

8. Turn on power by setting the Power Switch (S2) to ON/WO TIMER.

9. Slowly advance the Speed Control (R1) for a rotor speed of 1,000 rpm as indicated on the Tachometer (M1).

10. Return the Power Switch (S2) to OFF (center position). The centrifuge will start to slow down.

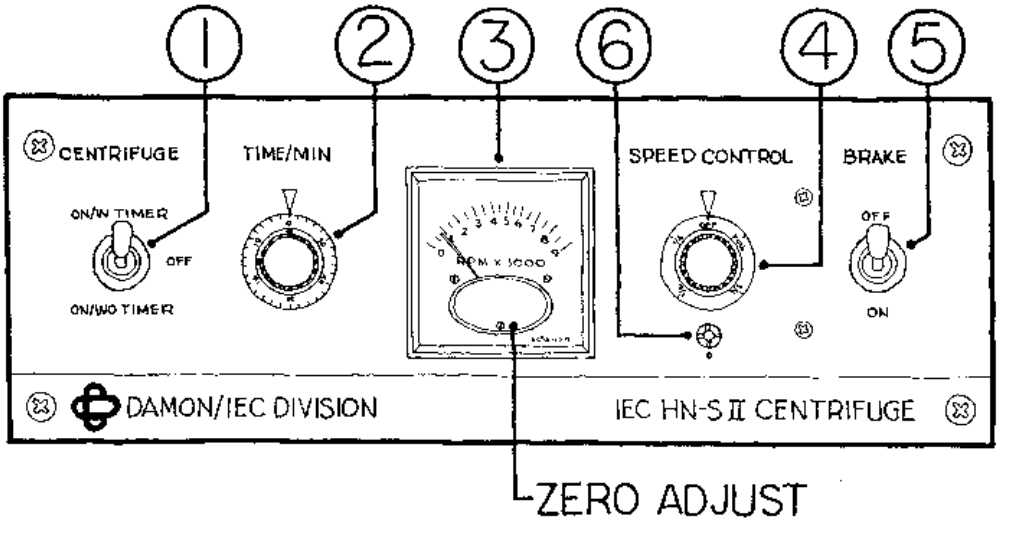
11. While the rotor is still coasting, press the spring-loaded Brake Switch (S1). Listen for a slowing effect, and note the reduction in speed as shown on the Tachometer (M1). Hold the switch down until Tachometer (M1) indicates zero (0) RPM. Continued braking after the rotor has come to a stop gives reverse motor rotation, with possible damage to the motor brushes.

12. Advance the Timer (M2) to 10 minutes, then return to a 3-minute setting.

13. Turn on power by setting the Power Switch (S2) to ON/W TIMER.

14. The centrifuge will now operate for approximately three minutes, and turn off automatically at the end of that interval.

15. Return the Power Switch (S2) to OFF (center position).



1. Power Switch (S2)

2. Timer (M2)

3. Tachometer (M1)

4. SPEED CONTROL (R1)

5. BRAKE Switch (S1)

6. Calibration Potentiometer (R5)

NOTE: Letters enclosed in parentheses refer to schematic and wiring diagram designations for these items. Refer to paragraph 5.0 for component part numbers. Refer to paragraph 4.11 for ZERO ADJUST.

Figure 3-1 Control Panel

3.0 OPERATION

3.1 General

This section of the manual contains instructions for the operation of the centrifuge, and is intended primarily to acquaint the user of the instrument with the various controls, indicators, and operating characteristics.

3.2 Description of Operation

Centrifuge operation normally requires the following steps: installing a rotor, installing balanced accessories and a balanced load, selecting the speed and timing, closing and latching the cover, applying power, and starting the run cycle.

3.3 Control Panel

All of the controls and indicators necessary to operate and monitor the centrifuge are on the Control Panel, shown in figure 3-1.

1. Power Switch (S2) This three position toggle switch is used to control power to the instrument and to select the mode of operation.
Its three positions are:
   (1) ON/W TIMER for timed runs.
   (2) OFF for power off (except to brake circuit).
   (3) ON/WO TIMER for untimed runs.
Set this switch to OFF when the instrument is not in use.

2. Timer (M2) This electrical timer is used to select the run cycle time when the Power Switch (S2) is in the ON/W TIMER position. The total run cycle time can be selected from 2 to 60 minutes. For timed periods of less than ten minutes, set the control beyond the ten-minute position to close the internal timer switch, and then turn back to the desired time. For timed periods of ten minutes or more, simply advance the knob to the desired setting. When the timer control knob runs down to zero, the power is removed from the motor.

3. Tachometer (M1) This Tachometer is an electrical voltmeter, displaying in RPM, which operates from a tachometer generator connected to the drive motor. Readout is from 0 to 9,000 RPM, in 500 RPM increments. Accuracy of the reading is ± 2% of full scale.

4. SPEED CONTROL (R1) This potentiometer controls the speed of the centrifuge through the speed control circuit board. Fractions marked on the knob *are for reference only*. For maximum accuracy and repeatability, set speed by reference to the Tachometer.

5. BRAKE Switch (S1) This switch is a spring-loaded toggle switch which returns to OFF when released. It is used to increase deceleration, and can reduce coast time by approximately 50%. Be sure to switch the Power Switch to OFF before using the BRAKE Switch at the end of a run cycle. Release the BRAKE Switch when the rotor comes to a stop, otherwise the rotor will begin to turn in the reverse direction, with possible damage to the motor brushes.

6. Calibration Potentiometer (R5) This potentiometer is used to calibrate the Tachometer, and is not used in everyday operation. Adjustments are to be made by factory-trained personnel only.

3.4 Operational Precautions

1. Do not operate rotors which do not have a full complement of accessories. See paragraph 3.5.2.

2. Load and balance all rotors properly. See paragraph 3.5.2.

3. CAUTION: Do not use mercury in cups or shields for balancing purposes. See paragraph 3.5.2.

4. Do not use other manufacturer's accessories on Damon/IEC centrifuges. Doing so will void the Damon/IEC Warranty.

5. Do not adjust any of the potentiometers on a printed circuit board or on the Control Panel unless recalibration is necessary, and then only by use of the established recalibration procedure, with the proper equipment, as outlined in this manual, and by factory-trained service personnel only.

6. Do not block the vent hole in the cover or on the louvered cover plate on the bottom of the machine. Doing so may result in excessive heat buildup and early failure of components and/or damage to samples.

7. Never open the cover while the rotor is spinning.

8. Replace the knurled nut securely by hand even when no rotor is installed, to prevent loss.

9. Turn the Power Switch to OFF when the instrument is not in use.

10. Do not use the centrifuge chamber for storage purposes.

11. Always pull out the power plug before cleaning the machine. Clean immediately after *any* spillage occurs, with mild soap and a cloth dampened with warm water. CAUTION: Do not use acetone type cleaners. See paragraph 3.13.

12. WARNING: REMOVAL OF THE CONTROL PANEL OR BOTTOM PLATE WILL EXPOSE ELECTRICAL SHOCK AREAS WHERE POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

3.5 Operating Procedures

Operating procedures include installing the rotor, loading the rotor, setting the controls, performing the run cycle (with timer or without timer), determination of Relative Centrifugal Force (RCF) (see Table 3-1), and removing the rotor.

3.5.1 Installing the Rotor

Set all controls to their OFF position, and then unlatch and open the cover. Remove the knurled nut from the top of the motor shaft by turning the nut counter-clockwise (CCW). Align the keyway in the rotor with the key on the shaft, and place empty rotor on shaft. Replace the knurled nut and tighten finger-tight. Always install the rotor without accessories, and then add shields, trunnions, glass, or plasticware as needed. Insert the larger rotors through the guard bowl opening with care. The normal direction of rotation is counter-clockwise (CCW), as viewed from above.

3.5.2 Loading the Rotor

If constant vibration is noted during normal laboratory use, this is almost always caused by an unbalance in the rotor loading. The operator should be certain that the rotor is loaded symmetrically and with a full complement of accessories, and that the shields, trunnion rings, cups and/or carriers are all within 0.5 grams of each other. Also check that each shield has an equal number of the proper cushions. Tubes with samples must be of equal weight.
It is essential that only Damon/IEC rotors and accessories be used on this centrifuge.

Accessory balance is an important factor in prolonging the life of the armature and bearings. Damon/IEC rotors, as well as all rotating parts of the centrifuge, are dynamically balanced at the factory. In addition, Damon/IEC trunnion rings, shields, cups and carriers are weighed and matched to one-half gram. The gram weight is stamped on each piece.

All horizontal rotors should be loaded with a full complement of accessories to prevent unequal stresses on the rotor during operation.

To obtain good dynamic balance the opposite loads must not only be equal in mass, but must have the same center of gravity. Take care to select centrifuge tubes and bottles in pairs which are alike in shape, thickness, and distribution of glass or plastic. The larger the container, the more critical the selection should be.

When measuring weight, use a laboratory balance having a sufficient capacity to handle the size container being used, and which has a sensitivity of one-tenth of a gram at full load.

The following balancing technique renders the best possible weight distribution, as well as providing maximum external support for the glassware or plasticware.

1. Place opposite cups containing filled glassware or plasticware on the balance.

2. To the lighter centrifuge cup, add water around the glassware, or plasticware, until the assembly is balanced.

CAUTION

Mercury should never be placed in cups or shields for balancing. Mercury vapors are toxic, and will react with aluminum.

3.5.3 Control Settings Prior to Run Cycle

Set panel controls as follows before starting the Run cycle:

1. Power Switch (S2) ..... OFF position
2. Timer (M2) ..... 0 minutes
3. Speed Control (R1) ..... OFF position

3.5.4 Run Cycle with Timer

1. Install rotor (see paragraph 3.5.1)
2. Load rotor (see paragraph 3.5.2)
3. Close and latch cover.
4. Turn Timer knob to the desired time setting.
5. Set the Power Switch to ON/W TIMER position.
6. Slowly turn the SPEED CONTROL knob to the desired setting.
7. Check the Tachometer to insure desired speed is achieved.
8. When the timer returns to zero (0 minutes), the motor power will shut off and the loaded rotor will coast to a stop. For increased deceleration, set the Power Switch to OFF and press the Brake Switch (S1). Release the BRAKE Switch when the rotor has come to a stop, as indicated on the Tachometer.

3.5.5 Run Cycle Without Timer

1. Install rotor (see paragraph 3.5.1).
2. Load rotor (see paragraph 3.5.2).
3. Close and latch cover.
4. Set the Power Switch to the ON/WO TIMER position.
5. Slowly turn the SPEED CONTROL knob to the desired setting.
6. Check the Tachometer to insure desired speed is achieved.
7. The centrifuge will continue operation until the run is terminated by the operator. The run is terminated by:
   (1) Returning the SPEED CONTROL knob to OFF, and
   (2) Setting the Power Switch to OFF.
8. After the run is terminated, the rotor will coast to a stop. For increased deceleration, set the Power Switch to OFF and press the BRAKE Switch (S1). Release the BRAKE Switch when the rotor has come to a stop as indicated on the Tachometer.

3.5.6 Determination of RCF

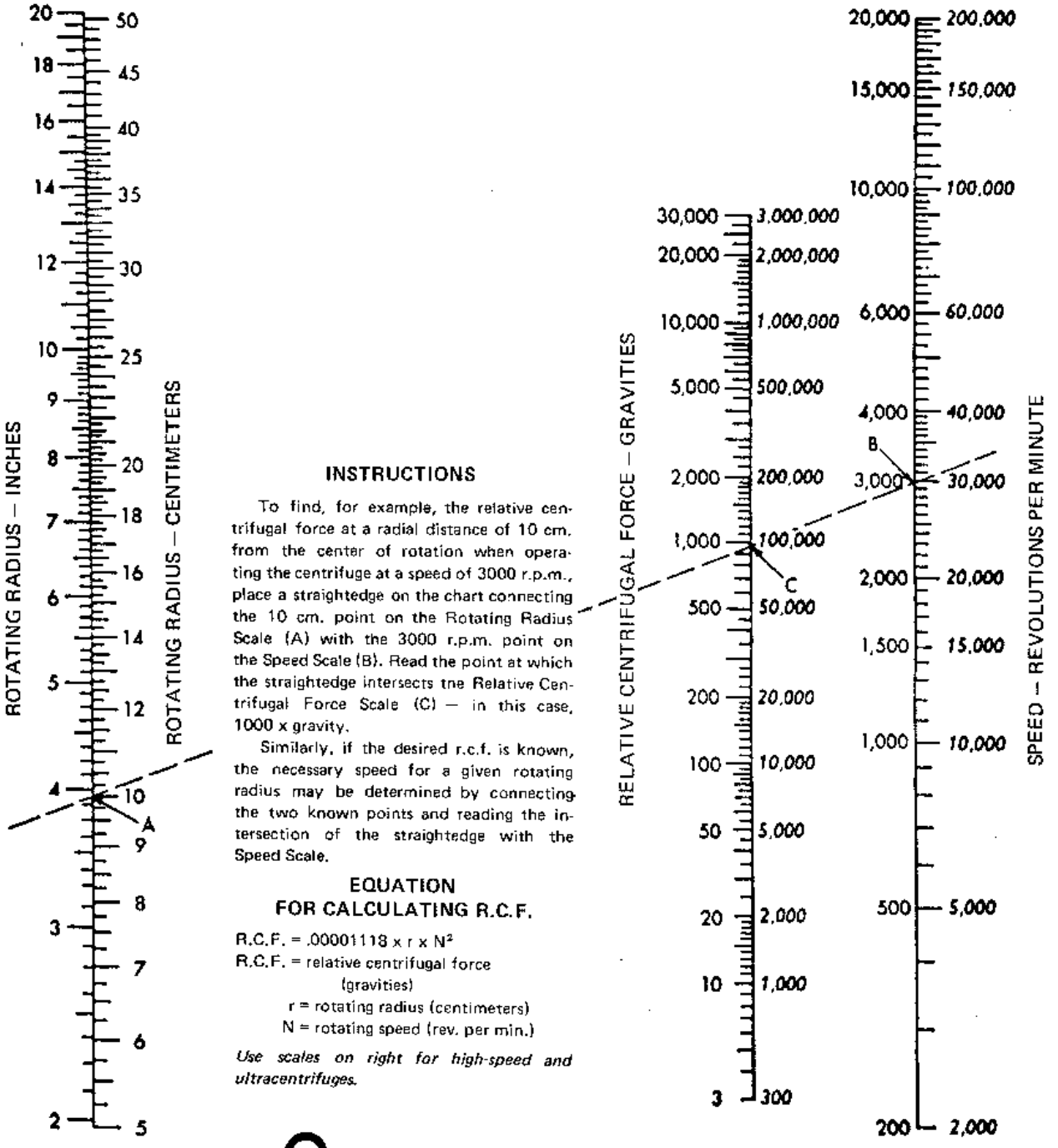
The Relative Centrifugal Force, in units of "g", may be determined by using the Damon/IEC nomograph which is shown in Table 3-1, or refer to the Speed/Force Table for maximum values, where "g" represents the force of gravity.

3.5.7 Removing the Rotor

Always unload the rotor before removing it from the centrifuge. The rotor can then be removed without damage to the centrifuged media or its containers.

When removing the rotor, it is helpful to first loosen the knurled nut, leaving it in place. Lift upward on the rotor with the fingers while pressing downward on the knurled nut with the thumbs. This procedure will normally provide all the leverage necessary to remove the rotor from the tapered shaft and keyway. If the rotor cannot be removed by using this procedure, check that the knurled nut is protecting the shaft threads, by screwing down several turns without contacting the rotor. Using a rubber-headed mallet, lightly tap the knurled nut flatly on its top surface while pulling upward on the rotor. When the rotor is loosened, remove the knurled nut and lift the rotor from the shaft and out of the guard bowl. Take care not to damage the screw threads while removing the rotor. After removal, screw the knurled nut back in place to prevent loss.

THE IEC RELATIVE CENTRIFUGAL FORCE NOMOGRAPH



INSTRUCTIONS

To find, for example, the relative centrifugal force at a radial distance of 10 cm. from the center of rotation when operating the centrifuge at a speed of 3000 r.p.m., place a straightedge on the chart connecting the 10 cm. point on the Rotating Radius Scale (A) with the 3000 r.p.m. point on the Speed Scale (B). Read the point at which the straightedge intersects the Relative Centrifugal Force Scale (C) — in this case, 1000 x gravity.

Similarly, if the desired r.c.f. is known, the necessary speed for a given rotating radius may be determined by connecting the two known points and reading the intersection of the straightedge with the Speed Scale.

EQUATION FOR CALCULATING R.C.F.

$R.C.F. = .00001118 \times r \times N^2$

R.C.F. = relative centrifugal force (gravities)

r = rotating radius (centimeters)

N = rotating speed (rev. per min.)

Use scales on right for high-speed and ultracentrifuges.

DAMON/IEC DIVISION

300 SECOND AVE., NEEDHAM HTS., MASS. 02194, TEL: (617) 449-0800

Table 3-1 Damon/IEC Nomograph

3.6 Operators Reference Data

The following paragraphs present valuable reference data for the operator, with emphasis on detail and with the goal of providing a maximum of complete information. The tabular information shown in this manual provides information on a wide range of tubes and centrifuge bottles. The following paragraphs refer to these tables.

3.6.1 Tubes and Bottles

IEC plastic centrifuge tubes and centrifuge bottles referenced by catalog number in the tables at the rear of this section of the manual will withstand the maximum "(g)" forces listed *if in good condition.* Plasticware having such conditions as crazing or deformation should be discarded. All plasticware should be filled to at least 85% of nominal ml capacity when centrifuged at or near the maximum RPM.

Other manufacturer's centrifuge tubes and centrifuge bottles, as listed in these tables by their catalog or code numbers, may be used. However, Damon/IEC Division does not guarantee performance of other manufacturer's centrifuge tubes or centrifuge bottles including those listed in the tables. When selecting tubes for use in the centrifuge refer to the manufacturer's recommendations and claims regarding tube strength and suitability for centrifuge use.

3.6.2 Tube Nominal Capacity in ml

See Table 3-2, "IEC Centritubes™ ", for a listing of nominal ml for IEC centrifuge tubes and centrifuge bottles. IEC plastic caps can be assembled to these tubes when filled to nominal capacity without displacing the liquid contents.

3.6.3 Maximum Attainable RPM

The maximum attainable RPM listed in Table 3-3 is based on a line voltage supply of 120 VAC. Speeds listed will be maintained relatively contant for ±5% change in line voltage. The maximum values of RPM listed require the following:

1. Centrifuging the full complement of the specific accessories listed at the RPM shown under "Maximum Attainable RPM".
2. Use of tubes of the same length and fill level, to assure symmetrical loading and good balance.

3.6.4 Loading Requirements

Damon/IEC does not recommend that multiple combinations be used. Examples of such non-recommended loading would include loading such as four trunnion rings with shields and two multi-carriers on a six-place horizontal rotor.

Best operating results will be obtained with a balanced, fully-loaded rotor. If a complete complement of full tubes cannot be used, at least all accessory items (trunnions, shields, etc.) must be in place.

3.6.5 Strength Considerations

The maximum allowable values of RPM followed by (+) and footnoted "Speed Limited" *must not be exceeded* because of strength limitations of sample containers.

3.6.6 Rotating Radius (Refer to Figure 3-2)

The "rotating radius" is the distance measured from the rotor axis to the tip of the liquid inside the tubes at the greatest horizontal distance from the rotor axis.

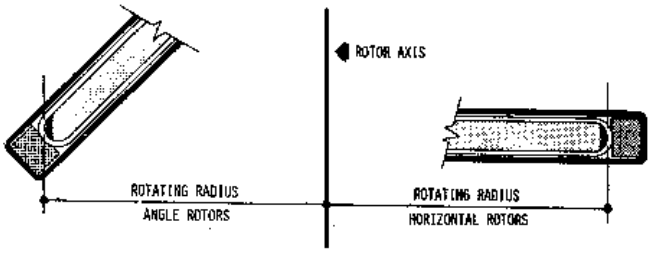


Figure 3-2 Rotating Radius

3.6.7 Maximum Tube Lengths

The maximum tube lengths listed in the tables at the rear of this section include caps or stoppers assembled to the tubes. The column which lists the maximum tube sizes for the specified combination of accessories give dimensions which allow for clearance of the tube O. D. in the accessory and rotational clearance in horizontal rotors. Maximum lengths for angle rotors have been restricted to ¾" (19mm) above the tube support area in shields, carriers, and adapters.

3.6.8 Minimum Tube Diameter x Maximum Length in mm

For horizontal rotors, the recommended minimum tube diameters are, with few exceptions, approximately 0.080" (2mm) less than the maximum tube diameters. This is a guideline to prevent excessive clearance and resulting poor support between the tubes and bottles and their respective holders. The recommended maximum lengths generally allow for a maximum of 1½" (38mm) above the support area of the shield, adapter, carrier or cup.

For angle rotors, the recommended minimum tube diameters are approximately 0.080" (2mm) less than maximum tube diameters, or the same as with horizontal rotors. However, the recommended tube lengths generally allow for only ¾" (19mm) of tube length to be above the tube support area of the shield or adapter.

3.6.9 Table Notes and Legends

The notes and legends listed below apply to the tables which follow.

1. 1113* Adapter – "Use plastic tubes only" – 1113 adapter does not have spherical bottom in the adapter cavity. Glassware should not be used.

2. "Omit Caps" – This instruction indicates that the use of a cap with the referenced accessory would increase the overall length of the accessory (e. g. 298 and 300 tubes) beyond the length which will physically fit in the given combination.

3. 305A where listed – The 305A is a 305 shield with a catalog 571 cushion, to accept tubes and adapters with round bottoms. Rotating radius is greater than when using the 320 shield.

4. 398A – The 398A is a 398 carrier with a catalog 668 cushion. This allows the 398 carrier to accept the 2858, 2837, and 1648 tubes in the 958 rotor. The rotating radius is greater than when using the standard 398 carrier with the 570 cushion. The greatest volume centrifuged in the instrument is obtained when using the 398A with 36 – catalog 2837 tubes. 36 x 19ML = 684ML

5. "1127, 1128, 1129 Not Recommended. Adapters too short." – Use of these adapters in the 303, 302, and 306 shields causes these adapters to be below the top of the shields. If used, tweezers, pliers, etc., would be needed to remove tubes from adapters. This may be an *inconvenience* to some users. Damon/IEC does *not* forbid these adapters to be used in these shields provided tube diameters and tube lengths are within the recommended dimensions for each adapter.

6. "1125 Adapter. Not Recommended. Adapter too Long" – (For 356 shield in 803, 809, and 815 rotors.) Use of this adapter in the above rotors using the 356 shield allows the adapter to protrude beyond the ¾" recommended limit above the support area of the shield. The 303 and 302 shield will properly accept this adapter.

3.7 Preventive Maintenance

Preventive maintenance includes those procedures designed to ensure continued operation of the centrifuge with a minimum of "down-time" which may be caused by failure of a part or by unsatisfactory operation. The most important feature of preventive maintenance lies in the care and cleaning of the centrifuge, with special attention to the rotors, cups, and carriers, for the prevention of corrosion.

3.8 Corrosion

The operator or person responsible for preventive maintenance must be careful to prevent corrosion of the rotors and structural accessories (shields, cups and carriers). These parts are manufactured by Damon/IEC, and are properly finished and checked by quality control facilities before leaving the factory. Consideration has been taken in their design and manufacture to provide a maximum resistance to corrosion. However, long-term satisfactory operation requires a high standard of preventive maintenance to maintain this high level of corrosion resistance. If corrosion is allowed to continue, small cavities will form within the part which will grow deeper with continued operation, resulting in eventual failure. Deep-seated corrosion may also occur, and be more serious than appears on the surface.

3.9 Inspection

Before and after each run, accessories should be routinely examined for corrosion and cracks. Give special attention to the inside and bottom of rotor cavities, shields, and cups, and to the inside surfaces of multiple carriers. If corrosion is found, and cannot be removed (see paragraph 3.12), discard the accessory immediately and order a replacement from your authorized Damon/IEC Distributor.

3.10 Corrosion Prevention

The hazard of corrosion can be almost completely eliminated by conscientious operator technique. After each run, the part should be rinsed in warm tap water and finally in distilled water. If material is spilled onto the part, it should be washed out with a MILD DETERGENT solution, and the cavities scrubbed with a stiff test-tube brush having end bristles. The part should be rinsed in warm tap water after scrubbing, and given a final rinse in distilled water. When particularly caustic materials are run, this procedure should be carried out immediately upon completion of the run.

3.11 Drying

After the part has been thoroughly cleaned, it is important to dry it properly, preferably by wiping with a clean, absorbent towel. A drying oven may be used, but the temperature should not exceed 80°C. Angle rotors should be stored open to the atmosphere. Horizontal rotors should be turned upside down to expose the greatest amount of surface area. Shields, cups, and carriers should have their cavities open to the atmosphere. Parts should be stored on a soft surface to prevent damage to anodized or other finished surfaces. Parts may be stored under refrigeration, after the proper cleaning and drying procedures have been followed, when the part is in routine use. For general storage, however, it is advisable to store the part clean and dry at room temperature. Parts should not be stored wrapped in a plastic bag, as moisture may be trapped or develop in the bag, with resulting corrosion.

3.12 Corrosion Removal

If corrosion occurs, it is of the utmost importance to remove it as soon as possible. The following procedure is recommended.

1. The part should be soaked to remove deposits from the metal surface. Use a mild detergent solution. Do not use soaps or detergents which contain strong alkalis.

2. Scrub the part thoroughly with a stiff test-tube brush having end bristles. Pay particular attention to the bottom of the tube carriers, and to multiple carriers.

3. Allow the part to soak again in clear warm water for a minimum of one hour.

4. Rinse the part well in warm water, and finally rinse thoroughly in distilled water.

5. Dry the part thoroughly with a clean, absorbent cloth.

6. If corrosion cannot be removed with a tube brush, discard the item and order a replacement from your authorized Damon/IEC dealer.

3.13 Cleaning the Centrifuge

The centrifuge should be maintained in a clean, uncluttered condition, to insure satisfactory operation and a long service life. The following procedure is recommended:

1. Always unplug the power cord for safety during cleaning.

2. Unlatch and open the cover of the centrifuge, and remove the rotor.

3. Check the guard bowl for spillage or broken glass. Remove with a vacuum cleaner if possible. Clean with a damp sponge. Remove rubber cushions and replace in case of glass breakage. Grey dust is the result of finely ground glass. This must be removed to insure satisfactory motor life, to prevent sample contamination, and to prevent abrasion of the inside painted surfaces.

4. Clean the inside of the guard bowl, and then the outside, using a moist (not wet) sponge, with warm water and a mild detergent. Repeat using clear warm water.

5. Observe the following precautions at all times:

   a. Never use an abrasive cleaner or steel wool pads. If there are stubborn stains, remove them with a plastic scrub pad.

   b. Never pour water into the guard bowl chamber.

> *WARNING*
>
> *When the cleanup involves hazardous, contaminated, or radioactive material, wear rubber gloves and take any other precautions appropriate to the hazards involved. Contact laboratory safety personnel, if available.*

Table 3-2 IEC Centritube™ Table

IEC Centritubes

Centritubes are manufactured specifically for centrifugation to International Equipment Company (IEC) specifications. Each IEC tube, bottle and cap is designed and molded for perfect fit, maximum strength and wide versatility

"Oak Ridge" Type Screw Cap Tubes

"Oak Ridge" type screw-cap Centritubes eliminate the need for costly, time-consuming 5-piece metal sealing sytems. With a simple twist of the wrist, a one-piece IEC knurled metal cap seals tightly, assuring a positive vacuum tight seal. The caps are available in anodized aluminium and teflon coated aluminium.
"Oak Ridge" type screw cap tubes are ideal for working with virological or other infectious material, and are available in polypropylene and Autoclear polycarbonate.
Plastic screw caps are supplied with the tubes and may be safely used in low speed centrifuges.

Autoclear Polycarbonate Tubes			Metal Screw Caps		
Tubes Catalog No.	Nominal Capacity (ml)	Outside* Dimensions (mm)	Replacement Plastic Screw Caps Catalog No.	Anodized Aluminum Catalog No.	Teflon Coated Aluminum Catalog No.
2067	10	16.1x81.4	2887	2066	2064
2055	30	25.3x93	2886	2056	2057
2053	50	28.6x106.1	2888	2063	2054
2059	73	38.1x110.2	2889	2060	2058

*Includes Plastic Cap

Polypropylene Tubes			Metal Screw Caps		
Tubes Catalog No.	Nominal Capacity (ml)	Outside* Dimensions (mm)	Replacement Plastic Screw Caps Catalog No.	Anodized Aluminum Catalog No.	Teflon Coated Aluminum Catalog No.
2046	10	16.1x81.4	2887	2066	2064
2047	30	25.3x93	2886	2056	2057
2048	50	28.6x106.1	2888	2063	2054

*Includes Plastic Cap

Round Bottom Polypropylene Tubes

IEC general purpose polypropylene Centritubes are molded from a special high strength resin which is the clearest of the translucent polypropylene plastics. All are autoclavable.

Tubes Catalog No.	Nominal Capacity (ml)	Outside Dimensions (mm)	Plastic Caps Catalog No.	Aluminum Sealing Caps Catalog No.
1629	13	16x98.3	1514	1578
1630	46	28.6x103.8	1518	1580

Autoclear Conical Graduated Tubes

Autoclear polycarbonate graduated tubes are ideal for clinical work requiring percise graduations and are molded under extremely close tolerances.

Tubes Catalog No.	Nominal Capacity (ml)	Outside Dimensions (mm)	Plastic Caps Catalog No.
2809	50	28.6x133.4	1518
2810	15	16.8x119.1	2884

Autoclear® Round Bottom Tubes

Autoclear round bottom tubes combine many of the advantages of glass with the strength and economy of plastic. Ideal for high or low speed applications, these crystal clear polycarbonate tubes are shatterproof, autoclavable and resistant to most chemicals.

Tubes Catalog No.	Nominal Capacity (ml)	Outside Dimensions (mm)	Plastic Caps Catalog No.	Aluminum Sealing Caps Catalog No.
2852	3	10.9x54.7		
2804	4	10.9x77.2	2880	
1696	8	16x60.3	2876	
1698	8.5	13x106.3	1699	
2816	10	14.5x96	1676	1586
2801	10	16.1x76.2	2877	1183
1649	12	16.0x98.7	1514	1578
2808	12	20.4x60.4	1677	
1648	15	16x114.3	1514	1578
2805	22	18.7x111.1	2881	
2802	30	25.3x88.9	2878	1177
2997	47	28.6x103.8	1580	1580
2806	96	31.9x161.8	2882	

Transparent Polyallomer Tubes

Special IEC transparent thin-walled polyallomer tube combine the flexibility and capacity of cellulose nitrate with the autoclavability and chemical stability of polypropylene. Ideal for gradient or routine analysis, these tubes may be easily pierced with a hypodermic syringe.

Tubes Catalog No.	Nominal Capacity (ml)	Dimensions (mm)	Plastic Caps Catalog No.	Aluminum Sealing Caps Catalog No.
2841	3.5	10.9x54.7	1524	
2840	5	10.9x77.2	1524	
2860	9	16.1x57.9	2897	
2836	10	12.7x98.4		
2864	10	12.7x108		
2842	12	14.5x96	1514	
2850	12	16.1x76.2	2897	1181
2859	16	16.1x101.6	2897	
2858	17	16.1x108	2897	
2837	19	16.1x114.3	2897	
2839	28	26.2x66.8	2899	
2847	37	25.4x88.9		1175
2828	52	28.6x103.7		

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 1 of 6)

CAT. ROTOR AND NO. OF PLACES	CAT. TRUNNION AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
204(4)		338		100ML OIL BOTTLE KIMAX45244 (PEAR SHAPED)		100	4 x 100	400	2500	1350	19.2	7.550		
215(4)	310(1)	356			2046 2067 2801	10-13	4 x (10-13)	40-52	3900	2225	13.1	5.179	17.2 x 113	15.3 x 104
		356			1629 1649 2850	10-13	4 x (10-13)	40-52	3900	2225	13.1	5.179	17.2 x 113	15.3 x 104
		356		1125(1)	1698 2836 2864	8-10	4 x (8-10)	32-40	3900	2225	13.1	5.179	13.6 x 114	11.7 x 114
		356		1126(1)	2804 2840	4-5	4 x (4-5)	16-20	3900	2225	13.1	5.179	11.1 x 114	9.3 x 105
		356		1127(1)	2804 2840	4-5	4 x (4-5)	16-20	3900	2225	13.1	5.179	11.1 x 114	9.3 x 95
		356		1128(1)	PYREX 8060 1ML	1	4 x 1	4	3900	2225	13.1	5.179	8.6 x 114	6.7 x 92
		356		1129(1)	PYREX 8060 0.5ML	0.5	4 x 0.5	2	3900	2225	13.1	5.179	6.4 x 114	4.5 x 89
215(4)	310(1)	303			1629 1649 1648 2810	13-19	4 x (13-19)	52-76	3500	2025	14.7	5.803	17.2 x 128	15.3 x 123
		303			2858 2859 2837	13-19	4 x (13-19)	52-76	3500	2025	14.7	5.803	17.2 x 128	15.3 x 123
		303		1125(1)	1698 2836 2864	8-10	4 x (8-10)	32-40	3500	2025	14.7	5.803	13.6 x 130	11.7 x 127
		303		1126(1)	2804 2840	4-5	4 x (4-5)	16-20	3500	2025	14.7	5.803	11.1 x 130	9.3 x 105
		303		1127,11	28,1129 NOT RECOMMENDED. TOO SHORT.									
215(4)	310(1)	302			2858 2859 1648	15-19	4 x (15-19)	60-76	3050	1725	16.6	6.556	17.2 x 146	15.3 x 135
		302			2837 2810	15-19	4 x (15-19)	60-76	3050	1725	16.6	6.556	17.2 x 146	15.3 x 135
		302		1125(1)	1698 2864	8-10	4 x (8-10)	32-40	3050	1725	16.6	6.556	13.6 x 148	11.7 x 130
		302		1126(1)	2804 2840	4-5	4 x (4-5)	16-20	3050	1725	16.6	6.556	11.1 x 148	9.3 x 105
		302		1127,11	28,1129 NOT RECOMMENDED. TOO SHORT									
215(4)	310(1)	306		DO NOT USE. SHIELD HITS GUARDBOWL										
215(4)	325(1)	320			1630 2997 2048 2053	48-52	4 x (48-52)	192-208	3700	2125	13.9	5.453	30.0 x 116	28.2 x 107
		320			2828 613SS	48-52	4 x (48-52)	192-208	3700	2125	13.9	5.453	30.0 x 116	28.2 x 107
		320		651(1)	2805	22	4 x 22	88	3800	2250	13.9	5.453	18.8 x 117	16.9 x 117
		320		1105(1)	1698 2864	8-10	4 x (8-10)	32-40	3800	2250	13.9	5.453	14.0 x 120	12.2 x 120
		320		1106(1)	1648 2858 2837 2810	15-19	4 x (15-19)	60-76	3800	2250	13.9	5.453	17.4 x 122	15.5 x 122
		320		1108(1)	2805 514PYREX 12ML	12-22	4 x (12-22)	48-88	3800	2150	13.4	5.258	19.3 x 116	17.4 x 116
		320	*	1113(3)	2804 2840	4-5	12 x (4-5)	48-60	3800	1800	11.1	4.363	11.3 x 90	9.4 x 90
		320		2917(1)	2816 2842(Omit Caps)	10-12	4 x (10-12)	40-48	3800	2200	13.6	5.359	14.4 x 117	12.5 x 117
		320		3151(1)	2805	22	4 x 22	88	3800	2250	13.9	5.453	18.8 x 118	16.9 x 118
215(4)	325(1)	320		3152(1)	1698 2864	8-10	4 x (8-10)	32-40	3800	2200	13.7	5.381	14.2 x 120	12.3 x 120
		320		3153(1)	1648 2837 2858	15-19	4 x (15-19)	60-76	3800	2200	13.7	5.381	16.1 x 120	14.1 x 120
		320	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE, FISHER #5-668-2				3800	2275	14.1	5.543	8.3 x 117	7.1 x 117
215(4)	325(1)	320A		312(1)	2810CONICAL(Omit Cap)	15	4 x 15	60	3700	2125	13.9	5.481	18.0 x 119	16.0 x 119
215(4)	325	320A			USE CONICAL TUBES ONLY				3700	2125	13.9	5.481	30.0 x 113	28.2 x 113
215(4)	325(1)	305		312(1)	2810 CONICAL	15	4 x 15	60	3200	1825	15.9	6.276	18.0 x 139	16.0 x 139
		305			2809 CONICAL(Omit Cap)	50	4 x 50	200	3100	1700	15.9	6.276	30.0 x 133	28.2 x 133
215(4)	325(1)	305A	†		1630 2997 2048	48-52	4 x (48-52)	192-208	3150	1775	15.9	6.248	30.0 x 135	28.2 x 107
		305A			2053 2828 613SS	48-52	4 x (48-52)	192-208	3150	1775	15.9	6.248	30.0 x 135	28.2 x 107
		305A		651(1)	2805	22	4 x 22	88	3150	1775	15.9	6.248	18.8 x 138	16.9 x 130
		305A		1105(1)	1698 2864	8-10	4 x (8-10)	32-40	3150	1775	15.9	6.248	14.0 x 140	12.2 x 130
		305A		1106(1)	1648 2837 2858 2810	15-19	4 x (15-19)	60-76	3150	1775	15.9	6.248	17.4 x 140	15.5 x 130
		305A		1108(1)	2805 514PYREX 12ML	12-22	4 x (12-22)	48-88	3150	1700	15.3	6.053	19.3 x 130	17.4 x 120
		305A	*	1113(3)	2804 2840	4-5	12 x (4-5)	48-60	3150	1450	13.1	5.158	11.3 x 108	9.4 x 100
		305A		2917(1)	2816 2842(Omit Caps)	10-12	4 x (10-12)	40-48	3150	1725	15.6	6.154	14.4 x 138	12.5 x 130
		305A		3151(1)	2805	22	4 x 22	88	3150	1775	15.9	6.248	18.8 x 138	16.8 x 130
		305A		3152(1)	1698 2864	8-10	4 x (8-10)	32-40	3150	1750	15.7	6.176	14.2 x 138	12.3 x 130
		305A		3153(1)	1648 2837 2858	15-19	4 x (15-19)	60-76	3150	1750	15.7	6.176	16.1 x 138	14.1 x 130
		305A	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE, FISHER #5-668-2				3150	1800	16.1	6.338	8.3 x 117	7.1 x 117
215(4)	326(2)	320,	305, 305A		DO NOT USE, INNER SHIELD HITS MOTOR HOUSING									
215(4)	350(1)	341			2806(Omit Cap)	96	4 x 96	384	2550	1375	18.8	7.388	33.2 x 162	31.3 x 162
215(4)	366(1)		369(5)		2841 2852 2804 2840	3-5	20 x (3-5)	60-100	4150	2125	11.1	4.384	12.6 x 83	10.7 x 81
	366		1018(4)		2836	10	16 x 10	160	3650	1900	12.8	5.030	14.2 x 103	12.3 x 103
	366	365							3350	1850	14.8	5.838	38.0 x 118	36.0 x 118
	366	367A			KIMAX #15066 BOTTLE				2500	1325	19.0	7.468	38.0 x 165	36.0 x 165
215(4)		362Cup							3650	1875	12.6	4.958	36.7 x 100	34.8 x 100

*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 2 of 6)

CAT. ROTOR AND NO. OF PLACES	CAT. TRUN. RING AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
221(6)		356			1629 1649 2801	10-13	6 x (10-13)	60-78	3750	2050	13.0	5.118	17.2 x 102	15.3 x 102
		356			2850 2046 2067	10-13	6 x (10-13)	60-78	3750	2050	13.0	5.118	17.2 x 102	15.3 x 102
		356		1125(1	2836	10	6 x 10	60	3750	2050	13.0	5.118	13.6 x 104	11.7 x 104
		356		1126(1	2804 2840	4-5	6 x (4-5)	24-30	3750	2050	13.0	5.118	11.1 x 104	9.3 x 104
		356		1127(1	2804 2840	4-5	6 x (4-5)	24-30	3750	2050	13.0	5.118	11.1 x 104	9.3 x 95
		356		1128(1	PYREX 8060 1ML	1	6 x 1	6	3750	2050	13.0	5.118	8.6 x 104	6.7 x 92
		356		1129(1	PYREX 8060 0.5ML	0.5	6 x 0.5	3	3750	2050	13.0	5.118	6.4 x 104	4.5 x 89
221(6)		303			1629 1649 1648 2858	13-19	6 x (13-19)	78-114	3400	1875	14.6	5.743	17.2 x 119	15.3 x 119
		303			2859 2837 2810(Omit Cap)	13-19	6 x (13-19)	78-114	3400	1875	14.6	5.743	17.2 x 119	15.3 x 119
		303		1125(1	1698 2836 2864	8-10	6 x (8-10)	48-60	3400	1875	14.6	5.743	13.6 x 120	11.7 x 120
		303		1126(1	2804 2840	4-5	6 x (4-5)	24-30	3400	1875	14.6	5.743	11.1 x 120	9.3 x 105
		303		1127,	1128, 1129, NOT RECOMMENDED, TOO SHORT									
221(6)		302			1648 2858 2859	15-19	6 x (15-19)	90-114	2950	1600	16.5	6.495	17.2 x 133	15.3 x 130
		302			2837 2810	15-19	6 x (15-19)	90-114	2950	1600	16.5	6.495	17.2 x 133	15.3 x 130
		302		1125(1	2864 1698	8-10	6 x (8-10)	48-60	2950	1600	16.5	6.495	13.6 x 134	11.7 x 130
		302		1126(1	2804 2840	4-5	6 x (4-5)	24-30	2950	1600	16.5	6.495	11.1 x 134	9.3 x 105
		302		1127,	1128, 1129, NOT RECOMMENDED, TOO SHORT									
221(6)		306			DO NOT USE, SHIELD HITS GUARDBOWL									
930(24 PLACE)					HEMATOKIT 1.75x75MM CAPILLARY TUBES				7800	6200	9.1	3.594		
957(4)		1120			100ML ASTM OIL BOTTLE	100	4 x 100	400	2450	1350	20.1	7.898		
					KIMAX 45243									
958(6)	310(1)	356			1629 1649 2046	10-13	6 x (10-13)	60-78	2950	1575	16.1	6.322	17.2 x 119	15.3 x 104
		356			2067 2801 2850	10-13	6 x (10-13)	60-78	2950	1575	16.1	6.322	17.2 x 119	15.3 x 104
		356		1125(1	1698 2836 2864	8-10	6 x (8-10)	48-60	2950	1575	16.1	6.322	13.6 x 120	11.7 x 110
		356		1126(1	2804 2840	4-5	6 x (4-5)	24-30	2950	1575	16.1	6.322	11.1 x 120	9.3 x 105
		356		1127(1	2804 2840	4-5	6 x (4-5)	24-30	2950	1575	16.1	6.322	11.1 x 120	9.3 x 95
		356		1128(1	PYREX 8060 1ML	1	6 x 1	6	2950	1575	16.1	6.322	8.6 x 120	6.7 x 92
		356		1129(1	PYREX 8060 0.5ML	0.5	6 x 0.5	3	2950	1575	16.1	6.322	6.4 x 120	4.5 x 89
958(6)	310(1)	303			1629 1649 1648 2810	13-19	6 x (13-19)	78-114	2700	1425	17.6	6.946	17.2 x 134	15.3 x 122
		303			2859 2858 2837	13-19	6 x (13-19)	78-114	2700	1425	17.6	6.946	17.2 x 134	15.3 x 122
		303		1125(1	1698 2836 2864	8-10	6 x (8-10)	48-60	2700	1425	17.6	6.946	13.6 x 135	11.7 x 122
		303		1126(1	2804 2840	4-5	6 x (4-5)	24-30	2700	1425	17.6	6.946	11.1 x 135	9.3 x 105
		303		1127,	1128,1129 NOT RECOMMENDED, TOO SHORT.									
958(6)	310(1)	302			DO NOT USE, SHIELD HITS GUARDBOWL									
958(6)	310(1)	306			DO NOT USE, SHIELD HITS GUARDBOWL									
958(6)	325(1)	320			1630 2997 2048	48-52	6 x (48-52)	288-312	2800	1475	16.7	6.580	30.0 x 124	28.2 x 107
		320			2053 2858 613SS	48-52	6 x (48-52)	288-312	2800	1475	16.7	6.580	30.0 x 124	28.2 x 107
		320		651(1	2805	22	6 x 22	132	2800	1475	16.7	6.580	18.8 x 127	16.9 x 125
		320		1105(1	1698 2864	8-10	6 x (8-10)	48-60	2800	1475	16.7	6.580	14.0 x 128	12.2 x 125
		320		1106(1	1648 2858 2837 2810	15-19	6 x (15-19)	90-114	2800	1475	16.7	6.580	17.4 x 127	15.5 x 125
		320		1108(1	2805 514 PYREX 12ML	12-22	6 x (12-22)	72-132	2800	1425	16.2	6.385	19.3 x 124	17.4 x 122
		320	*	1113(3	2804 2840	4-5	18 x (4-5)	72-90	2800	1225	13.9	5.490	11.3 x 95	9.4 x 95
		320		2917(1	2816 2842(Omit Caps)	10-12	6 x (10-12)	60-72	2800	1450	16.5	6.486	14.4 x 122	12.5 x 120
		320		3151(1	2805	22	6 x 22	132	2800	1475	16.7	6.580	18.8 x 127	16.8 x 125
		320		3152(1	1698 2864	8-10	6 x (8-10)	48-60	2800	1450	16.5	6.508	14.2 x 127	12.3 x 125
		320		3153(1	1648 2837 2858	15-19	6 x (15-19)	90-114	2800	1450	16.5	6.508	16.1 x 127	14.1 x 125
		320	REMOVE 571 CUSHION	368(5	8 x 95MM WINTROBE.	FISHER #5-668-2			2800	1500	16.9	6.670	8.3 x 120	7.1 x 117
958(6)	325(1)	320A		312(1	2810 CONICAL	15	6 x 15	90	2800	1475	16.8	6.608	18.0 x 124	16.0 x 124
958(6)	325(1)	320A			USE CONICAL TUBES ONLY				2800	1475	16.8	6.608	30.0 x 116	28.2 x 116

*USE PLASTIC TUBES ONLY

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 3 of 6)

CAT. ROTOR AND NO. OF PLACES	CAT. TRUN. RING AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
958(6)	325(1)	305		312(1)	2810 CONICAL	15	6 x 15	90	2400	1200	18.8	7.416	18.0 x 143	16.0 x 140
	325(1)	305			2809 CONICAL	50	6 x 50	300	2400	1200	18.8	7.416	30.0 x 137	28.2 x 137
958(6)	325(1)	305A	†		1630 2997 2048	48-52	6 x (48-52)	288-312	2400	1200	18.8	7.388	30.0 x 142	28.2 x 107
		305A			2053 2828 613SS	48-52	6 x (48-52)	288-312	2400	1200	18.8	7.388	30.0 x 142	28.2 x 107
		305A		651(1)	2805	22	6 x 22	132	2400	1200	18.8	7.388	18.8 x 144	16.9 x 130
		305A		1105(1)	1698 2864	8-10		48-60	2400	1200	18.8	7.388	14.0 x 146	12.2 x 130
		305A		1106(1)	1648 2858 2837 2810	15-19	6 x (15-19)	90-114	2400	1200	18.8	7.388	17.4 x 147	15.5 x 130
		305A		1108(1)	2805 514PYREX 12ML	12-22	6 x (12-22)	72-132	2400	1175	18.3	7.193	19.3 x 142	17.4 x 130
		305A		*1113(3)	2804 2840	4-5	18 x (4-5)	72-90	2400	1025	16.0	6.298	11.3 x 115	9.4 x 110
		305A		2917(1)	2816 2842 (Omit Caps)	10-12	6 x (10-12)	60-72	2400	1200	18.5	7.294	14.4 x 146	12.5 x 130
		305A		3151(1)	2805	22	6 x 22	132	2400	1200	18.8	7.388	18.8 x 144	16.8 x 130
		305A		3152(1)	1698 2864	8-10	6 x (8-10)	48-60	2400	1200	18.6	7.316	14.2 x 146	12.3 x 130
		305A		3153(1)	1648 2858 2837	15-19	6 x (15-19)	90-114	2400	1200	18.6	7.316	16.1 x 141	14.1 x 141
		305A	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE,	FISHER	#5-668-2		2400	1225	19.0	7.478	8.3 x 140	7.1 x 120
958(6)	355(3)	356			1629 1649 2801	10-13	18 x (10-13)	180-234	2450	1075	16.1	6.322	17.2 x 112	15.3 x 107
		356			2850 2046 2067	10-13	18 x (10-13)	180-234	2450	1075	16.1	6.322	17.2 x 112	15.3 x 107
		356		1125(1)	1698 2836 2864	8-10	18 x (8-10)	144-180	2450	1075	16.1	6.322	13.6 x 113	11.7 x 111
		356		1126(1)	2804 2840	4-5	18 x (4-5)	72-90	2450	1075	16.1	6.322	11.1 x 113	9.3 x 105
		356		1127(1)	2804 2840	4-5	18 x (4-5)	72-90	2450	1075	16.1	6.322	11.1 x 113	9.3 x 95
		356		1128(1)	PYREX 8060 1ML	1	18 x 1	18	2450	1075	16.1	6.322	8.6 x 113	6.7 x 92
		356		1129(1)	PYREX 8060 0.5ML	0.5	18 x 0.5	9	2450	1075	16.1	6.322	6.4 x 113	4.5 x 89
958(6)	355(3)	303			1629 1649 1648 2858	13-19	18 x (13-19)	234-342	2250	1000	17.6	6.946	17.2 x 129	15.3 x 123
		303			2859 2837 2810	13-19	18 x (13-19)	234-342	2250	1000	17.6	6.946	17.2 x 129	15.3 x 123
		303		1125(1)	1698 2836 2864	8-10	18 x (8-10)	144-180	2250	1000	17.6	6.946	13.6 x 130	11.7 x 125
		303		1126(1)	2804 2840	4-5	18 x (4-5)	72-90	2250	1000	17.6	6.946	11.1 x 131	9.3 x 105
		303		1127,	1128, 1129, NOT RECOMMENDED, TOO SHORT									
958(6)	355(3)	302,	306, SHIELDS		DO NOT USE, SHIELDS HIT GUARDBOWL									
958(6)	354(4)	356			1629 1649 2801	10-13	24 x (10-13)	240-312	2400	1025	16.1	6.322	17.2 x 103	15.3 x 102
		356			2850 2046 2067	10-13	24 x (10-13)	240-312	2400	1025	16.1	6.322	17.2 x 103	15.3 x 102
		356		1125(1)	2836	10	24 x 10	240	2400	1025	16.1	6.322	13.6 x 105	11.7 x 102
		356		1126(1)	2804 2840	4-5	24 x (4-5)	96-120	2400	1025	16.1	6.322	11.1 x 105	9.3 x 102
		356		1127(1)	2804 2840	4-5	24 x (4-5)	96-120	2400	1025	16.1	6.322	11.1 x 105	9.3 x 95
		356		1128(1)	PYREX 8060 1ML	1	24 x 1	24	2400	1025	16.1	6.322	8.6 x 105	6.7 x 92
		356		1129(1)	PYREX 8060 0.5ML	1	24 x 0.5	12	2400	1025	16.1	6.322	6.4 x 105	4.5 x 89
958(6)	354(4)	303			1629 1649 1648 2858	13-19	24 x (13-19)	312-456	2200	950	17.6	6.946	17.2 x 119	15.3 x 119
		303			2859 2837 (2810 Omit Cap)	13-19	24 x (13-19)	312-456	2200	950	17.6	6.946	17.2 x 119	15.3 x 119
		303		1125(1)	1698 2836 2864	8-10	24 x (8-10)	192-240	2200	950	17.6	6.946	13.6 x 120	11.7 x 115
		303		1126(1)	2804 2840	4-5	24 x (4-5)	96-120	2200	950	17.6	6.946	11.1 x 120	9.3 x 105
		303		1127,	1128, 1129 NOT RECOMMENDED, TOO SHORT									
958(6)	354(4)	302,	306, SHIELDS		DO NOT USE, SHIELDS HIT GUARDBOWL									
958(6)			379(6)		1696 2860	8-9	36 x (8-9)	288-324	2900	1300	13.7	5.398	17.7 x 77	15.7 x 75
			380(6)		1696 2860 2850	8-12	36 x (8-12)	288-432	2600	1125	15.0	5.898	17.7 x 88	15.7 x 86
			380(6)		2801 2046 2067	8-12	36 x (8-12)	288-432	2600	1125	15.0	5.898	17.7 x 88	15.7 x 86
			381(8)				48 x		2600	1125	15.0	5.898	13.6 x 92	11.7 x 91
			398(6)		1629 1649 2801 2850	10-16	36 x (10-16)	360-576	2150	875	16.8	6.598	17.7 x 109	15.7 x 107
			398(6)		2046 2067 2859	10-16	36 x (10-16)	360-576	2150	875	16.8	6.598	17.7 x 109	15.7 x 107
			1080(6)		2801 2850 2046 2067	10-13	36 x (10-13)	360-468	2350	975	15.6	6.148	16.4 x 112	14.5 x 110
			1080(6)		1629 1649	10-13	36 x (10-13)	360-468	2350	975	15.6	6.148	16.4 x 112	14.5 x 110
			2760(8)		2804 2840	4-5	48 x (4-5)	192-240	2600	1125	14.9	5.873	11.0 x 92	9.1 x 90
958(6)	366(1)		369(5)		2841 2852 2804 2840	3-5	30 x (3-5)	90-150	3200	1600	14.0	5.523	12.6 x 98	10.7 x 95
	366(1)		1018(4)		2836	10	24 x 10	240	2800	1375	15.7	6.173	14.2 x 106	12.3 x 104
958(6)		362 Cup							2800	1350	15.5	6.098	36.7 x 101	34.8 x 100
958(6)	366(1)	365							2600	1350	17.8	6.998	38.0 x 123	36.0 x 120
	366(1)	367A			DO NOT USE, SHIELD HITS GUARDBOWL									

*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Horizontal Rotors (sheet 4 of 6)

CAT. ROTOR AND NO. OF PLACES	CAT. TRUN. RING AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
					CARRIERS WITH ADAPTERS									
958(6)			380 (6)	1125(1)	DO NOT USE. ADAPTER TOO LONG.									
958(6)			380 (6)	1126(1)	2804 2840	4-5	36 x (4-5)	144-180	2600	1125	15.0	5.898	11.1 x 88	9.3 x 88
			380 (6)	1127(1)	2804 2840	4-5	36 x (4-5)	144-180	2600	1125	15.0	5.898	11.1 x 88	9.3 x 88
			380 (6)	1128(1)	PYREX 8060 1ML	1	36 x 1	36	2600	1125	15.0	5.898	8.6 x 88	6.7 x 88
			380 (6)	1129(1)	PYREX 8060 0.5ML	0.5	36 x 0.5	18	2600	1125	15.0	5.898	6.4 x 88	4.5 x 88
958(6)			398 (6)	1125(1)	2836 2864 1698	8-10	36 x (8-10)	288-360	2150	875	16.8	6.598	13.6 x 109	11.7 x 109
			398 (6)	1126(1)	2804 2840	4-5	36 x (4-5)	144-180	2150	875	16.8	6.598	11.1 x 109	9.3 x 105
			398 (6)	1127,1	128,1129 NOT RECOMMENDED.		TOO SHORT.							
958(6)			•398A(6)		1629 1649 2859	13-19	36 x (13-19)	468-684	2150	900	17.5	6.898	17.7 x 117	15.3 x 117
			•398A(6)		2858 2837 1648	13-19	36 x (13-19)	468-684	2150	900	17.5	6.898	17.7 x 117	15.3 x 117
			•398A(6)	1125(1)	2836 2864 1698	8-10	36 x (8-10)	288-360	2150	900	17.5	6.898	13.6 x 120	11.7 x 115
			•398A(6)	1126(1)	2804 2840	4-5	36 x (4-5)	144-180	2150	900	17.5	6.898	11.1 x 120	9.3 x 105
			398A(6)	1127,1	128,1129 NOT RECOMMENDED.		TOO SHORT							
958(6)	326(2)	320			1630 2997 2048	48-52	12 x (48-52)	576-624	2400	1100	16.9	6.650	30.0 x 120	28.2 x 107
		320			2053 2828 613SS	48-52	12 x (48-52)	576-624	2400	1100	16.9	6.650	30.0 x 120	28.2 x 107
		320		651(1)	2805	22	12 x 22	164	2400	1100	16.9	6.650	18.6 x 126	16.9 x 120
		320		1105(1)	1698 2864	8-10	12 x (8-10)	96-120	2400	1100	16.9	6.650	14.0 x 127	12.2 x 120
		320		1106(1)	1648 2858 2837 2810	15-19	12 x (15-19)	180-228	2400	1100	16.9	6.650	17.4 x 126	15.5 x 120
		320		1108(1)	2805 514PYREX 12ML	12-22	12 x (12-22)	144-164	2400	1050	16.4	6.455	19.3 x 121	17.4 x 115
		320	*	1113(3)	2804 2840	4-5	36 x (4-5)	144-180	2400	900	14.1	5.560	11.3 x 98	9.4 x 95
		320		2917(1)	2816 2842(Omit Caps)	10-12	12 x (10-12)	120-144	2400	1075	16.7	6.556	14.4 x 122	12.5 x 115
		320		3151(1)	2805	22	12 x 22	164	2400	1100	16.9	6.650	18.8 x 126	16.8 x 120
		320		3152(1)	1698 2864	8-10	12 x (8-10)	96-120	2400	1075	16.7	6.578	14.2 x 126	12.3 x 120
		320		3153(1)	1648 2858 2837	15-19	12 x (15-19)	180-228	2400	1075	16.7	6.578	16.1 x 125	14.1 x 120
		320	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE FISHER #5-668-2				2400	1100	17.1	6.740	8.3 x 120	7.1 x 117
958(6)	326(2)	320A		312(1)	DO NOT USE. ADAPTER INTERFERENCE AT O.D.									
958(6)	326(2)	320A			USE CONICAL TUBES ONLY				2400	1100	16.9	6.650	30.0 x 116	28.2 x 116
958(6)	326(2)	305		312(1)	DO NOT USE. ADAPTER INTERFERENCE AT O.D.									
958(6)	326(2)	305			2809 CONICAL	50	12 x 50	600	2150	975	19.0	7.486	30.0 x 137	28.2 x 137
958(6)	326(2)	305A	†		1630 2997 2048	48-52	12 x (48-52)	576-624	2150	975	18.9	7.458	30.0 x 140	28.2 x 107
		305A			2053 2828 613SS	48-52	12 x (48-52)	576-624	2150	975	18.9	7.458	30.0 x 140	28.2 x 107
		305A		651(1)	2805	22	12 x 22	164	2100	925	18.9	7.458	18.8 x 147	16.9 x 130
		305A		1105(1)	1698 2864	8-10	12 x (8-10)	96-120	2100	925	18.9	7.458	14.0 x 148	12.2 x 130
		305A		1106(1)	1648 2858 2837 2810	15-19	12 x (15-19)	180-228	2100	925	18.9	7.458	17.4 x 147	15.5 x 130
		305A		1108(1)	2805 514 PYREX 12ML	12-22	12 x (12-22)	144-164	2100	900	18.5	7.263	19.3 x 143	17.4 x 130
		305A	*	1113(3)	2804 2840	4-5	36 x (4-5)	144-180	2100	800	16.1	6.368	11.3 x 110	9.4 x 100
		305A		2917(1)	2816 2842(Omit Caps)	10-12	12 x (10-12)	120-144	2100	925	18.7	7.364	14.4 x 146	12.5 x 130
		305A		3151(1)	2805	22	12 x 22	164	2100	925	18.9	7.458	18.8 x 147	16.8 x 130
		305A		3152(1)	1698 2864	8-10	12 x (8-10)	96-120	2100	925	18.8	7.386	14.2 x 146	12.3 x 130
		305A		3153(1)	1648 2858 2837	15-19	12 x (15-19)	180-288	2100	925	18.8	7.386	16.1 x 145	14.1 x 130
		305A		368(5)	8 x 95MM WINTROBE. FISHER		#5-668-2		2100	950	19.2	7.548	8.3 x 140	7.1 x 120
					ANGLE ROTORS									
801(6)		320			1630 2997 2048	48-52	6 x (48-52)	288-312	4600	2550	10.8	4.250	30.0 x 115	28.2 x 107
		320			2053 2828 613SS	48-52	6 x (48-52)	288-312	4600	2550	10.8	4.250	30.0 x 115	28.2 x 107
		320		651(1)	2805	22	6 x 22	132	4600	2525	10.7	4.200	18.8 x 126	16.8 x 116
		320		1105(1)	1698 2864	8-10	6 x (8-10)	48-60	4600	2500	10.6	4.170	14.0 x 122	12.2 x 116
		320		1106(1)	1648 2858 2837 2810	15-19	6 x (15-19)	90-114	4600	2500	10.6	4.190	17.4 x 122	15.5 x 122
		320		1108(1)	2805 514 PYREX 12ML	12-22	6 x (12-22)	72-132	4600	2500	10.5	4.125	19.3 x 116	17.4 x 116
		320	*	1113(3)	2804 2840	4-5	18 x (4-5)	72-90	4600	2250	9.5	3.750	11.3 x 91	9.4 x 85
		320		2917(1)	2816 2842(Omit Caps)	12-22	6 x (10-12)	60-72	4600	2500	10.5	4.115	14.4 x 117	12.5 x 110
		320		3151(1)	2805	22	6 x 22	132	4600	2525	10.7	4.200	18.8 x 125	16.8 x 125
		320		3152(1)	1698 2864	8-10	6 x (8-10)	48-60	4600	2500	10.5	4.125	14.2 x 122	12.3 x 122
		320		3153(1)	1648 2837 2858	15-19	6 x (15-19)	90-114	4600	2500	10.5	4.150	16.1 x 122	14.1 x 122
				368(5)	8 x 95MM WINTROBE FISHER		#5-668-2		DO NOT	USE.	TUBES	TOO	LONG.	

•398A IS 398 USING A 668 CUSHION
*USE PLASTIC TUBES ONLY
† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Angle Rotors (sheet 5 of 6)

CAT. ROTOR AND NO OF PLACES	CAT. TRUN. RING AND NO OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
801(6)		320A		312(1)	USE CONICAL TUBES ONLY				4600	2550	10.8	4.250	18.0 x 114	16.0 x 114
		320A			USE CONICAL TUBES ONLY				4600	2550	10.8	4.250	30.0 x 111	28.2 x 111
801(6)		305		312(1)	DO NOT USE. ADAPTER O.D. INTERFERES IN ROTOR									
		305			USE CONICAL TUBES ONLY				4000	2150	12.1	4.750	30.0 x 114	28.2 x 114
801(6)		305A	†		1630 2997 2048	48-52	6 x (48-52)	288-312	4000	2150	12.1	4.750	30.0 x 115	28.2 x 107
		305A			2053 2828 613SS	48-52	6 x (48-52)	288-312	4000	2150	12.1	4.750	30.0 x 115	28.2 x 107
		305A		651(1)	2805	22	6 x 22	132	4000	2125	11.9	4.700	18.8 x 126	16.8 x 116
		305A		1105(1)	1698 2864	8-10	6 x (8-10)	48-60	4000	2125	11.9	4.670	14.0 x 125	12.2 x 116
		305A		1106(1)	1648 2858 2837 2810	15-19	6 x (15-19)	90-114	4000	2125	11.9	4.690	17.4 x 124	15.5 x 122
		305A		1108(1)	2805 514 PYREX 12ML	12-22	6 x (12-22)	72-132	4000	2100	11.8	4.625	19.3 x 116	17.4 x 116
		305A		*1113(3)	2804 2840	4-5	18 x (4-5)	72-90	4000	1950	10.9	4.300	11.3 x 91	9.4 x 85
		305A		2917(1)	2816 2842 (Omit Caps)	10-12	6 x (10-12)	60-72	4000	2100	11.7	4.615	14.4 x 117	12.5 x 110
		305A		3151(1)	2805	22	6 x 22	132	4000	2125	11.9	4.700	18.8 x 125	16.8 x 125
		305A		3152(1)	1698 2864	8-10	6 x (8-10)	48-60	4000	2100	11.8	4.625	14.2 x 122	12.3 x 122
		305A		3153(1)	1648 2837 2858	15-19	6 x (15-19)	90-114	4000	2100	11.8	4.650	16.1 x 122	14.1 x 122
		305A	REMOVE 571 CUSHION	368(5)	8. 95MM WINDROBE FISHER #5-668-2				4000	2300	12.8	5.050	8.3 x 117	7.1 x 117
803(6)		356			2046 2067 2801 2850	10-12	6 x (10-12)	60-72	4900	2750	10.2	4.000	17.2 x 88	15.3 x 88
		356		1125(1)	NOT RECOMMENDED. ADAPTER TOO LONG.									
		356		1126(1)	2804 2840	4-5	6 x (4-5)	24-30	4900	2700	10.1	3.975	11.1 x 88	9.3 x 88
		356		1127(1)	2804 2840	4-5	6 x (4-5)	24-30	4900	2700	10.1	3.975	11.1 x 80	9.3 x 80
		356		1128(1)	PYREX 8060 1ML	1	6 x 1	6	4900	2700	10.1	3.960	8.6 x 80	6.7 x 75
		356		1129(1)	PYREX 8060 0.5ML	0.5	6 x 0.5	3	4900	2675	10.0	3.945	6.4 x 80	4.5 x 70
803(6)		303			1629 1649	12-13	6 x (12-13)	72-78	4450	2500	11.3	4.440	17.2 x 102	15.3 x 102
		303		1125(1)	1698 2836 2864	8-10	6 x (8-10)	48-60	4450	2475	11.2	4.400	13.6 x 111	11.7 x 111
		303		1126(1)	2804 2840	4-5	6 x (4-5)	24-30	4450	2450	11.1	4.370	11.1 x 88	9.3 x 88
				1127,	1128, 1129, NOT RECOMMENDED, TOO SHORT.									
803(6)		302			1648 2858 2837 2810	13-19	6 x (13-19)	78-114	4000	2275	12.7	5.000	17.2 x 122	15.3 x 122
		302		1125(1)	1698 2864	8-10	6 x (8-10)	48-60	4000	2250	12.6	4.960	13.6 x 115	11.7 x 111
		302		1126(1)	2804 2840	4-5	6 x (4-5)	24-30	4000	2225	12.5	4.930	11.1 x 88	9.3 x 88
		302		1127,	1128, 1129, NOT RECOMMENDED TOO SHORT.									
803(6)		306							3150	1700	15.4	6.080	17.2 x 158	15.3 x 150
		306		ADAPTERS 1125, 1126, 1127, 1128, 1129 TOO SHORT NOT RECOMMENDED FOR USE.										
809(12)		356			2046 2067 2801 2850	10-12	12 x (10-12)	120-144	4550	2350	10.2	4.000	17.2 x 88	15.3 x 88
		356		1125(1)	NOT RECOMMENDED. ADAPTER TOO LONG.									
		356		1126(1)	2804 2840	4-5	12 x (4-5)	48-60	4550	2350	10.1	3.975	11.1 x 88	9.3 x 88
		356		1127(1)	2804 2840	4-5	12 x (4-5)	48-60	4550	2350	10.1	3.975	11.1 x 80	9.3 x 80
		356		1128(1)	PYREX 8060 1ML	1	12 x 1	12	4550	2350	10.1	3.960	8.6 x 80	6.7 x 75
		356		1129(1)	PYREX 8060 0.5ML	0.5	12 x 0.5	6	4550	2300	10.0	3.945	6.4 x 80	4.5 x 70
809(12)		303			1629 1649	12-13	12 x (12-13)	144-156	4100	2125	11.3	4.440	17.2 x 102	15.3 x 102
		303		1125(1)	1698 2836 2864	8-10	12 x (8-10)	96-120	4100	2100	11.2	4.400	13.6 x 111	11.7 x 111
		303		1126(1)	2804 2840	4-5	12 x (4-5)	48-60	4100	2100	11.1	4.370	11.1 x 88	9.3 x 88
		303		1127,	1128, 1129, NOT RECOMMENDED, TOO SHORT									
809(12)		302			1648 2837 2810	15-19	12 x (15-19)	180-228	3650	1900	12.7	5.000	17.2 x 122	15.3 x 122
		302		1125(1)	1698 2864	8-10	12 x (8-10)	96-120	3650	1875	12.6	4.960	13.6 x 115	11.7 x 115
		302		1126(1)	2804 2840	4-5	12 x (4-5)	48-60	3650	1850	12.5	4.930	11.1 x 88	9.3 x 88
		302		1127,	1128, 1129 NOT RECOMMENDED. TOO SHORT.									
809(12)		306							2900	1450	15.4	6.080	17.2 x 158	15.3 x 150
		306		1125,	1126, 1127, 1128, 1129 ADAPTERS TOO SHORT. NOT RECOMMENDED FOR USE									

*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

Table 3-3, Speed and Force Tables, Angle Rotors (sheet 6 of 6)

CAT. ROTOR AND NO. OF PLACES	CAT. TRUN. RING AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
815(24)		356			2046 2067 2301 2850	10-12	24 x (10-12)	240-288	4200	○1800	9.1	3.600	17.2 x 88	15.3 x 88
										△2200	11.2	4.410		
		356		1125(1)	NOT RECOMMENDED, TOO LONG					○				
										△				
		356		1126(1)	2804 2840	4-5	24 x (4-5)	96-120	4200	○1750	8.9	3.500	11.1 x 88	9.3 x 88
										△2175	11.0	4.312		
		356		1127(1)	2804 2840	4-5	24 x (4-5)	96-120	4200	○1750	8.9	3.500	11.1 x 80	9.3 x 80
										△2175	11.0	4.312		
		356		1128(1)	PYREX 8060 1ML	1	24 x 1	24	4200	○1725	8.8	3.470	8.6 x 80	6.7 x 75
										△2150	10.9	4.281		
		356		1129(1)	PYREX 8060 1ML	0.5	24 x 0.5	12	4200	○1725	8.8	3.450	6.4 x 80	4.5 x 70
										△2125	10.8	4.260		
815(24)		303			1629 1649	12-13	24 x (12-13)	288-312	3900	○1675	9.9	3.906	17.2 x 102	15.3 x 102
										△2025	11.9	4.700		
		303		1125(1)	1698 2836 2864	8-10	24 x (8-10)	192-240	3900	○1675	9.8	3.875	13.6 x 111	11.7 x 111
										△2025	11.9	4.687		
		303		1126(1)	2804 2840	4-5	24 x (4-5)	96-120	3900	○1650	9.7	3.830	11.1 x 88	9.3 x 88
										△2000	11.8	4.670		
		303		1127,1	28,1129 NOT RECOMMENDED, TOO SHORT.					○				
										△				
815(24)		302			1648 2858 2837 2810	13-19	24 x (13-19)	312-456	3500	○1525	11.1	4.360	17.2 x 122	15.3 x 122
										△1800	13.1	5.160		
		302		1125(1)	1698 2864	8-10	24 x (88-10)	192-240	3500	○1500	11.0	4.312	13.6 x 115	11.7 x 111
										△1775	13.0	5.125		
		302		1126(1)	2804 2840	4-5	24 x (4-5)	96-120	3500	○1475	10.8	4.250	11.1 x 88	9.3 x 88
										△1750	12.8	5.062		
		302		1127,1	28,1129 NOT RECOMMENDED, TOO SHORT.					○				
										△				
815(24)		306							2950	○1300	13.2	5.200	17.2 x 158	15.3 x 150
										△1475	15.2	6.000		
815(24)		306		1125,1	26,1127,1128,1129, NOT RECOMMENDED, TOO SHORT.					○				
										△				

○ INNER ROW △ OUTER ROW

CAT. ROTOR AND NO. OF PLACES	CAT. TRUN. RING AND NO. OF PLACES	CAT. SHIELD	CAT. MULTI-CARRIER AND NO. OF PLACES	CAT. ADAPTER AND NO. OF PLACES	WILL ACCEPT IEC TUBE CATALOG NO.	TUBE NOMINAL ML	TOTAL PLACES X NOMINAL ML	MIN.-MAX. CAPACITY RANGE IN ML	MAX. RPM	RCF MAX. G'S	ROTATING RADIUS CM	ROTATING RADIUS INCHES	WILL ACCEPT TUBE MAX. OD X MAX. LENGTH IN MM	RECOMMENDED MIN. TUBE OD X RECOMMENDED MAX. LENGTH IN MM
816(8)		320			1630 2997 2048	48-52	8 x (48-52)	384-416	4250	2350	11.6	4.562	30.0 x 115	28.2 x 107
		320			2053 2828 613SS	48-52	8 x (48-52)	384-416	4250	2350	11.6	4.562	30.0 x 115	28.2 x 107
		320		651(1)	2805	22	8 x 22	176	4150	2200	11.4	4.500	18.8 x 126	16.8 x 116
		320		1105(1)	1698 2864	8-10	8 x (8-10)	64-80	4150	2175	11.3	4.437	14.0 x 122	12.2 x 116
		320		1106(1)	1648 2858 2837 2810	15-19	8 x (15-19)	120-152	4150	2200	11.4	4.468	17.4 x 122	15.5 x 122
		320		1108(1)	2805 514 PYREX 12ML	12-22	8 x (12-22)	96-176	4150	2150	11.1	4.375	19.3 x 116	17.4 x 116
		320	*	1113(3)	2804 2840	4-5	24 x (4-5)	96-120	4150	2050	10.6	4.187	11.3 x 91	9.4 x 85
		320		2917(1)	2816 2842(Omit Caps)	10-12	8 x (10-12)	80-96	4150	2150	11.2	4.406	14.4 x 117	12.5 x 110
		320		3151(1)	2805	22	8 x 22	176	4150	2200	11.4	4.500	18.8 x 125	16.8 x 125
		320		3152(1)	1698 2864	8-10	8 x (8-10)	64-80	4150	2175	11.3	4.437	14.2 x 122	12.3 x 122
		320		3153(1)	1648 2858 2837	15-19	8 x (15-19)	120-152	4150	2175	11.3	4.445	16.1 x 122	14.1 x 122
		320	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE FISHER #5-668-2				4150	2325	12.1	4.781	8.3 x 117	7.1 x 117
816(8)		320A		312(1)	USE CONICAL TUBES ONLY				4250	2350	11.6	4.562	18.0 x 114	16.0 x 114
		320A			USE CONICAL TUBES ONLY				4250	2350	11.6	4.562	30.0 x 111	28.2 x 111
816(8)		305		312(1)	DO NOT USE, ADAPTER OD INTERFERES IN ROTOR									
		305			USE CONICAL TUBES ONLY				3750	2000	12.7	5.000	30.0 x 114	28.2 x 114
816(8)		305A	†		1630 2997 2048	48-52	8 x (48-52)	384-416	3750	2000	12.7	5.000	30.0 x 115	28.2 x 107
		305A			2053 2828 613SS	48-52	8 x (48-52)	384-416	3750	2000	12.7	5.000	30.0 x 115	28.2 x 107
		305A		651(1)	2805	22	8 x 22	176	3750	1975	12.5	4.937	18.8 x 126	16.8 x 116
		305A		1105(1)	1698 2864	8-10	8 x (8-10)	64-80	3750	1950	12.4	4.875	14.0 x 122	12.2 x 116
		305A		1106(1)	1648 2858 2837 2810	15-19	8 x (15-19)	120-152	3750	1975	12.5	4.906	17.4 x 122	15.5 x 122
816(8)		305A	†	1108(1)	2805 514 PYREX 12ML	12-22	8 x (12-22)	96-176	3750	1925	12.2	4.812	19.3 x 116	17.4 x 116
		305A	*	1113(3)	2804 2840	4-5	24 x (4-5)	96-120	3750	1850	11.7	4.625	11.3 x 91	9.4 x 85
		305A		2917(1)	2816 2842(Omit Caps)	10-12	8 x (10-12)	80-96	3750	1925	12.3	4.843	14.4 x 117	12.5 x 110
		305A		3151(1)	2805	22	8 x 22	176	3750	1975	12.5	4.937	18.8 x 125	16.8 x 125
		305A		3152(1)	1698 2864	8-10	8 x (8-10)	64-80	3750	1950	12.4	4.875	14.2 x 122	12.3 x 122
		305A		3153(1)	1648 2837 2858	15-19	8 x (15-19)	120-152	3750	1950	12.4	4.882	16.1 x 122	14.1 x 122
		305A	REMOVE 571 CUSHION	368(5)	8 x 95MM WINTROBE, FISHER #5-668-2				3750	2075	13.2	5.187	8.3 x 117	7.1 x 117

*USE PLASTIC TUBES ONLY

† 305A IS A 305 USING A 571 CUSHION FOR ROUND BOTTOM TUBES

4.0 SERVICE

4.1 General

This section contains instructions on servicing the centrifuge and is intended primarily for the factory-trained serviceman or maintenance technician. The section is organized to present the operating theory first, explaining how the centrifuge operates in terms of its major functions and their inter-relationships. Then the section provides information on the maintenance aspects of troubleshooting, replacements, and adjustments. These sub-sections aid in diagnosis of faulty operation to determine the failing function and component (s) involved, in removal and replacement of the defective component (s), and in making adjustments and taking preventive action to insure proper operation after repairs are completed.

4.2 Operating Theory

Figure 4–1 is a functional diagram showing centrifuge operation. Refer also to the System Schematic Diagram, figure 4–2, and the system wiring diagram at the rear of the manual. Electrical circuits are shown in point-to-point illustrations. A schematic and a block diagram of the speed control board are also included as an aid toward understanding operation of the speed control circuit.

4.3 Centrifuge Functional Operation

Operation of the centrifuge is shown in the System Functional Diagram, figure 4–1, the System Schematic Diagram, figure 4–2, and in the System Block Diagram, figure 4–3. Input power from the power line is applied first to the Power Control Circuit, consisting of the Power Switch (S2) and the Timer (M2). For line voltages greater than 115 VAC, the power line is applied to the equipment through a voltage step-down transformer.
The voltage from the Power Control Circuit is applied to the Speed Control Circuit, which consists of the SPEED CONTROL (R1) and the associated circuits on the P.C. Speed Control Board.
The output from the P.C. Control Board is then applied directly to the drive motor armature. Associated with this armature are a BRAKE SWITCH (S1), and the Tachometer (M1) with its Speed Calibration Potentiometer (R5).

4.4 Power Control Circuit

The Power Control Circuit is shown in the System Functional Diagram, figure 4–1, the System Schematic Diagram, figure 4–2, and the Simplified Diagram, figure 4–4.
The Power Switch (S2) is a DPDT switch having a neutral center OFF position. When this switch is at its central position, all circuits, except brake circuit, are open, the Timer (M2) is inactive, and no voltage is delivered to the Speed Control Circuit.
When the Power Switch (S2) is at the ON/W TIMER position and the Timer (M2) is activated, the supply voltage is delivered to the Speed Control Circuit through the switch of the Timer (M2) and one set of Power Switch contacts. The timing motor will start turning back toward zero from its manually pre-set position, with its current supply through both sets of Power Switch contacts and its own motor-controlled set of contacts. This condition will continue, with supply voltage being delivered to the Speed Control Circuit and the Timer motor turning, until the timer reaches zero. When this occurs, the switch of Timer (M2) will open, to interrupt further rotation of the Timer motor, and to interrupt the supply of voltage to the Speed Control Circuit.
When the Power Switch (S2) is in its "Not Timed" position, the motor of Timer (M2) is inactive, and supply voltage is delivered directly to the Speed Control Circuit through one set of contacts of the Power Switch (S2). Supply voltage will continue being delivered to the Speed Control Circuit until the Power Switch (S2) is returned to its central OFF position.

4.5 Speed Control Circuit

The Speed Control Circuit is shown in the System Functional Diagram, figure 4–1, the System Schematic Diagram, figure 4–2, and the Simplified Diagram, figure 4–5.
The power-controlling element of the Speed Control Circuit is the Triac (Q1). This control element turns on at a pre-determined part of each half-cycle, as shown in the diagrams of figure 4–6. For low motor speeds, the Triac (Q1) turns on late in each half-cycle.

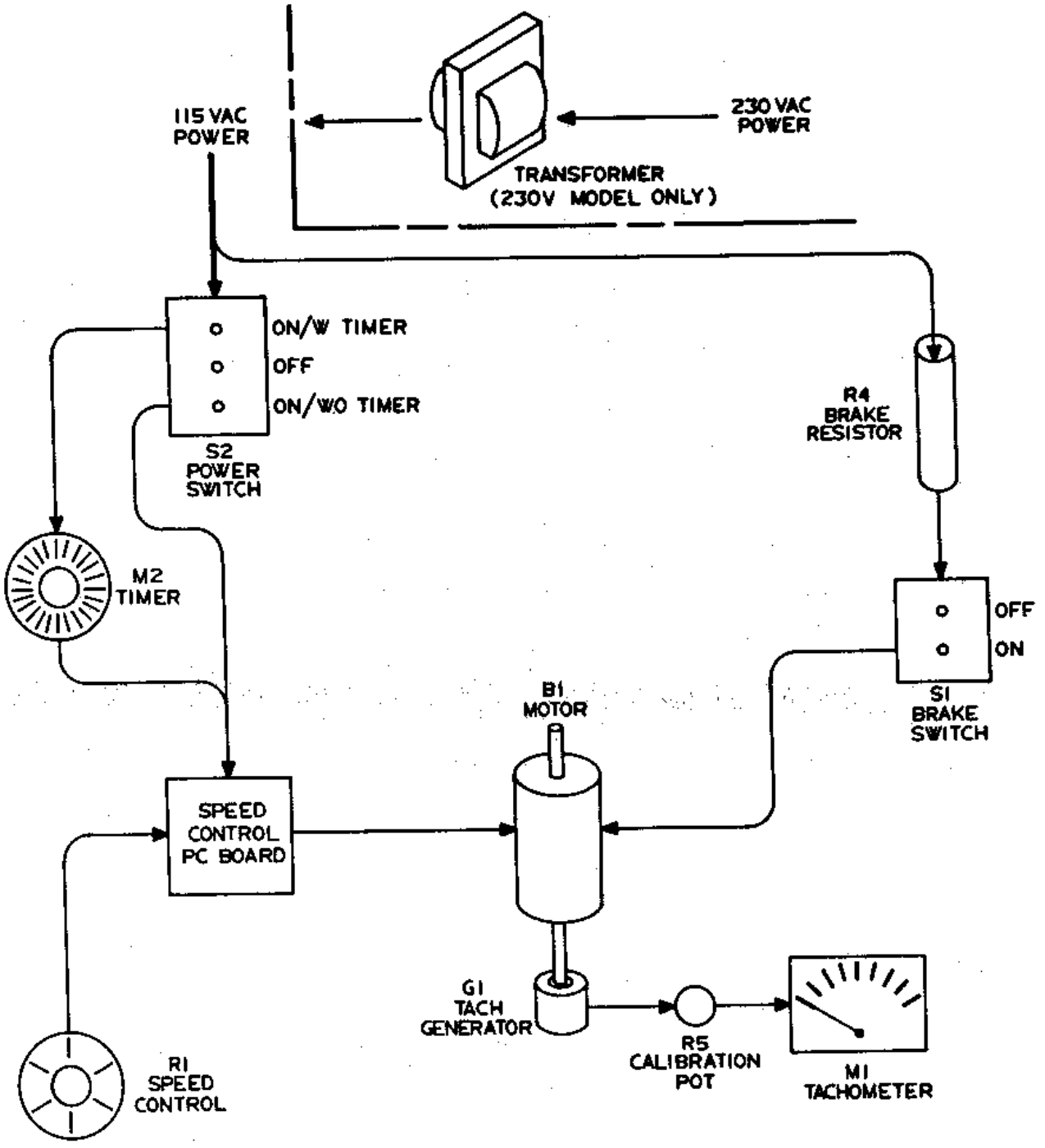


Figure 4-1 System Functional Diagram, 60/50 Hz units

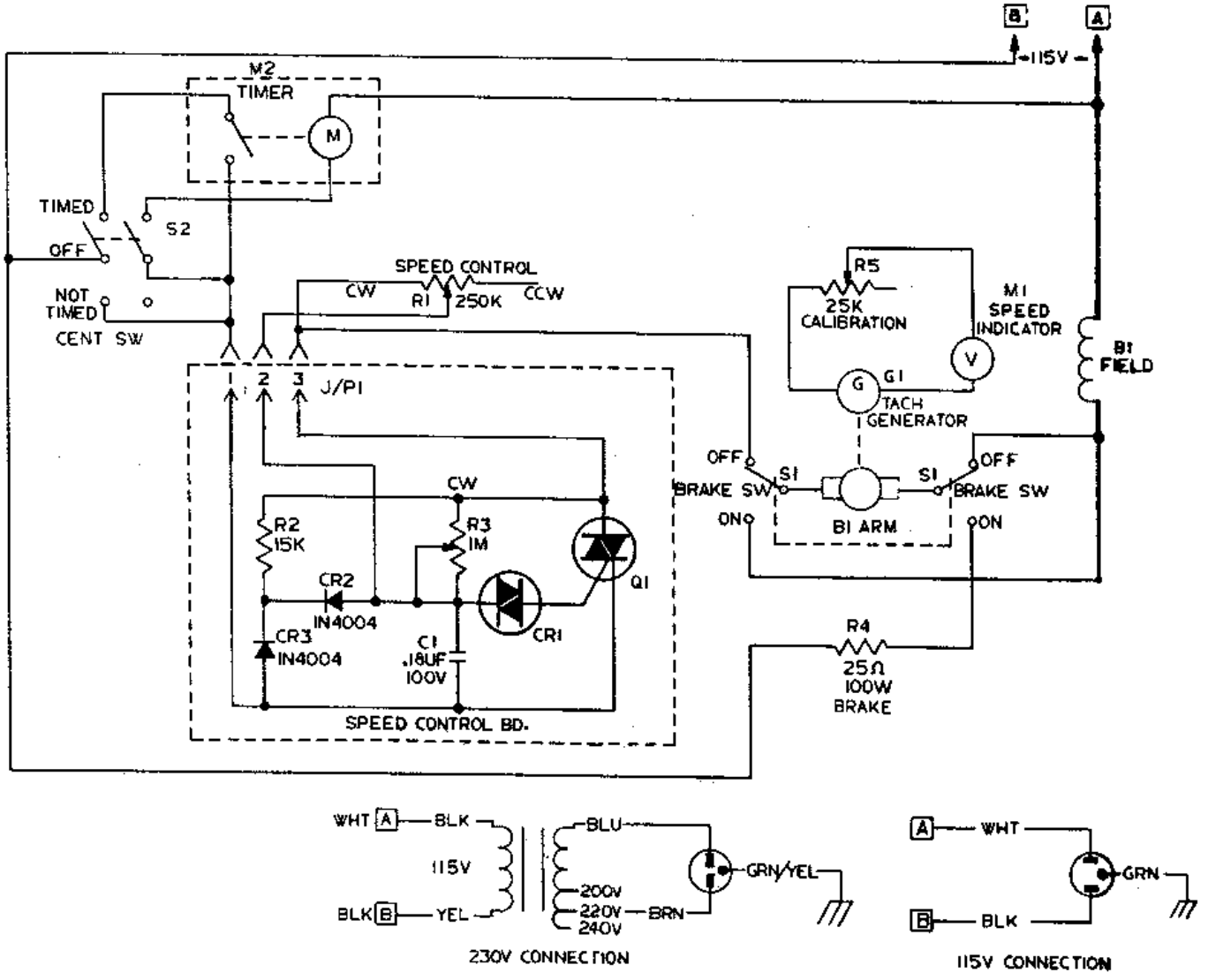


Figure 4-2 System Schematic Diagram

For high motor speeds, the Triac (Q1) turns on early in each half-cycle. To accomplish this, Resistor (R2) and Rectifiers (CR2 and CR3) provide a d-c "hold-off" voltage across Capacitor (C1). The panel-mounted SPEED CONTROL Potentiometer (R1) is set so that at the required moment in each half-cycle, the combination of the "hold-off" voltage and the voltage from the motor armature will reach the critical value at which the triggering Diode (CR1) will break down to fire the Triac (Q1). The supply to the motor armature will thereby be a successive series of partial half-waves, for motor speed control over a wide range. Adjustable Potentiometer (R3) on the P.C. Speed Control Board is adjusted at the factory to provide zero motor speed at the low end of SPEED CONTROL (R1) rotation.

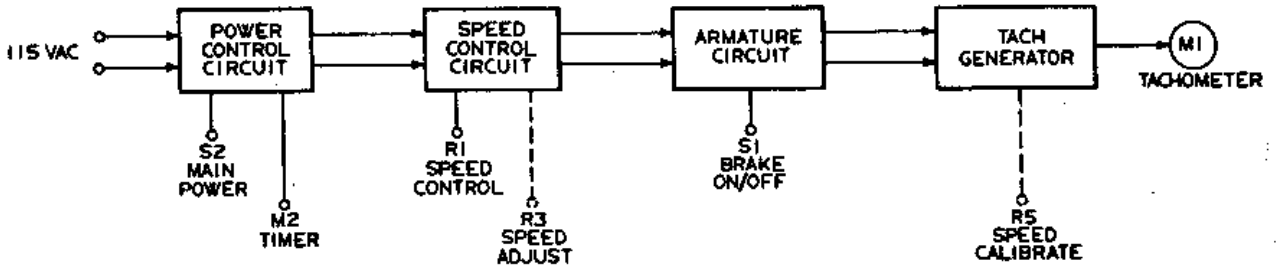


Figure 4-3 Centrifuge, HN-SII, System Block Diagram

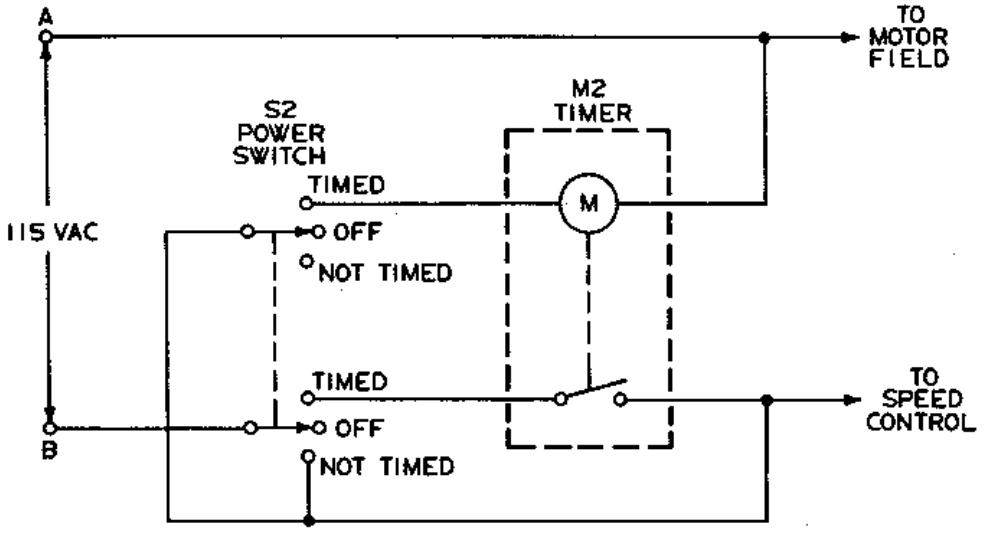


Figure 4-4 Power Control Circuit, Simplified Diagram

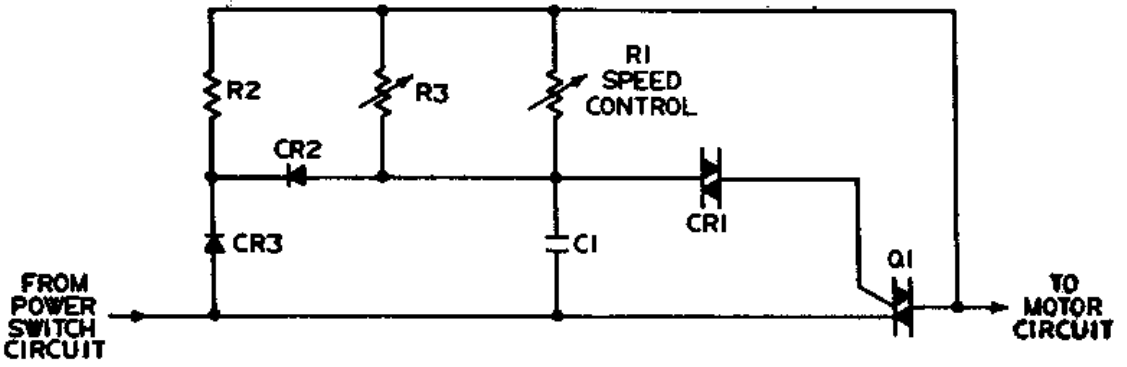
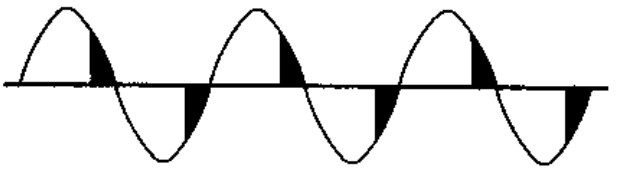
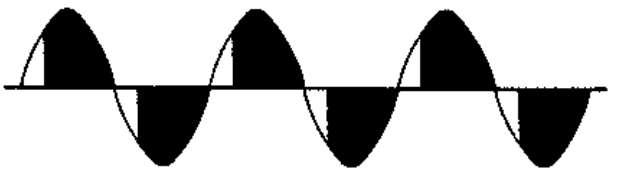


Figure 4-5 Speed Control Circuit, Simplified Diagram



a. Current flow, low speed setting



b. Current flow, high speed setting

Figure 4-6 Speed Control Circuit Operation

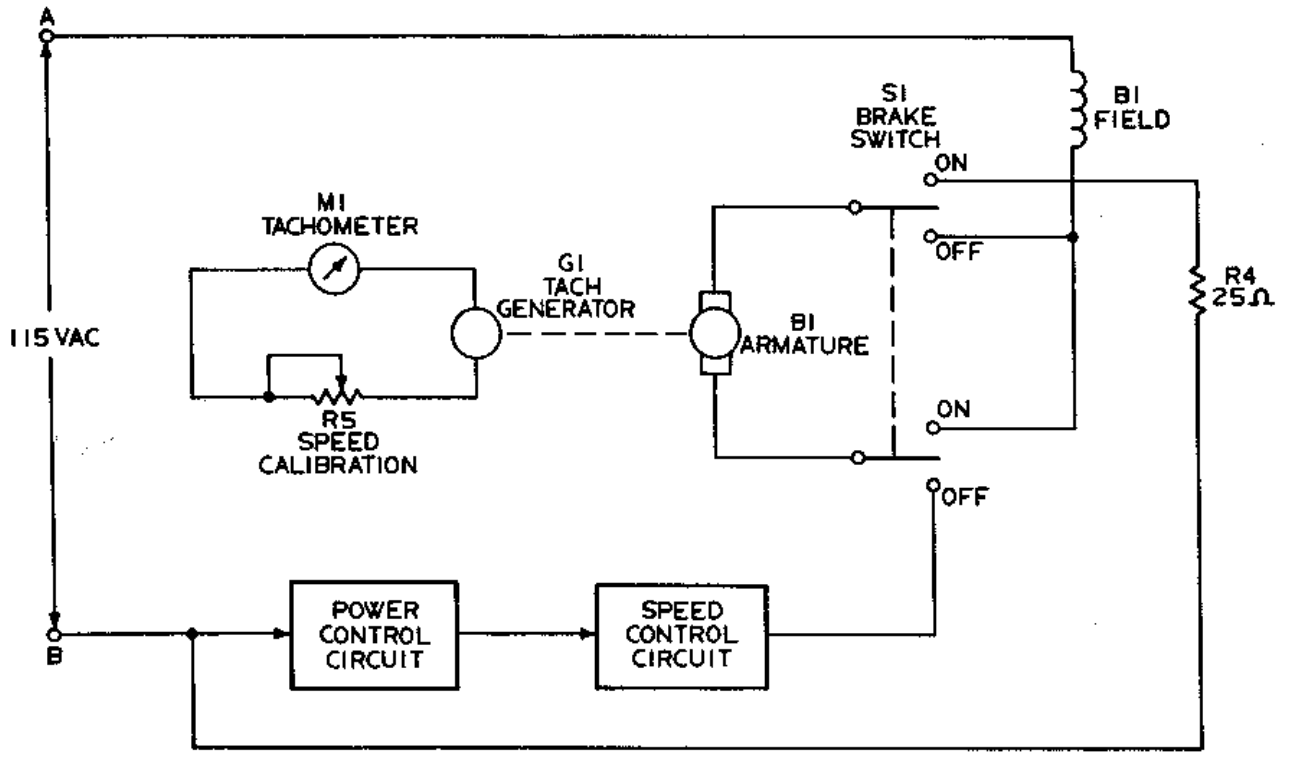


Figure 4-7 Armature Circuit, Simplified Diagram

4.6 Armature Circuit

The Armature Circuit is shown in the Systems Functional Diagram, figure 4-1, the System Schematic Diagram, figure 4-2, and the Simplified Diagram, figure 4-7.

The BRAKE Switch (S1) is a spring-loaded DPDT switch, which remains in the "OFF" position at all times except while being held at "ON". When finger pressure is released from the switch, it automatically returns to the OFF position. With the switch at OFF (no pressure on the switch), the relationship of armature connection and the direction of field current is such as to produce the normal CCW direction of armature rotation (when viewed from top). However, pressing the switch to the "ON" position reverses the armature connections with respect to the direction of field current, which results in the development of a motor force in the CW direction of rotation. This exerts a braking action on motor rotation, to shorten the coasting time. Note that when the switch is at the "ON" position, the motor connection is directly to the power line input terminals, through the 25-ohm resistor which determines the magnitude of the reverse-direction motor force for braking. Because of this direct connection the motor will start to turn in the reverse direction if the BRAKE Switch is held at "ON" after the armature has come to rest.

The armature is also mechanically linked to a tachometer generator, whose voltage output is directly proportional to the armature speed. The Tachometer (M1) will therefore deflect by an amount which is proportional to the motor speed. The calibration potentiometer (R5) is adjusted so that this deflection will match the correct speed in RPM on the face of the meter scale.

4.7 Corrective Maintenance

Corrective maintenance includes those procedures designed to restore the equipment to its normal operating condition after failure of some component or after unsatisfactory operation. The most important feature of corrective maintenance lies in the troubleshooting procedures which diagnose the source of difficulty, and which indicate the appropriate action to correct the fault.

4.8 Troubleshooting

> *WARNING*
>
> *Dangerous and potentially lethal voltages exist near the adjustment and measurement points used for calibration and troubleshooting. Exercise extreme caution when near these points.*

If trouble occurs, it is essential to locate and correct the cause. To locate electrical faults, the service person requires a volt-ohm meter (VOM) capable of measuring 115 VAC and resistance. In addition, a stroboscope will be required for Tachometer calibration.
Do not replace components indiscriminately; take care first to be certain that replacement is needed. Take the time to think through what the machine or the component should be doing. Use the Schematic Diagram, figure 4-2, and the circuit diagrams, schematics, and block diagrams earlier in this section of the manual, as a guide toward proper operation. Frequently, the problem will be caused by some simple fault, such as a loose or open connection, or even by such a simple mistake as trying to operate the centrifuge without plugging in its power cord.

Listening to the machine, and watching it in operation, will often indicate where to look for the source of the problem. Some of the important things to note are:

1. Does the motor fail to operate when the operating procedures are followed, as given in the Operating Section of this Manual?

2. Does the Tachometer fail to read normally?

3. Does the BRAKE SWITCH fail to cause the motor to turn in the reverse direction when the Power Switch is set to OFF?

Refer also to the Troubleshooting Chart, Table 4-1, for a list of symptoms, their possible causes, and their remedy.
If the trouble appears to be located on the PC board, always check the connector for good contact and engagement before deciding that replacement is necessary. Field repair of the PC board is not recommended. If the PC board is replaced, check the SPEED CONTROL adjustment (see paragraph 4.12) after replacement.

4.9 Motor Check (115 volt models only)

For a quick check on the motor, unplug the centrifuge and connect an ohmeter across the power plug terminals (115 volt models only). Set the Power Switch to OFF. Press the BRAKE switch, and the resistance should drop to a value in the vicinity of 30 ohms, to show that the field winding and resistor (R4) are not open circuited, and that the brushes and armature circuit will conduct.

4.10 Lubrication

The centrifuge does not require lubrication. Motor bearings in the drive assembly are lubricated for life.

4.11 Tachometer Calibration

The Tachometer (M1) is a voltmeter which measures the voltage generated by the Tachometer Generator (G1). Calibration is performed by adjusting the

Calibration Potentiometer (R5). These adjustments must be performed only by factory-trained service personnel. The calibration adjustment is made at the factory before shipment, but may require re-setting because of tampering, change in component characteristics, or parts removal or replacement.
Tools required for calibration are:
1. One small screwdriver.
2. One calibrated stroboscopic tachometer.

To perform the speed calibration, proceed as follows:

1. Set Power Switch (S2) at OFF (center position). Set the SPEED CONTROL (R1) to OFF.

2. Install rotor (see paragraph 3.5.1).

3. Check that Tachometer on front panel reads zero. Adjust to zero if necessary by the Meter Zero Adjust screw on face of Tachometer.

4. Check that cover is securely closed and latched. Set the Power Switch (S2) to ON/WO TIMER. Slowly advance the SPEED CONTROL (R1) until 2000 RPM is shown on the panel Tachometer.

5. Shine the calibrated stroboscopic tachometer through the vent hole in the cover, at a calibrated setting of 2000 RPM. Slowly adjust the SPEED CONTROL (R1) to bring the rotor speed into synchronism.

6. Observe the Tachometer on the centrifuge panel. If this Tachometer does not read 2000 RPM, adjust the Calibration Potentiometer (R5) for an exact reading. (R5 is adjusted with a small screwdriver through the front panel, immediately below the Speed Control knob).

4.12 SPEED CONTROL Adjustment

This adjustment assures that the centrifuge motor is at or below the point of barely starting to rotate when the speed control is in the OFF position (fully CCW). The calibration is performed at the factory before shipment, but may require re-setting because of tampering, change in component characteristics, or parts removal or replacement. This adjustment must be performed by factory-trained service personnel. To adjust, proceed as follows:

1. Remove centrifuge power plug from wall socket, remove rotor, and replace knurled nut finger-tight.

2. Latch cover securely. Invert the centrifuge on a secure, protective surface, taking care not to damage the latch assembly.

3. Remove bottom plate retaining screws and remove bottom plate.

4. Set Power Switch (S2) to OFF.

5. Set Speed Control to OFF.

6. Plug centrifuge power plug into wall socket.

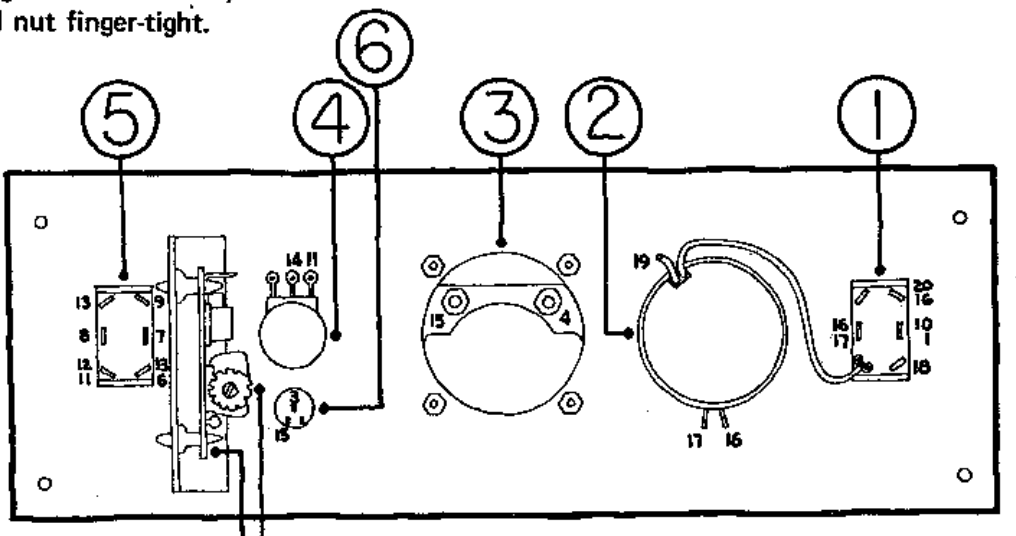
> *WARNING*
> *Dangerous and potentially lethal voltages exist near the points of adjustment and observation. Exercise extreme caution.*

7. Set Power Switch (S2) to ON/WO TIMER.

8. Locate Trimpot (R3) on the Speed Control PC board. Refer to Figure 4-8.

9. Adjust Trimpot (R3) to be just to the point at which the motor barely starts to turn, as observed at the magnet nut at the bottom end of the lower motor shaft.

10. Unplug the centrifuge and re-assemble.



1. Power Switch (S2) 9943
2. Timer (M2) 45873E (60 Hz)
   45873F (50 Hz)
3. Tachometer (M1) 41125
4. SPEED CONTROL (R1) 61621
5. BRAKE Switch (S1) 9942
6. Calibration Potentiometer (R5) 61603

NOTE: Letters enclosed in parentheses refer to schematic and wiring diagram designations for these items. Refer to paragraph 4.12 for TRIMPOT (R3) 61617M.

Figure 4-8 Control Panel, Rear

Table 4-1 Trouble-Shooting Chart

SYMPTOM	POSSIBLE CAUSE	REMEDY
Centrifuge inoperative.	Centrifuge not plugged in.	Check that power cord is plugged into socket.
	No power available.	Check for voltage at power socket.
	Improper operation.	Check for proper operation as given in Section 3 of this manual.
	Defective Speed Control potentiometer.	Check potentiometer and replace if necessary.
	Defect in Speed Control PC Board.	Check PC board connections.
	Defective motor or BRAKE switch.	Check as per procedure in paragraph 4.9 (115 volt models only).
Inoperative on TIMED position, operates on NOT TIMED position of Power Switch.	Timer improperly set.	Advance Timer to mid-position, to check on Timer switch operation.
	Defective contact or Power Switch.	Remove power and check for contact operation with ohmeter; replace if necessary.
	Timer defective	Replace timer if shown to be defective.
Inoperative on NOT TIMED position, operates normally on TIMED position of Power Switch.	Defective contact on Power Switch.	Remove power and check for proper contact with ohmeter; replace switch if necessary.
Centrifuge continues operation after Timer has timed out.	Defective Timer Switch.	Replace Timer.
Speed Control does not operate.	Defective Speed Control potentiometer R1.	Replace Speed Control.
	Defect in Speed Control PC Board.	Check PC Board connections. Replace Board if necessary.

SYMPTOM	POSSIBLE CAUSE	REMEDY
No indication on Tachometer.	Defective Tachometer.	Replace Tachometer.
	Open Calibration potentiometer (R5).	Replace potentiometer.
	Defective Tachometer Generator.	Replace Tachometer Generator.
Incorrect indication on Speed Indicator.	Incorrect calibration.	Re-calibrate as outlined in paragraph 4.11.
BRAKE Switch inoperative.	Defective BRAKE Switch.	Replace BRAKE Switch.
	Open resistor R4.	Replace resistor.
Speed control does not operate properly at low speeds.	Speed control PC Board out of calibration.	Calibrate PC Board.

4.13 Parts Replacement

The following paragraphs contain information necessary for replacing various parts of the centrifuge. See the Replacement Parts List at the rear of this manual for a list of parts with Damon/IEC part numbers for ordering replacements. Parts must be ordered from your authorized Damon/IEC distributor.

WARNING

These operations may expose service personnel to potential electrical shock areas. All service personnel must be factory-trained for work on this type of equipment. Except where otherwise instructed, always unplug the centrifuge before starting any repair procedures.

4.14 Brush Removal and Replacement

Proper attention to motor brushes is necessary to ensure proper operation and long life. Operation with worn brushes can lead to serious damage to the motor commutator. To examine brushes for excessive wear, proceed as follows.

1. Remove the centrifuge power plug from wall socket, remove rotor, and replace knurled nut finger-tight.

2. Locate the two brush holders, located on either side of the motor housing, accessible from inside the guard bowl.

3. Unscrew the two brush caps, and remove the two brushes. If brushes are less than ¼ " in length, not including the brush spring, they should be replaced. See the Replacement Parts List at the rear of this manual for brush part number. Use only the proper Damon/IEC replacement brushes.

4. To replace brushes, insert into holder so that curvature of brush matches the curvature of the commutator. (This may be accomplished by being certain that the end of the brush has a circular curvature as seen from above, before insertion). Screw the brush caps back in place.

5. Re-connect the centrifuge to power, and check for operation.

4.15 Armature Removal and Replacement

The armature is the rotating member of the armature-and-field combination, which drives the centrifuge rotor. While the armature is a rugged element, it may need removal in the event of serious damage, as may occur from operation with excessively worn brushes, operation with replacement brushes which are incorrect or have been inserted improperly, or operation with gross unbalance. To remove the armature, proceed as follows:

1. Remove centrifuge power plug from wall socket, remove rotor, and replace knurled nut finger-tight.

2. Remove the brushes as described in paragraph 4.14.

3. Unscrew and lift out the two motor screws in the top cap of the motor as viewed inside the guard bowl. NOTE: Mark top cap and base assembly to assure proper orientation when re-assembling.

4. Carefully lift up the armature and motor top cap, and remove. Do not allow magnet on lower motor shaft to contact any magnetic material.

5. Inspect the armature for evidence of damage, with special attention to the commutator. It should be copper-colored, with no pits, scratches, or excessive scoring. If carbon-coated, clean and polish lightly with a soft cloth and mild industrial solvent. Do not use any abrasive. Excessive scoring or evidence of electrical arcing is cause for concern; consult your Damon/IEC dealer or representative.

6. To replace the armature and motor top cap, carefully re-insert and locate in place, and follow the earlier steps in their reverse order, taking care that magnet does not contact any magnetic material.

7. Place the centrifuge on its side on a protective surface, with precautions to prevent damage to the finish, and to prevent rolling.

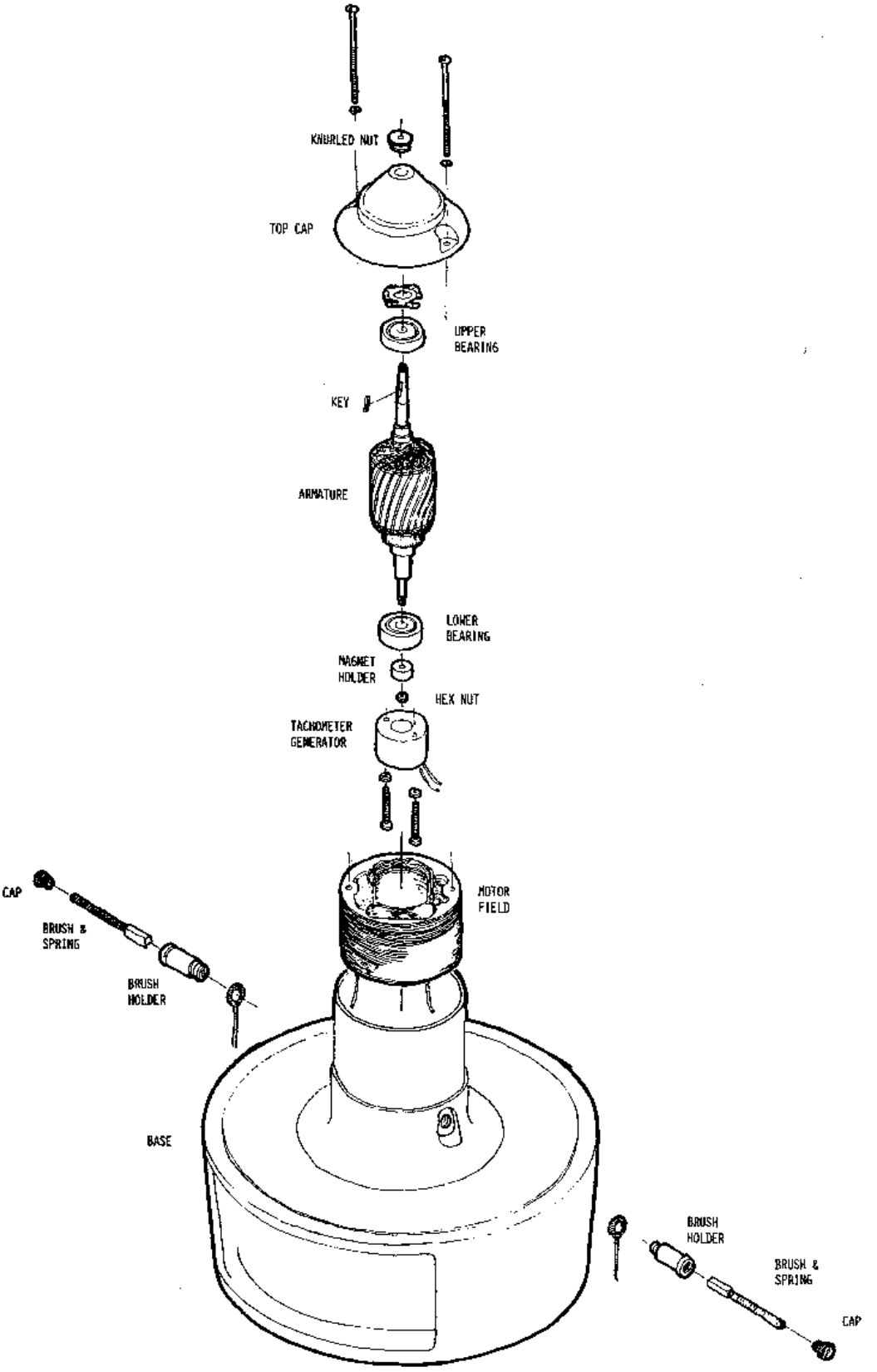


FIGURE 4-9 PARTS ASSEMBLY

8. Remove bottom plate retaining screws and remove bottom plate.

9. Identify tachometer generator at center of lower motor axis as seen from beneath, with magnet at the center of the tachometer generator coil. Rotate motor shaft, and check that magnet does not contact inner surface of coil during rotation. If such contact does occur, loosen the two tachometer generator coil hold down screws, re-center the tachometer generator coil, and re-tighten. Check again for magnet contact, and repeat as necessary.

10. When adjustment is complete, replace bottom plate and fasten with mounting screws.

4.16 Field Assembly Removal and Replacement

The field assembly and magnetic structure are the part of the armature-and-field combination which develops the magnetic fields necessary for armature rotation. The field is seldom a source of trouble, but may have to be removed for inspection or replacement. To remove the field assembly, proceed as follow.

1. Remove the brushes and armature as described in paragraphs 4.14 and 4.15.

2. Place the centrifuge on its side, with precautions to prevent damage to its finish, and to prevent rolling. Cover latch and controls should be uppermost, or conveniently close to being uppermost. Remove bottom plate retaining screws and remove bottom plate.

3. Identify the four motor leads which enter the wiring compartment through four holes. One field lead is closest to the Brake Switch (S1). The other field lead is opposite the first one. (The other two leads are to the motor brushes).

4. Identify the termination of the field leads, to allow proper re-connection, and disconnect the leads.

5. Open the centrifuge cover, reach into the space vacated by the armature, and remove the field assembly.

6. Inspect the field assembly. It should be free of metallic particles or evidence of overheating. If evidence of damage is found, consult your Damon/IEC dealer or representative.

7. To replace the field assembly, insert the free end of each field lead into the proper hole in the bottom of the open motor compartment, and insert the field assembly into place.

8. Re-connect the field wires to their original terminations.

9. Replace armature and brushes as given in paragraphs 4.14 and 4.15.

4.17 Cover Assembly Removal and Replacement

To remove the cover assembly, proceed as follows.

1. Remove the centrifuge power plug from wall socket.

2. Remove the two chrome acorn nuts at the rear cover hinge, taking care not to damage their finish.

3. Loosen the two set screws now visible, and remove the cover.

4. To replace the cover, install the cover in place, tighten the two set screws to allow free cover motion without looseness, taking care not to over-tighten.

5. Replace the two chrome nuts.

4.18 Latch Assembly Removal and Replacement

The Latch Assembly has two parts, one on the cover and one on the guard bowl. Either or both parts may have to be removed for replacement in case of damage. Proceed as follows.

1. Remove the centrifuge power plug from the wall socket.

2. To remove the upper latch assembly, lift the cover and remove the three screws holding the latch assembly in place.

3. To remove the lower latch half, open the cover and remove the two screws on the inside of the guard bowl beneath the latch.

4. To replace the upper or lower latch half, follow the preceding steps in their reverse order. When replacing, fasten part loosely, check alignment, and then tighten securely in place.

4.19 Control Panel Removal and Replacement

The Control Panel mounts the centrifuge controls. It has been designed for easy removal, to simplify problems of repair and maintenance which involve the centrifuge controls. To remove the control panel, proceed as follows.

1. Remove centrifuge power plug from wall socket, remove rotor, and replace knurled nut finger-tight.

2. Place the centrifuge either on its side, or in an inverted position, as described:
   a. To invert the centrifuge, close cover securely, and invert on a secure protective surface, taking care to not damage the latch assembly.
   b. To place the centrifuge on its side, close cover securely, and place centrifuge on its side on a secure protective surface, taking care not to damage the latch assembly. Cover latch and controls should be uppermost. Take precautions that centrifuge will not roll.

3. Remove the bottom plate retaining screws and remove bottom plate. Place screws in a secure location to prevent loss.

4. The control panel wiring harness terminates at the twelve-terminal connector J/P-2. Unplug the connector.

5. At the front of the Control Panel carefully loosen the four screws at the corners, taking care not to scratch the panel surface. Carefully remove the Control Panel from the centrifuge, together with the two front panel support brackets.

6. The Control Panel may now be placed on a convenient work-bench for further inspection and repair as may be needed. Watch particularly for evidence of electrical overload at the Power Switch (S2) and the Brake Switch (S1).

7. To replace the Control Panel, follow the preceding steps in their reverse order. Re-connect the harness to terminal connector J/P-2.

4.20 Removal and Replacement of Tachometer Generator

The Tachometer Generator provides a voltage proportional to rotor speed, which is indicated in RPM on the front-panel Tachometer (M1). The unit consists of a magnet, fastened to the lower end of the shaft by means of a magnet holder, and a coil within which the magnet rotates. Each coil and magnet form a matched pair, and must be replaced as a pair. To remove, proceed as follows.

1. Remove centrifuge power plug from wall socket, remove rotor, and replace knurled nut finger-tight.

2. Close the cover securely, and place the centrifuge on its side on a secure protective surface, taking care to not damage the latch assembly. Cover latch and controls should be uppermost. Take precautions that centrifuge will not roll.

3. Remove the bottom plate retaining screws and remove the bottom plate. Place screws in a secure location to prevent loss.

4. Identify the generator at center of motor axis, as seen from beneath. Remove nut holding the tachometer magnet in place. (Use caution not to bend the magnet holder). Disconnect the coil wires at the butt connector, remove the two coil hold-down screws, and carefully lift out the coil and magnet (Note: If the magnet does not come free with the coil, carefully remove the magnet from its holder by turning the magnet CCW; this may be caused by "Loctite" on the threads).

5. Inspect magnet and coil carefully, wiping off with a dry, clean cloth to remove any magnetic particles or dust which might be clinging to the structures, Do not allow the magnet to contact any magnetic material.

6. Check that coil has resistance of 300 ± 10% ohms, and that it shows no evidence of damage. Check that magnet shows no evidence of melted lead in its bore. If either the coil or magnet fails to pass this inspection, discard both coil and magnet and install replacements.

7. To replace coil and magnet, follow the preceding steps in their reverse order, taking care that the magnet does not contact any magnetic material. Make the following checks during re-assembly:

a. Check for run-out of the magnet and holder by rotating the armature manually from inside the guard bowl and observing the rotation below. Replace the holder if there is noticeable run-out.

b. After assembling the magnet to the holder, partially tighten magnet nut and the two coil hold-down screws. Rotate the armature manually and check that there is no contact between the magnet and the inner surface of the coil, and then tighten in place. As an alternate procedure, use plastic shim stock approx. 0.008" - 0.010" thick around the magnet without overlapping to center the magnet while tightening in place. After tightening and removing shims, check for centering as above.

c. NOTE: "Loctite (medium strength)" is used at three locations: (1) between the magnet holder threads and the armature shaft; (2) between the magnet holder and the magnet retaining nut; (3) between the coil holding screws and the base.

8. After re-assembly, check calibration of Tachometer (M1) as given in paragraph 4.11.

5.0 PARTS LIST

5.1 Spare Parts

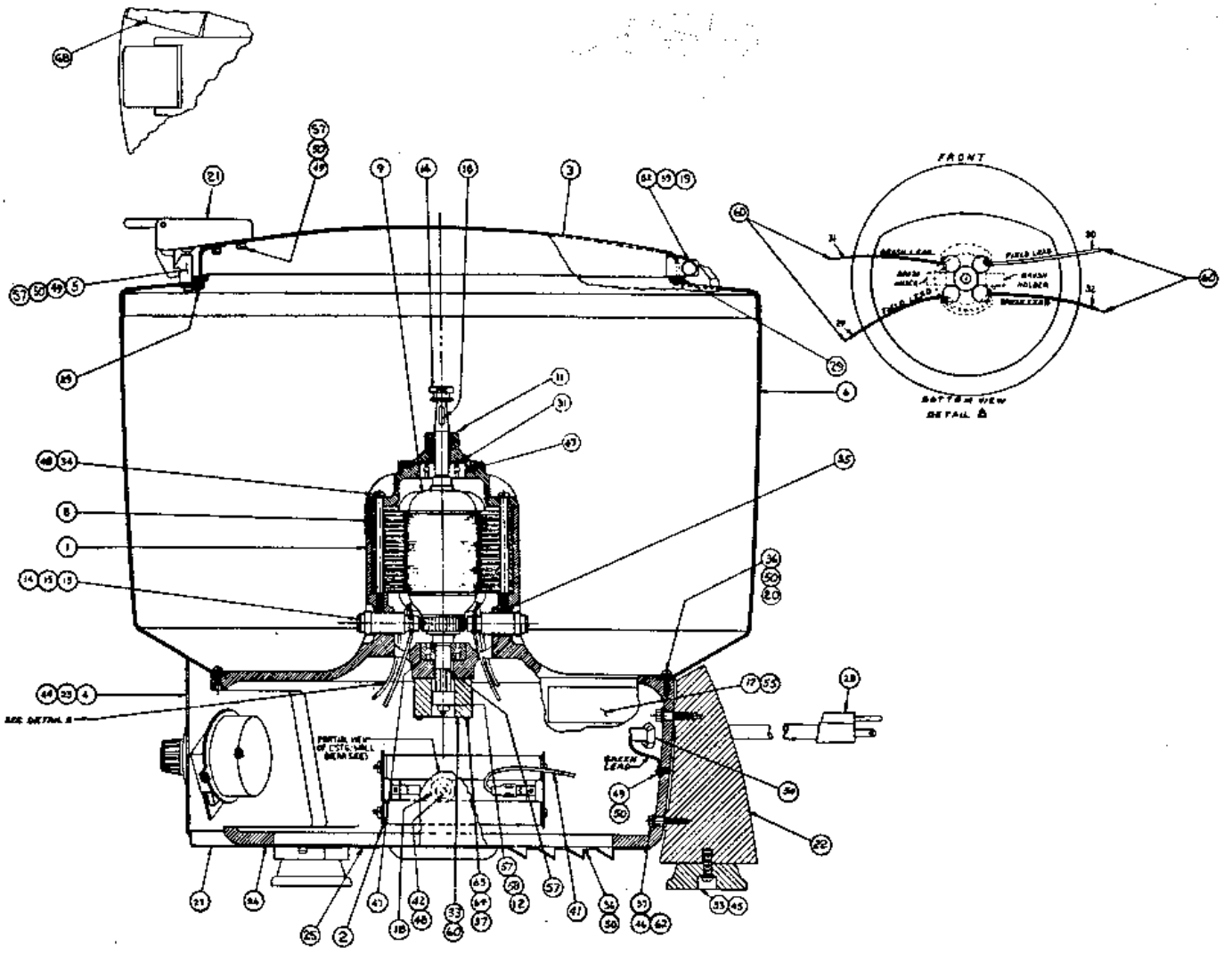
The following items are recommended as spare parts:

Item	Description	P/N	Qty.
1	Brush Assembly	1780	1 pair
2	Speed PC Board	17304	1
3	Knurled nut	1729	1

5.2 Replacement Parts List

Replacement parts are listed with the applicable assembly or detail drawing. Major assemblies are listed first, sub-assemblies next, and detail drawings last. Reference designations (R1, R2, etc.) are shown for electrical and electronic components on their applicable parts list. All items listed are for both 60 Hz and 50 Hz use except as indicated.

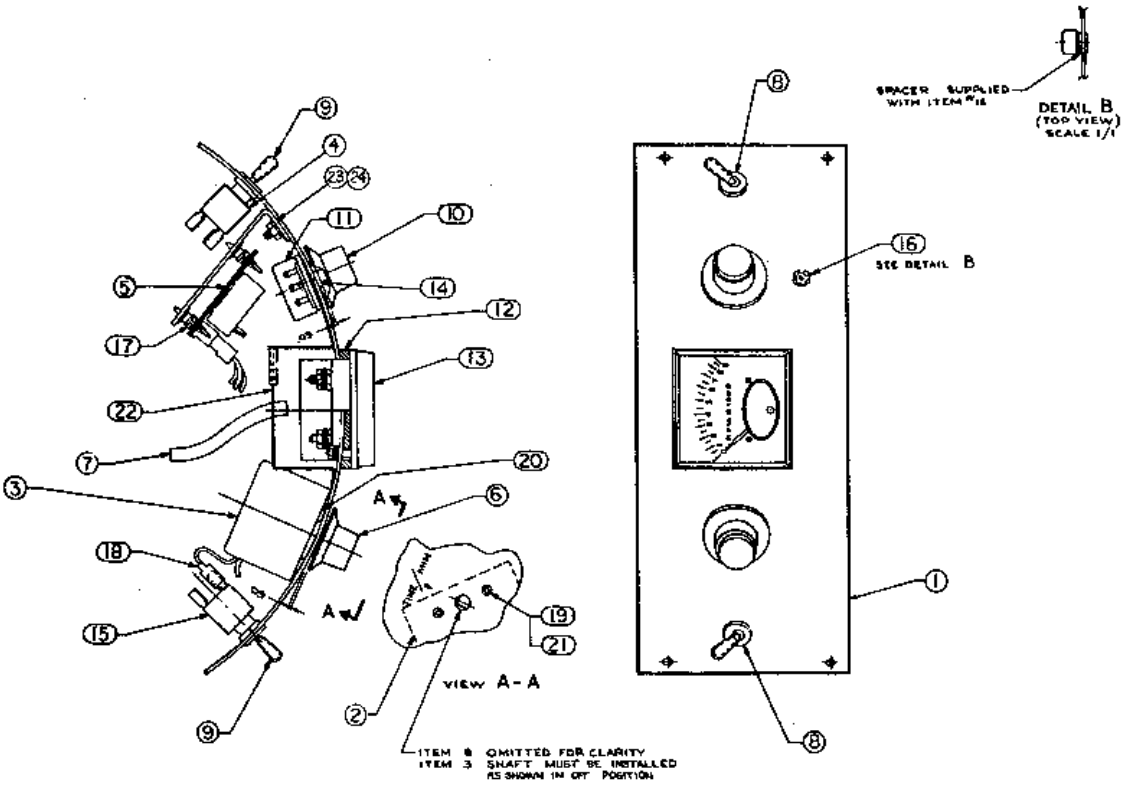
NOTES



ITEM	DESCRIPTION	PART NO.
1	ASSEMBLY, BASE	42967
2	ASSEMBLY, BRAKE RESISTOR RH	41313
3	ASSEMBLY, GUARD BOWL COVER	46764
4	ASSEMBLY, CONTROL PANEL (SEE FIGURE 5-3)	46753
5	BLOCK CLAMP	46822
6	ASSEMBLY, GUARD BOWL	46765
7	DELETED	-----
8	MOTOR FIELD B1	1954
9	MOTOR ARMATURE B1	41101
10	KEY	32385
11	TOP CAP - MACH	42249
12	HOLDER, MAGNET	41100
13	BRUSH HOLDER (TWO) (PT 1)	9037
14	CAP, BRUSH HOLDER (TWO) (PT 2)	9036
15	BRUSH AND SPRING (TWO)	1780
16	NUT, KNURLED	1729
17	PLATE, DATA	30633
18	SPACER, BRAKE RESISTOR	41098
19	LOCKWASHER, STEEL, CAD/PL, 1/4 INT TOOTH (TWO)	COM'L
20	GASKET	42269
21	ASSEMBLY, LATCH	46828
22	LEG, CENTRIFUGE (THREE)	42324A
23	BRACKET (TWO)	32383
24	DELETED	-----
25	LABEL, WARNING	45997
26	BOTTOM PLATE	32367
27	GUARD, ELECTRICAL	32390
28	POWER CORD	38805
29	RUBBER CUSHION (FOUR)	1779
30	DELETED	-----
31	WASHER, SPRING (WALLACE BARNES #5-10)	41778A
32	DELETED	-----
33	TACHOMETER GENERATOR	41461
34	SCREW - RD-HD-SLOT STL CAD PL (TWO) 10-32 x 3.25	COM'L

ITEM	DESCRIPTION	PART NO.
35	SCREW-SET-SOC-NYLOC-STL CAD PL (TWO) 10-32 x .25	COM'L
36	SCREW - RD-HD-PHIL (TEN) STL CAD PL 10-32 x .38	COM'L
37	SCREW, HEX HD STL CAD PL 1/4-20 x 1.25	COM'L
38	DELETED	-----
39	SCREW-SET-SLOT-CONE PT - STL CAD PL 1/4-20 x .62	COM'L
40	DELETED	-----
41	WIRING HARNESS, BRAKE RESISTORS	46760
42	SCREW - RD-HD-PHIL STL CAD PL 10-32 x 1.25	COM'L
43	DELETED	-----
44	SCREW-TRUSS-HD-PHIL STL CAD PL 8-32 x 1.25 (FOUR)	COM'L
45	SCREW-RD-HD-PHIL STL CAD PL 1/4-20 x 1.00 (THREE)	COM'L
46	LOCKWASHER, SPLIT (SIX)	COM'L
47	BEARING (TWO)	9939A
48	LOCKWASHER (FIVE) STL CAD PL #10	COM'L
49	SCREW RD HD PHIL STL CAD PL 8-32 x .32 (SIX)	COM'L
50	LOCKWASHER STL CAD PL #8 (FIFTEEN)	COM'L
51	DELETED	-----
52	NUT, ACORN, SMALL, BRASS, CHROME PL 1/4-20 (TWO)	COM'L
53	MOUNTING FOOT (THREE) (ATLANTIC INDIA RUBBER #106)	33340
54	STRAIN RELIEF (HEYCO #SR-6L-1)	COM'L
55	SCREW, DRIVE (TWO) STN STL (#0X.19L6)	COM'L
56	NUT, HEX (TWO)	COM'L
57	LOCTITE (AS REQ.) (COMP #242)	COM'L
58	NUT, HEX STL CAD PL 6-32	COM'L
59	DELETED	-----
60	CONTACT, SOCKET (SIX) (AMP #350536-1)	COM'L
61	CLOSED END SPLICE (TWO)	COM'L
62	WASHER, PLAIN STL CAD PL 1/4 (SIX)	COM'L
63	SCREW RD HD SLOT STL CAD PL 4-40 x 1.25 (TWO)	COM'L
64	WASHER, PLAIN (TWO) STL CAD PL #4	COM'L
65	BUTT SPLICE	COM'L
66	DELETED	-----
67	ASSEMBLY, JUMPER	46767
68	LABEL, FDA CODE 36980	46290

Figure 5-1 Centrifuge Assembly, 115 V 60 Hz, 2355



ITEM	DESCRIPTION	PART NO.
1	PANEL - CONTROL MARKING	46755
2	INSULATOR, TIMER	45874
3	TIMER	45873E (60Hz) 45873F (50Hz)
4	SWITCH, BRAKE, DPDT MOMENTARY	9942
5	ASSEMBLY P.C. BOARD SPEED CONTROL (SEE FIGURE 5-4)	~~46692~~ 49032
6	KNOB, TIMER	46758
7	WIRING HARNESS	46754
8	NUT FACE KNURLED (TWO)	42011
9	VINYL TIP (TWO)	45390
10	KNOB, SPEED CONTROL	46757
11	POTENTIOMETER	61621
12	ADAPTER, METER	40974
13	TACHOMETER INDICATOR	41125
14	NUT, HEX	42280
15	SWITCH, DPDT CENT-OFF	9943
16	POTENTIOMETER, CALIBRATION	61603
17	CIRCUIT BOARD SUPPORT (FOUR)	COM'L — AUCO. CORP LCBS-3R
18	TERMINAL FASTON 1/4	COM'L
19	SCREW, RD HD PHIL 4-40 (TWO)	COM'L
20	WASHER, FLAT (TWO)	COM'L
21	LOCKWASHER, INT TOOTH #4 (TWO)	COM'L
22	SHIELD, ASSEMBLY SPEED INDICATOR	42981
23	BRACKET, ELECTRICAL	46752
24	NUT, FLANGE WHIZ LOCK 6-32	COM'L

FIGURE 5-3 CONTROL PANEL, 46753 (60 Hz), 46756 (50 Hz)

PARTS LIST	DAMON/IEC DIVISION	CODE IDENTIFICATION	PL C 49032	REV
TITLE: ASSY P.C. BD. SPEED CONTROL	PREPARED / CHECKED / APPROVED		SHEET 1 OF 1; INITIAL RELEASE; ECO NO. DATE	

REVISION SHEET	ECO NO.	DATE	BY	APPROVED	APPLICATION USED ON	NEXT ASSY
						D-49457

ITEM	QTY	PART NUMBER	DESCRIPTION	REMARKS	REV.
1	1	C-49031	DETAIL ASSY MACHINING P.C. BD. SPEED CONTROL		
2	1	COML	RESISTOR, CARBON 1/2W 2.7K 5%	R4	
3	2	COML	RESISTOR, CARBON 1/2W 15K 10%	R1, R2	
4	1	C-61617M	RESISTOR, VARIABLE CARBON 1MEG	R3	
5	1	COML	HEAT SINK (WAS B49005)	AAVID #530613U00000	
6	1	C-60650R	CAPACITOR (FILM POLYESTER); .18UF 100V	C1	
7	4	A-61513D	DIODE, SILICON 1N4004	CR2, CR3, CR4, CR5	
8	1	*-41404	DIAC, SILICON BIDIRECTIONAL TRIGGER	CR1	(TECCOR
9	1	~~-61325~~	TRIAC, ~~6AMP~~ 400V 8 AMP	Q1 - ~~RCA T2700D~~	Q4008R4
10	2	COML	SCREW, P.H. PHIL 4-40UNC-2A x .38LG	STL/CAD PL	
11	1	COML	CONNECTOR, P.C. BD. HEADER (3 POS.)	J07; AMP# 350210-1	
12					
13	1	49234	ARC SUPPRESSOR NETWORK .25UF, 50 Ω	RC1; PAKTRON (ITW) #254M06QD150	
14		COML	STANDOFF NYLON	RICHCO # R-9105-02	
15	REF	C-10657	SCHEMATIC P.C. BD. SPEED CONTROL		
16	2	COML	NUT HEX 4-40	STL/CAD PL	
17	4	COML	WASHER LOCK INT TOOTH #4	STL/CAD PL	
18	AR	COML	THERMAL GREASE	WAKEFIELD 120 OR EQ	

THIS PRINT DATE

PL 49032

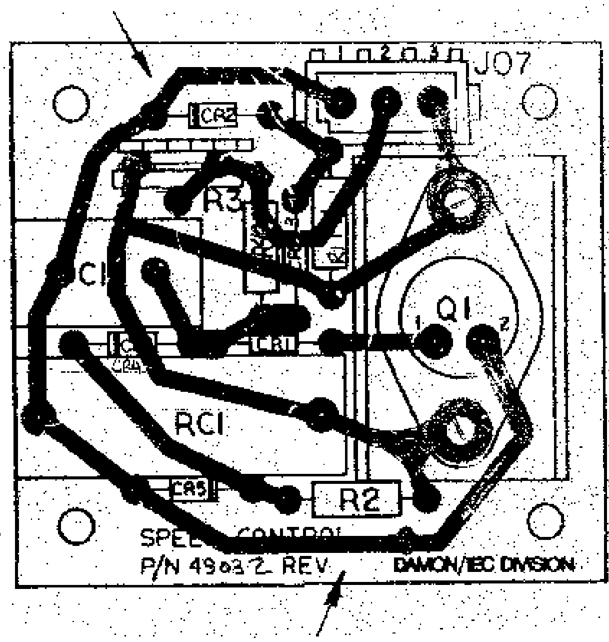


FIGURE 5-4 SPEED CONTROL P. C. BOARD, ~~46692~~ 49032

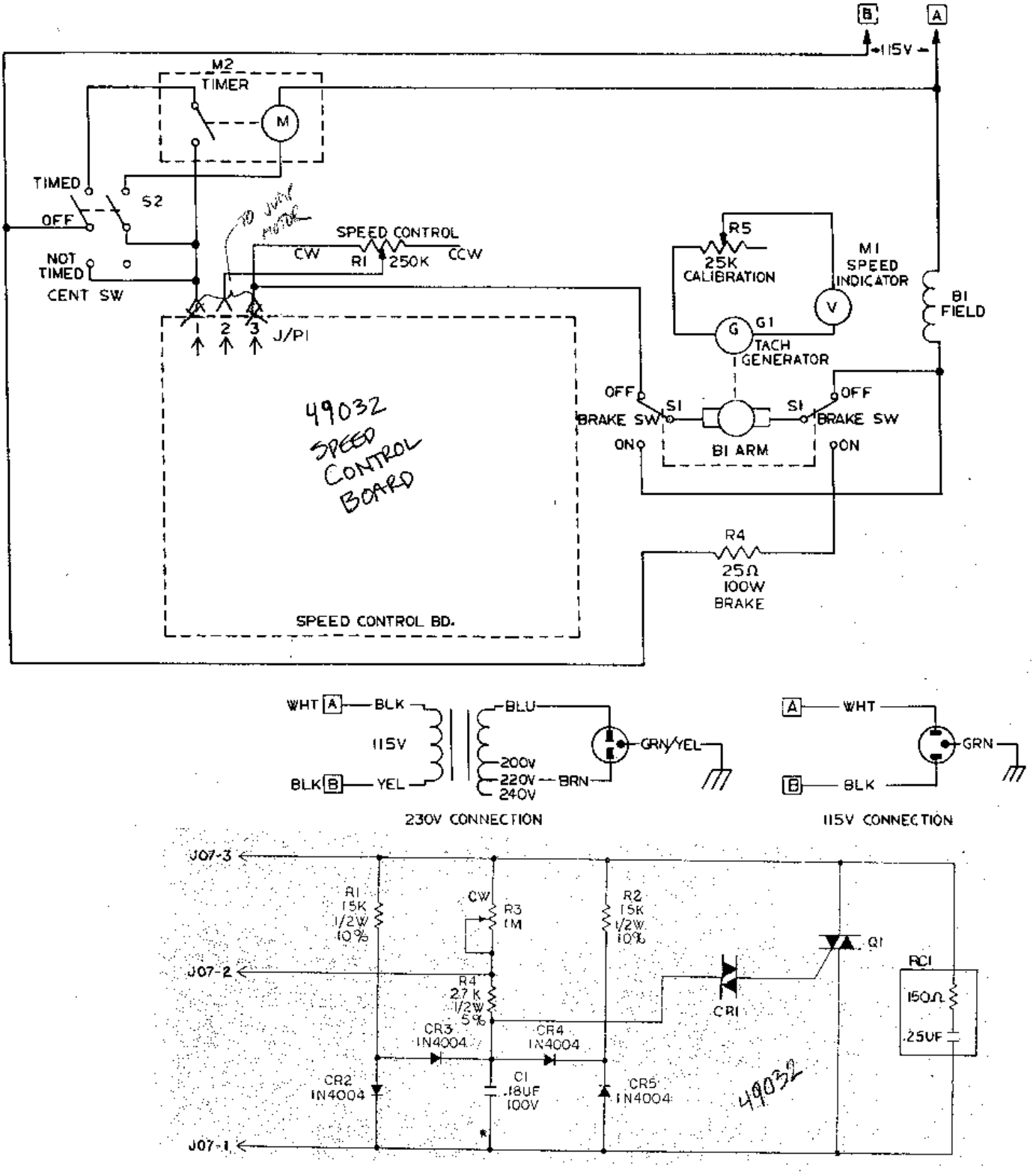


FIGURE 5-5 SCHEMATIC DIAGRAM, C10402

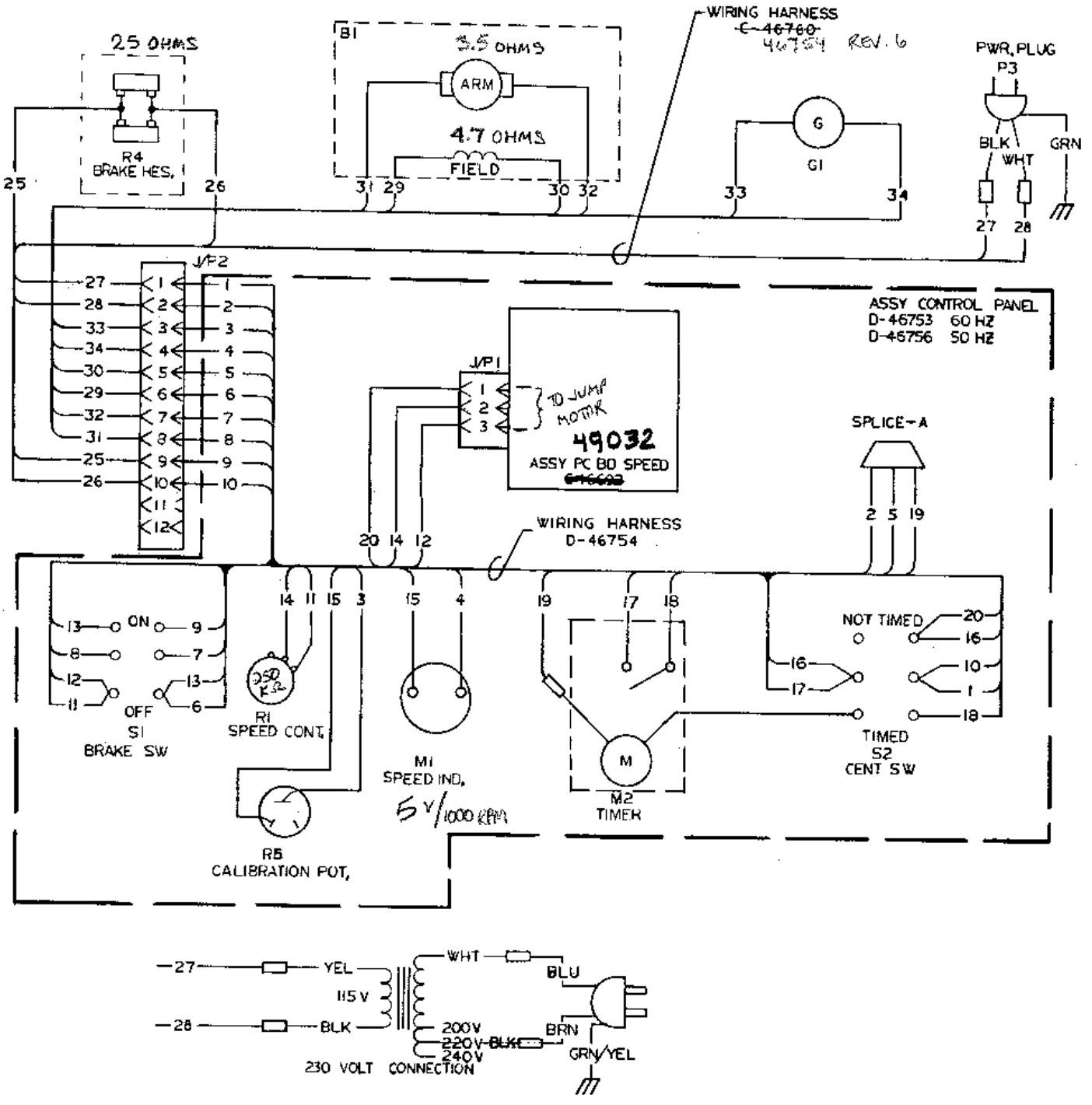
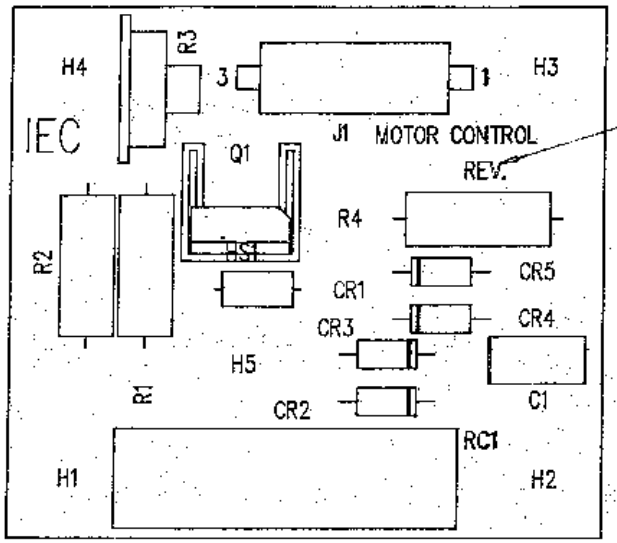


FIGURE 5-6 WIRING DIAGRAM C10441



SEE NOTE 2

IEC 300 SECOND AVE. NEEDHAM HGTS, MA. 02194

ELECTRONICS ASSEMBLY PARTS LIST COVER SHEET

PARTS LIST	TITLE	
PL C45004 REV 1	ASSY, P.C. BD, SPEED CONTROL	USED ON: HBS-II,H-60 NEXT ASSY:

REV	SHEET	ECO	DATE	APPROVAL
0	1	0493	7/14/92	JAB
1	ALL	0558	8/17/92	JAB

8/17/92 IEC PARTS LIST C45004 REV 1
ASSY-PC BOARD,CONTROL SHEET 1 OF 1

ITEM	QTY	IEC PN	DESCRIPTION	REFERENCE	SUGGESTED MANUF.	MANUF. PN
1	1	C11389	MACH,AM,SLKSCN,SLDRMSK,P.C. BD			
2	1	COM'L	RES,CF,2.7K,1/2W,5%	R4	GENERIC	
3	2	COM'L	RES,CF,15K,1/2W,10%	R1,R2	GENERIC	
4	1	COM'L	RES,VAR;CF,1M,1/4W	R3	CLAROSTAT	C-105
5	1	COM'L	HEATSINK	FOR Q1	AAVID	657602B03200
6	1	COM'L	CAP,POLY FILM .10UF,10%,100V	C1	SPRAGUE	225P10491LD1
7	4	COM'L	DIODE,1A,400V	CR2-CR5	MOTOROLA	1N4004
8	1	COM'L	DIAC,1A,32V TYP	CR1	G.E.	ST-2
9	1	COM'L	TRIAC,8A,400V	Q1	TECCOR	Q4008R4
10	1	62293	CONNECTOR,PC MNT,3 PIN,STRT	J1		
11	1	COM'L	ARC SUPPRESSOR,.25UF,150 OHM 600V,1.13 C-C	RC1	ITW/PAKTRON	254N0600150
12	A/R	COM'L	THERMAL GREASE	FOR Q1	GENERIC	
13	REF	C10657	SCHEM,P.C.BD,SPEED CONTROL			
14						
15						
16						
17						
18						

QUARE PADS INDICATE TH FOLLOWING:
PIN "1" OF MULTILEAD DEVICES.
(DIPS, SIPS, POTS, ETC.)
POLRITY PINS OF DISCRETE COMPONENTS.
(CATHODE, EMITTER, "+", ETC.)

ART NO. & REVISION LEVEL TO BE WRITTEN
SING INDELABLE MARKER.

46756	HN-SII
46753	HN-SII
	[redacted]
	[redacted]
NEXT ASSY	USED ON

APPLICATION	BY	DATE
DRAWN	P.LYNCH	7/14/92
CHECKED	[illegible]	9-10-92
APPROVED	[illegible]	9-10-92

MATERIAL:

FINISH:

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
DIMENSIONS ARE AFTER FINISH.
REMOVE ALL BURRS & SHARP EDGES.
SURFACE QUALITY √

TOLERANCES		
2 PLACE DEC.	3 PLACE DEC.	ANGLES
± .02	± .005	± ½

PARTS LIST. SEE PL:

INTERNATIONAL EQUIPMENT COMP

TITLE:
ASSY PC BD
SPEED CONTROL

SIZE	CODE ID. NO.	DRAWING NO.
C		45004

SCALE: 2/1 SHE