Coaxial Dynamics
A CDI INDUSTRIES, INC. COMPANY
SPECIALISTS IN RF TEST EQUIPMENT & COMPONENTS

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Instruction Manual

Model 86527
Integrated Coaxial Load And Heat Exchanger

LIMITED WARRANTY

We take pride in manufacturing products of the highest quality and we warrant them to the original purchaser to be free from defects in material and workmanship for the period of one year from date of invoice.

Additionally, products of our manufacture repaired by us are warranted against defects in material and workmanship for a period of 90 days from date of invoice, with the provisions described herein.

Should a product, or a portion of a product of our manufacture prove faulty, in material or workmanship, during the life of this warranty, we hereby obligate ourselves, at our own discretion, to repair or replace such portions of the product as required to remedy such defect. If, in our judgment, such repair or replacement fails to be a satisfactory solution, our limit of obligation shall be no more than full refund of the purchase price.

This warranty is limited to products of our own manufacture. Equipment and components originating from other manufacturers are warranted only to the limits of that manufacturer's warranty to us. Furthermore, we shall not be liable for any injury, loss or damage, direct or consequential, arising out of the use, or misuse (by operation above rated capacities, repairs not made by us, or any misapplication) of the equipment.

Before using, the user shall determine the suitability of the product for the intended use; and the user assumes all risk and liability whatsoever in connection therewith.

The foregoing is the only warranty of Coaxial Dynamics and is in lieu of all other warranties expressed or implied.

Warranty returns shall first be authorized by the Customer Service Department and shall be shipped prepaid.

INTRODUCTION

This manual gives you specific information on the installation, operation and service Model 86527 Series Integrated Coaxial Load and Heat Exchanger. Most of the loads are field serviceable, but we recommend their return to us for repair. Mistakes can be costly compared to the low cost for our trained personnel to make the repairs and return the load to new performance specifications. Labor and packaging costs are minimal. We take the load completely apart, clean and inspect all parts, repair/replace as necessary, reassemble, water pressure test, power test, VSWR test and package the load for shipment. If new parts are required in the load (such as resistors etc.), this will be an additional cost. The average turn-around time on repairs is approximately 10 working days and generally will depend on your needs. When sending in repairs, please include: your company name and address, the operating frequency you use, fax number, telephone number and your name in case we need to talk to you about the load or obtain shipping instructions. We can accommodate most shipping methods.

SHIP TO:

Coaxial Dynamics
6800 Lake Abram Drive
Middleburg Heights, Ohio, USA 44130

For information call:

1-800-COAXIAL (1-800-262-9425)

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PRECAUTIONS

CAUTION

Do not block air grills; blocking air flow can cause unit to fail!

!!!WARNING!!!

Do not apply any RF power to the unit before transmitter interlock is connected and operational. Failure to do so may result in damage to equipment and/or injury to personnel.

CAUTION

Do not operate Heat Exchanger Load without connecting interlock!!! Application of RF even momentarily if unit is off or coolant flow is restricted will destroy the resistor element!!!

≈≈WARNING≈≈

Do not attempt any service or parts replacement without first disconnecting all AC power and RF power. Failure to do so may result in serious or *fatal electrical shock*.

CAUTION

Do not apply more than rated power to unit. Damage will occur before thermal protectors can activate interlock circuit if more than rated power is applied.

CAUTION

Do not use any stop leak, sealants, automotive antifreeze or Union Carbide Ucartherm™ in coolant.
Use only pure ethylene glycol and potable water!!!!

CAUTION

Do not operate pump with coolant low or empty.
To do so will result in damage to working parts and seals.

PRECAUTIONS

CAUTION

Operation above rated ambient temperature may result in motor thermal protection shutting off fan which may cause damage to unit. Provisions are made to trip interlock in the event of overheat; however care should be taken to operate the unit below stated maximum operating ambient temperature.

NOTICE

Failure of unit due to accumulation of solids in water will void the warranty.

CAUTION

HEAT EXCHANGER IS DIFFICULT TO DRAIN COMPLETELY! IF UNIT IS DRAINED TO PROTECT FROM FREEZE DAMAGE, IT IS NECESSARY TO USE A WET/DRY VACUUM TO PULL WATER FROM DRAINS OR TO USE COMPRESSED AIR TO BLOW OUT RESIDUAL WATER. FREEZE DAMAGE TO COILS OR OTHER COMPONENTS MAY RESULT FROM FAILURE TO DRAIN COMPLETELY.

☠WARNING☠

ETHYLENE GLYCOL IS A TOXIC SUBSTANCE THAT MAY CAUSE PERMANENT DAMAGE TO THE SKIN, KIDNEYS, LIVER AND OTHER ORGANS. AVOID CONTACT WITH SKIN. AVOID BREATHING VAPORS. SEE THE MATERIAL SAFETY DATA SHEET FOR THE SPECIFIC PRECAUTIONS AND FIRST AID MEASURES PRESCRIBED BY THE MANUFACTURER.

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. Purpose and Application of Equipment. The Model 86527 Coaxial Load is designed to safely dissipate a maximum of 25,000 watts of electrical energy over a frequency range of 60 Hz to 800 MHz.

1-2. Equipment Supplied. The Model 86527 Coaxial Load is supplied with standard RF connectors. Their designations are:

3 1/8 EIA Swivel flange:	Model 86552-1
3 1/8 Unflanged recessed:	Model 86552-2
3 1/8 Unflanged flush:	Model 86552-3

The standard 50/60 Hz power supply voltage and its designation is:

-115: 110-120VAC single phase
-230: 220-240VAC single phase

The standard power supply cord is a UL/CSA approved receptacle end to connect to the mating receptacle on the unit.

-115 units have a NEMA 6-20P male plug.
-230 units have a 2 inch stripped and tinned end.

1-3. Equipment Required But Not Supplied. The Model 86527 Coaxial Load is complete as supplied, but the user must furnish RF input, interlock control cable, ground cable and proper coolant. Where the purchaser specifies that the coaxial load be remotely mounted, it will be necessary for the user to supply suitable piping or hoses to connect the load to the heat exchanger.

1-4. General Description. The Model 86527 Coaxial Load is enclosed in a single aluminum case. Power connection is made through a multi-contact fixed, recessed receptacle on the lower rear panel. This panel also contains a 4-screw barrier terminal strip for connection of the interlock circuit and a 1/4-20 UNC-2B stud for attachment of the ground. The RF connector is located in the center of the top panel. The main chassis frame contains a Model 86027 load, pump, flow switch, delay relay, reservoir, heat exchanger and associated controls.

1-5. Electrical Description. The Model 86027 load contains a 50 ohm non-reactive resistor assembly capable of dissipating 25,000 watts of applied electrical energy at frequencies between 60 Hz and 800 MHz with a maximum VSWR of 1.1 to 1 to 800 MHz. No provisions are made for tuning the resistor assembly. Power to the blower and pump is controlled by a single "On/Off" switch (located on the front panel along with power on indicator, low coolant indicator, and overheat indicator lamps). The transmitter interlock circuit consists of flow switch, delay relay and thermal switch wired in series to control the interlock relay. Power is supplied to this relay whenever the equipment is attached to the correct power supply, neither the overtemperature thermal switch (82°C) or flow switch senses a fault and the time delay relay is activated (approx. 6 seconds after the flow switch closes). A lamp is provided to indicate when one or more of these switches is open. It is labeled ***OVERHEAT*** and indicates a change in state of the interlock circuit.

SECTION I

DESCRIPTION AND LEADING PARTICULARS (cont'd)

1-6. **Mechanical Description.** The Model 86527 RF Coaxial Load is a Model 86027 50 ohm resistor assembly cooled by a vented, closed-loop water system, utilizing a centrifugal pump, water-to-air heat exchanger (capacity of coolant is approximately 15 liters), and a centrifugal blower. The blower assembly is a 3/4 HP direct-drive centrifugal blower. The blower moves air from floor level into a closed plenum surrounding the resistor assembly, then exits through the heat exchanger to the rear of unit. This places the RF input connector at the coolest point and affords exceptionally quiet operation.

1-7. **General Principle of Operation.** After ascertaining that the Model 86527 is connected to the correct power supply and filled with coolant, connect the transmitter interlock circuit and RF source. Turn the main power switch ON to start operation and enable transmitter. Operate transmitter as desired.

To stop operation, it is necessary to first turn off the transmitter, then wait five minutes before turning off the power switch on the heat exchanger. It is important that the unit cools down and temperatures stabilize before fan and pump operation stops.

1-8. **Interlock Controls and Operation.** A 4-screw barrier terminal strip is provided at the lower rear panel for transmitter interlock. This terminal provides a normally closed and a normally open pair. The N/C pair is usually used for the transmitter interlock.It is highly recommended that the N/O pair be used for an alarm to indicate a malfunction. If there is an AC power failure, the interlock will not indicate a malfunction unless the alarm is independently powered.

1-9. **Operating and Adjustment Controls.** The only operating control is the main power switch. No field adjustments are necessary or possible.

SECTION II

TEST EQUIPMENT AND SPECIAL TOOLS

2-1. **Test Equipment Required.** No test equipment is required for routine maintenance, however it may be necessary to verify DC resistance of the coaxial resistor and/or verify coolant temperature, in which case you will need an accurate digital ohm-meter and precision thermometer.

2-2. **Special Tools Required.** Although no non-standard tools are required for routine maintenance, we recommend the technician have the following specialized tools available:

1 Tee handle hex key, 5/32 inch
1 Tee handle hex key, 3/32 inch
1 Tee handle hex key, 3/16 inch
1 Power screwdriver with torx T-15 bit
1 Torx T-15 screwdriver

CAUTION!

THE UNIT SHOULD BE ATTACHED TO THE PROPER AC POWER SUPPLY WITH THE INTERLOCK CONNECTED WHENEVER THE RF CONNECTOR IS ATTACHED TO THE SOURCE. INADVERTENT APPLICATION OF RF POWER TO THE UNIT WITHOUT AC POWER WILL DAMAGE OR DESTROY THE RESISTOR.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

3-1. **Unpacking.** The unit should be handled and unpacked with care. Inspect outer carton for evidence of damage during shipment. *Claims for damage in shipment must be filed promptly with the transportation company involved*. No internal packaging or bracing is used for domestic shipments and the unit should not rattle when being unpacked.

3-2. **Visual Inspection.** Conduct a thorough inspection of the unit, paying particular attention to the following items:

- Screws in place and tight.
- All panels and grills free of dents and scratches.
- Interlock terminal strip visually OK.
- RF connector visually OK. While inspecting RF connector, measure D.C. resistance of the unit by reading from the center conductor to the outer conductor. It should be 50 ohms (nominal).

3-3. **Pre-installation Tests.** Prior to installation, fill unit with specified coolant (see para. 3-4), then connect unit to a suitable source of AC power. Turn main switch on and check for quiet blower operation. Connect an ohmmeter or a battery operated test lamp across the normally closed terminal pair on the interlock terminal board (rear panel). Turn the main power switch off observing the indicator (ohmmeter or test lamp). It should change state (terminals open).

3-4. **Coolant.** The coolant should be potable water if the ambient temperature will not drop below +5°C (40°F). The U.S. Department of Public Health has set the standard for potable water at a maximum of 500ppm of total dissolved solids. The water hardness (content of calcium, lime and magnesium salts) should be less than 75ppm. These conditions can be achieved by mixing with distilled water. However, neither distilled nor deionized water should be used exclusively unless the pH is corrected to a value between 7.0 and 8.2. Acidic coolant solutions will cause early failure of the resistor, so the pH should be checked to insure values between 6.8 and 7.8.

SUGGESTION: If your municipal water has unpleasant tastes or odors, high salt or mineral levels (hardness, iron, sulfides, etc.), we suggest that you purchase bottled water (often sold as "spring water") for use in the load. It is very inexpensive insurance. If ambient temperatures are expected to fall below +5°C (40°F), a mixture of 35% technical grade ethylene glycol and potable water may be used (with a 20% de-rating of unit to 20KW at some temperatures). See Specifications.

To fill unit, first connect unit to AC power, then fill reservoir with coolant. Turn unit on to pull coolant into circuit and add coolant again until LOW COOLANT light goes out. Continue adding coolant to bring level to 2 inches below filler neck top. Capacity of unit is approximately 4 U.S. Gallons (15 liters).

SECTION III

PREPARATION FOR USE AND RESHIPMENT (cont'd)

!!!CHECK FOR LEAKS FROM DRAIN PLUGS AND RESERVOIR DRAIN AT THIS TIME!!!

CAUTION
Do not use any stop leak, sealants, automotive antifreeze or Union Carbide Ucartherm™ in coolant.
Use only pure ethylene glycol and potable water!!!!

3-5. Installation. Consideration must be given to accessibility for maintenance and unit replacement. No attempt is made in this handbook to present complete installation instructions, since physical differences in plant will determine the installation procedure. General guidelines are outlined in subsequent paragraphs.

3-6. Location. The location selected for the Model 86527 should be dry, free of excessive dust and have an ambient temperature between +5°C and 30°C (41°F and 86°F) with water only, and -20°C and +25°C (-4°F and 77°F) with ethylene glycol mixture. The room should be well ventilated to prevent excessive heat build-up.

The RF dissipation of the unit is 25,000 watts. This equals 83,325 Btu/hr which ordinarily must be ducted out of the building envelope, using as short and direct duct run as is possible to minimize static pressure and to prevent loss of cooling efficiency. The assistance of a competent heating and air conditioning installer will help avoid over-or-under specifying the duct system.

3-7. Mounting. It is not necessary to mount the Model 86527, which is designed to be a free-standing device. It rests on four heavy duty casters. Brakes are installed on the swivel casters to stabilize the unit during operation.

3-8. Connections. There are three connectors on the Model 86527: the RF connector, the AC power connector and the transmitter interlock (4 terminal, captive-screw terminal strip).

a. The RF connector is on the coaxial load, which is normally attached to the right side panel of the unit. Connect to the appropriate RF line from the transmitter.
b. The AC power supply connector is located on the rear panel. Connect with supplied cord.
c. The transmitter interlock is attached to the normally closed terminals of the terminal board on the rear of the unit. The terminals are closed whenever power is on to the unit and operating properly. The normally open pair is isolated from the normally closed pair and is provided for an alarm circuit.

SECTION III

PREPARATION FOR USE AND RESHIPMENT (cont'd)

CAUTION!

The unit should be attached to the proper AC power supply with interlock connected whenever the RF connector is attached to the source. Inadvertent application of RF power to the unit without AC power will damage or destroy the resistor assembly!!!

3-9. Ducting. In many installations it will be necessary to duct the discharge air from the Model 86527 to the exterior of the building. In some installations it will also be necessary to supply inlet air from outside of the climate controlled portion of the building. Due to the high temperatures involved, non-metallic duct materials should not be used. Make-up air is a ventilation term used to indicate the supply of outdoor replacement air to a building in a controlled manner. Replacement air will enter the building to equal the volume actually exhausted, whether or not provision is made for this replacement. It is important to plan for make-up air of the proper temperature and volume.

3-10. Adjustments. No field adjustments are necessary or possible.

3-11. Preparation for Reshipment. If unit is to be shipped by air freight or through an area where it is possible it will be exposed to freezing temperatures, it is imperative to prepare it properly for shipment. NOTE: Drains are incorporated into plumbing to allow easy drainage of unit. There are three small drains with brass caps under the unit on the front near the center. There is a drain valve located near these drains. It drains the reservoir and part of the system. The drain valve is fitted for a 3/4 inch garden hose. Drain the coolant from the unit (the use of a wet vacuum cleaner is very helpful to prevent spillage) prior to shipment. After coolant is completely drained, add three gallons of inhibited technical grade ethylene glycol or DOWTHERM SR-1® coolant to the reservoir. Start the pump and circulate this fluid thoroughly throughout the system. Now drain the unit of all free-flowing liquid and close all drain valves. Fluid which is trapped in the system will not freeze and damage the unit. Care must be taken to protect the RF connector and to immobilize the swivel flange, if it is fitted with one. It is suggested that you retain the original shipping crate to provide the optimum protection during reshipment.

SECTION IV

OPERATION

4-1. Overview. The Model 86527 incorporates a Model 86027Coaxial Resistor which dissipates RF energy by converting it to heat that is dissipated into the air via a vented, closed-loop water-to-air heat exchanger. This self-contained water system allows for the use of a water-cooled load, providing the best possible RF Load in areas that do not have suitable water supplies. Where water temperatures less than +5°C could be encountered, a solution of ≤35% technical grade ethylene glycol may be used as coolant *(automotive antifreeze or Union Carbide Ucartherm™ must not be used)*. Use of ethylene glycol mixture derates unit 20% to 20kW.

4-2. Control Circuits. There are 2 control circuits in the Model 86527. One circuit controls the blower and pump, the other controls the transmitter interlock circuit. The interlock circuit is controlled by a flow switch (detects adequate water flow) connected in series with a time delay relay that allows a short period of time after the water is flowing before energizing the interlock. This series circuit also contains the overtemperature thermal switch, which is mounted on the reservoir. The blower and pump are controlled by the main power switch, which activates their respective relays. The Low Coolant Lamp is controlled by a float in the reservoir and is for indication only. It is not connected to the interlock.

4-3. To Begin Operation. After following installation instructions, turn main power switch to *ON*. Unit is now ready for operation. The transmitter interlock will close approximately 6 seconds after the unit is turned on.

4-4. To Shutdown. *WARNING! Transmitter must be turned off prior to shutting down LOAD to prevent damage to load resistor.* After RF power has been turned off, WAIT 5 MINUTES before turning off load to allow heat in the unit to be stabilized and dissipated. Transmitter interlock will open when unit is turned OFF.

4-5. Performance. The Model 86527 will handle 25KW continuously at a maximum ambient temperature of 30°C using pure potable water. See SPECIFICATIONS for other conditions. Thermal performance is affected by impurities and chemicals in the coolant. Therefore, only potable water or an approved strength mixture of technically pure ethylene glycol and potable water should be used as a coolant. Accumulations of scale and other contaminants will greatly reduce the thermal efficiency and cause the unit to overheat and fail.

SECTION V

MAINTENANCE

WARNING!!

BEFORE PERFORMING ANY MAINTENANCE:

1. **DISCONNECT POWER AND ALLOW MOTOR TO COME TO A FULL STOP.**
2. **DISCONNECT RF CONNECTOR ASSEMBLY AND LOCK OUT TRANSMITTER OPERATING CONTROLS.**
3. **DISCONNECT TRANSMITTER LINE.**

FAILURE TO FOLLOW THESE DIRECTIONS MAY CAUSE FATAL ELECTRICAL SHOCK!

5-1. Cleaning. The enclosure of the Model 86527is finished with a durable acrylic finish. It should be cleaned with a neutral plastic and glass cleaner such as Miller-Stephenson MS-260. The RF connector should be cleaned with a non-residue contact cleaner such as Miller-Stephenson MS-171/CO_2. Remove dirt accumulations from the fan and motor by vacuuming. Do not use solvents or an air jet, as these can damage the motor. Remove dirt and dust accumulations from the grills, pump area and coil with an air jet and a soft brush. This should be done annually or more often if in a dirty environment.

5-2. Lubrication. The only lubrication required is for the sleeve bearings in the motors. Units in continuous service should be re-oiled annually, intermittent duty units every two years and occasional duty units every three years. Re-oil by removing the plastic plugs in the lubrication ports and applying 30 to 35 drops of SAE 20 motor oil. DO NOT OVER OIL.

5-3. Periodic Maintenance. The RF Load Resistor does not require any periodic maintenance, however a DC resistance check prior to each use is recommended. Repair to resistor unit is covered in Section VII.

5-4. Routine Service Checks. Check coolant level weekly if used intermittently, more frequently if used continuously. If ethylene glycol mixture is used as coolant, the mixture must be periodically verified using a precision hydrometer (range 1.000 to 1.070) or other suitable instrument to prevent the ethylene glycol from becoming too concentrated. A mixture more concentrated than 35% will lower the efficiency of the unit possibly causing a failure. An acidic condition will cause rapid failure of the resistor. Maintain pH at 7.0-8.2.

WARNING!: USE OF ANYTHING OTHER THAN PURE POTABLE WATER OR A MIXTURE OF TECHNICAL ETHYLENE GLYCOL AND POTABLE WATER, OR USE OF A MIXTURE MORE CONCENTRATED THAN 35% ETHYLENE GLYCOL WILL VOID THE WARRANTY!!!

NOTE: BUILD-UP OF LINT AND DUST ON COILS GREATLY DECREASES THE EFFICIENCY OF THE UNIT. KEEP THEM CLEAN!

Check for lint and dust build-up on the inside of the cooling coil annually by removing the right hand panel. This is accomplished by removing the 20 #8-32 screws around the edge of the panel. This should be done annually or more often if in a dirty environment.

SECTION VI

CALORIMETRY

6-1. General. Physicists have long known that it takes a definite amount of energy in the form of heat to raise the temperature of a certain mass of liquid and conversely, if you know the temperature rise and the mass of the liquid, you can determine the amount of heat and therefore, the amount of energy applied to the liquid. There are many variables in this equation. Among them are: specific heat of the fluid, specific gravity of the fluid, density of the fluid, thermometer accuracy and flow meter accuracy. These factors must be determined or minimized to yield accurate power measurements. The Power Test Load System is designed to provide the user with data which can be reduced to an accurate transmitted power measurement.

6-2. Calorimetry Theory. Since we know from physics that we can determine energy put into a system by measuring temperature and flow rate, we have only to adjust our readings to account for variance from classic values in order to accurately determine transmitter power. The theory of RF calorimetry requires a liquid-cooled coaxial load of low VSWR, accurate thermometry and accurate flow measurement. Data from the thermometers is used to obtain the specific heat, specific gravity and density of the fluid. This information is used to obtain coolant and flow meter factors for use in calculating power values.

Some of the terms we use:

- **Specific heat (C_p)**: The number of calories required to raise 1gram of a substance 1 °K.
- **Specific gravity (G)**: A ratio of the mass per unit volume at a known temperature to the mass per unit volume of pure water at the same temperature.
- **Density**: The mass per unit volume of a substance at a certain temperature.

6-3. Practical Calorimetry. Practical calorimetry with the Power Test Load System can be reduced to a systematic process requiring no technical skills beyond the ability to read instruments, use graphs and tables and calculate final values (a handheld calculator helps with the multiplication).

First, a warning! If you don't know what the fluid is, you'll never get a correct answer!

If your system uses "pure" water, i.e. tap water, distilled water, deionized water, etc., you know what the fluid is accurately enough for calorimetry. If your coolant is a mixture of water and ethylene glycol, you cannot be certain what your fluid is until you obtain the specific gravity of your fluid (corrected for temperature) with a laboratory grade hydrometer. Water evaporates from your coolant system, but ethylene glycol doesn't. Therefore, glycol concentrations vary almost daily in an operating system. In systems where fluid loss is made up with water/glycol mixtures, the concentration of glycol gradually increases. Be sure that you know what the specific gravity of your coolant is before you start! Use this value and the Ethylene Glycol Solution Densities chart to determine the percentage of ethylene glycol in your system. The percentage value is used in the calorimetry process.

To accurately determine the transmitted power going to the load:

1. Add clean water to each thermowell until water flows out of the small hole near the base of the column.

SECTION VI

CALORIMETRY (CONT'D)

2. Turn on coolant flow and ensure that it is above the minimum value for your system.
3. After 2 to 3 minutes of transmitter operation, you may begin reading instruments.
4. Read flow meter and record observed ("gauge") value.
5. Read inlet fluid temperature and record this value.
6. Read outlet fluid temperature and record this value. Take this reading immediately after reading inlet water temperature.
7. Find the average value of the temperature readings recorded. (Temp $_{in}$ + Temp $_{out}$ / 2)
8. Use the average temperature from step 7 to determine K_t from the K_t Graph.
9. Use the outlet fluid temperature determined in step 6 to determine flow meter correction factor from the Coolant Density/Flow Meter Correction nomograph.
10. The equation used to solve the power problem:

$$P = K_t \times (T_{outlet} - T_{inlet}) \times Q \times F$$

Where: P = Power in kilowatts

K_t = Coolant correction factor

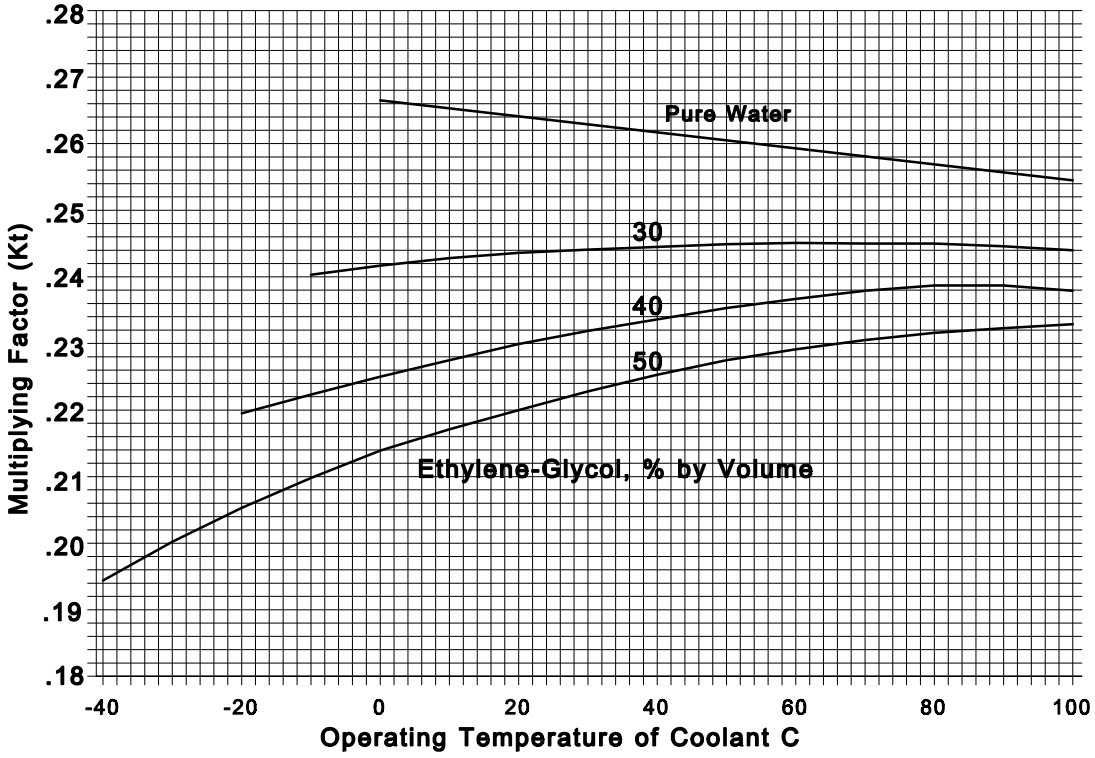
T_{outlet} is expressed in °C.

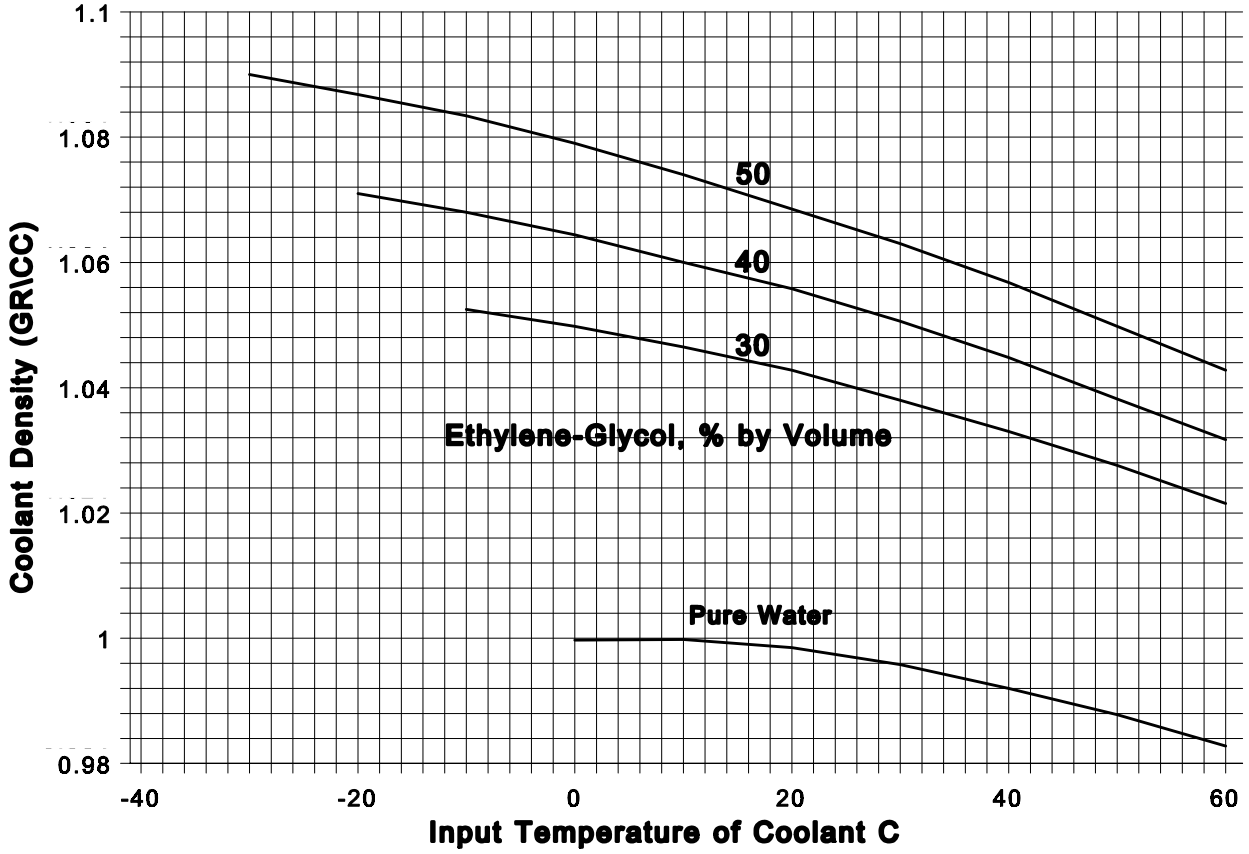
T_{inlet} is expressed in °C.

Q = Coolant flow in gallons per minute

F = Flow Meter Correction Factor

With the data obtained from earlier steps, you should be able to determine the transmitted power within ± 3%.

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1.02
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Coolant Density (GR\CC)
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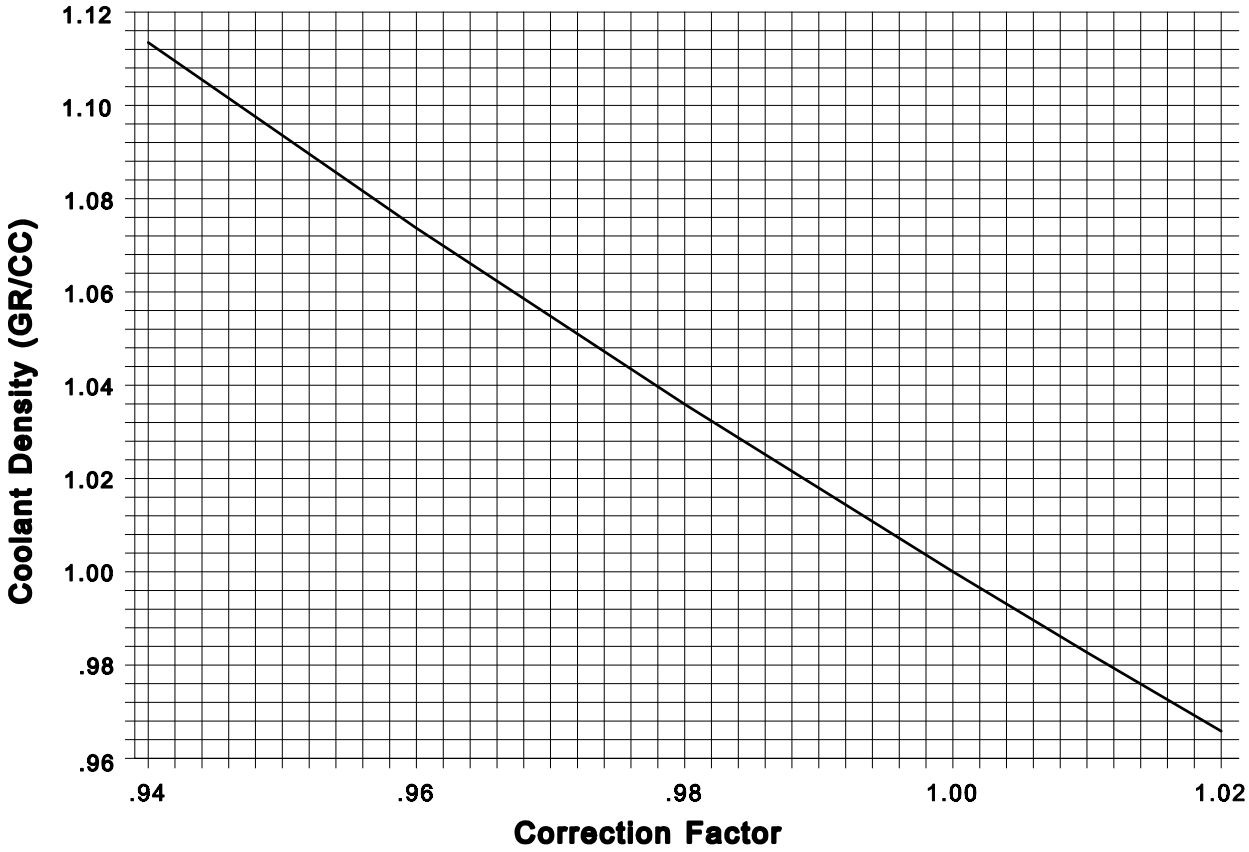
-20
0
20
40
60
Input Temperature of Coolant C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1.10
1.08
1.06
1.04
1.02
1.00
.98
.96
Coolant Density (GR/CC)
.94
.96
.98
1.00
1.02
Correction Factor

SECTION VII

REPAIR PROCEDURES

7-1. Overview. The Model 86527 Coaxial Load Resistor is basically a termination type unit, having its characteristic impedance at the input end and tapered to zero impedance (short circuit) at the other end. The center conductor is a tubular resistor whose DC resistance is equal to the characteristic impedance of the line. The outer conductor of the coaxial line is a symmetrical horn-shaped enclosure, contoured in a semi-logarithmic taper to obtain practically a reflection-free termination. The RF dielectric medium consists of three distinct materials: the coolant, the teflon or noryl water jacket, and the air space. The housing is constructed of aluminum and bronze or brass. Coolant enters the load at the electrically shorted end, flows axially down the center of the resistor tube, mushrooms over into the annular channel under the water jacket, and makes a second pass over the resistor in direct contact with the resistive film. Thus the coolant makes intimate contact with both the inside and the outside of the resistor, providing optimum heat transfer with minimum coolant flow.

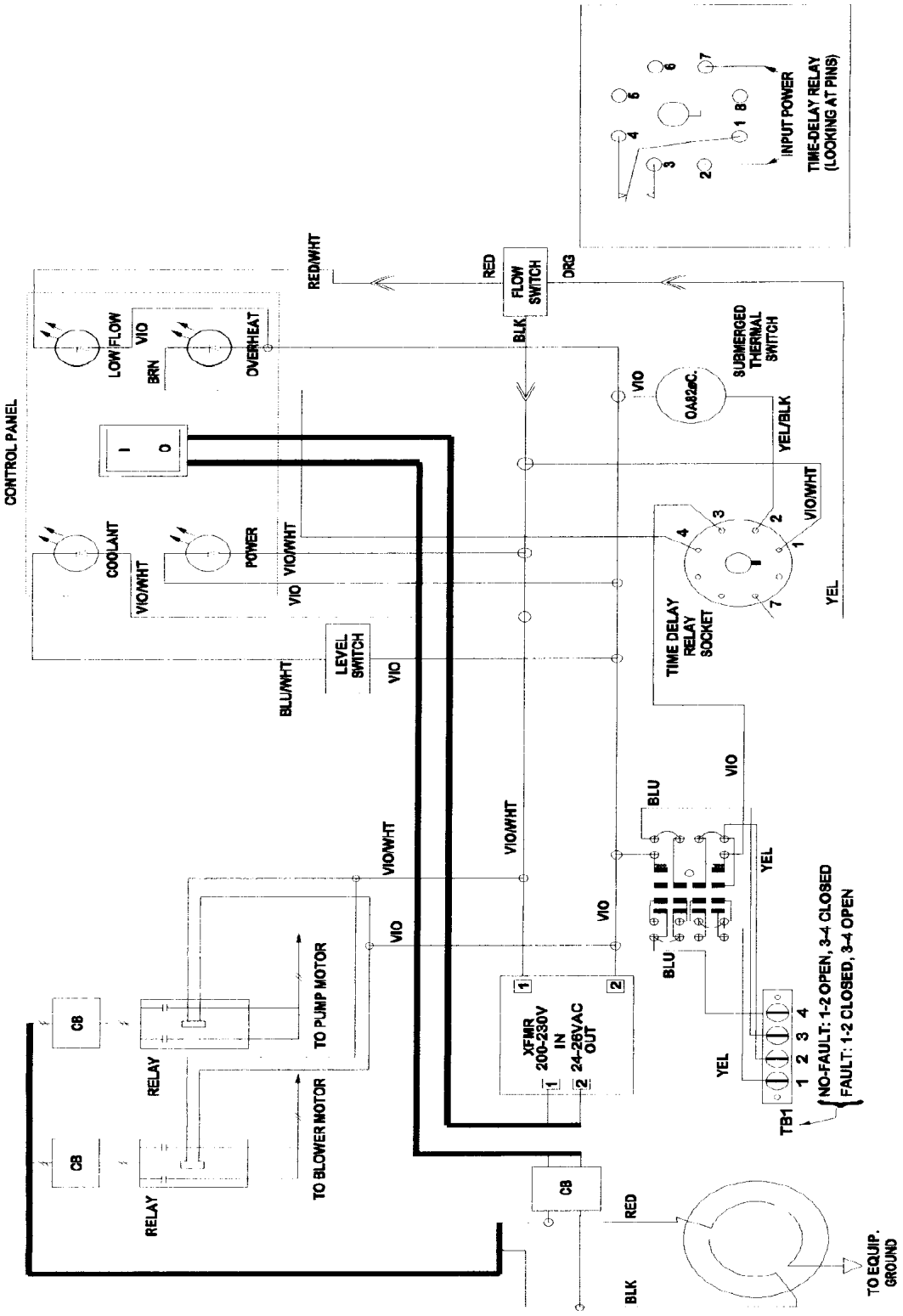
7-2. Resistor Replacement. First, remove upper right hand side panel by removing 20 #8-32 screws using a T-15 torx driver. Then, remove three drain caps on the side panel to drain coolant. A wet/dry vacuum cleaner is very helpful to remove coolant and avoid spillage. Next, remove 4 #1/4-20 screws at the bottom of the Load Resistor using 3/16 hex driver. Pull down to remove cap and resistor. If resistor is fractured, further disassembly may be required to recover all fragments. Replacement resistor is installed by reversing the disassembly procedure. Before replacing the side panel, fill unit with coolant and run pump to check for leaks.

7-3. Water Jacket Replacement. Follow same steps as above to disassemble, then remove the six 1/4-20 screws holding the load main body. Using something like a broom handle, knock the anchor insulator assembly out (anchor assembly will need to be frozen to reinstall in housing). With a twisting motion pull water jacket from housing. Replace O-rings and reverse procedure to install the new water jacket.

SPECIAL NOTE: After maintenance has been performed on cooling circuit (including resistor replacement), or when there is reason to suspect that the coolant is contaminated, the cooling circuit should be thoroughly flushed with clean water. This should be done by filling the system with clean water and running a short time, then draining and cleaning filter screen. This should be done several times until water is completely clear and filter remains clear of particles. Then refill system with required amount of potable water or approved 35% ethylene glycol mixture.

7-4. Other Repairs. Normal electrical and mechanical skills are required for repair and replacement of pump and fan assembly.

SCHEMATIC DIAGRAM



REPLACEMENT PARTS LIST
Model 86527

Item	Qty.	Description	P/N
1	1	On-Off Switch	339-10000-041
2	2	Circuit Breaker 18A/2P	666-10000-010*
3	2	Circuit Breaker 10A/2P	313-10000-010**
4	3	Red Lamp	304-10000-117
5	1	Green Lamp	304-10000-116
6	1	Thermal Switch, 82 C.	566-10000-127
7	1	Molex 2 Wire Plug	304-10000-045
8	1	Molex 2 Wire Receptacle	304-10000-108
9	2	Molex 3 Wire Plug	304-10000-046
10	2	Molex 3 Wire Receptacle	304-10000-109
11	1	Molex 4 Wire Plug	304-10000-047
12	1	Molex 4 Wire Receptacle	304-10000-110
13	1	Molex 9 Wire Plug	304-10000-106
14	1	Molex 9 Wire Receptacle	304-10000-107
15	24	Molex .093 Pin Male	304-10000-048
16	24	Molex .093 Pin Female	304-10000-049
17	1	Relay 24V, Blower	161-3A354-000
18	1	Relay 24V, Pump	354-10000-106
19	1	Relay 24V, Interlock	339-10000-001
20	1	Relay 24V, Time Delay	304-10000-029
21	1	Interlock Terminal Strip	304-10000-050
22	1	Circuit Breaker 3A/2P	304-10000-022
23	1	115V Blower, 60 Hz	161-5C094B-000
24	1	230V Blower, 50 Hz	161-4C770-000
25	1	230V Blower Assy., 60 Hz	161-4C592-000
26	1	230V Blower Motor, 60Hz	161-3M222-000
27	1	230V Blower Motor, 50Hz	161-3K879-000
28	1	Pump Motor, 115V or 230V, 60Hz	161-2K418-000
29	1	Pump Motor, 230V, 50Hz	616-10000-001
30	1	Pump Only	616-10000-005
31	1	Level Switch	578-10000-126
32	1	Transformer, 26VAC	354-5041C-000
33	1	Capacitor 10mfd, 370V (50Hz)	161-6X656-000**
34	1	Capacitor 15mfd, 370V (60Hz)	161-6X658-000*
35	1	Capacitor 7.5mfd, 370V (60Hz)	161-6X655-000**
OPTIONS			
1	1	Exhaust Duct Adapter	000-05825-008
2	1	Intake Blanking Plate	000-05825-009
3	1	Thermometer -2°C to +68°C	TC-1
4	1	Thermometer 25°C to 105°C	TC-2

SPECIFICATIONS
Model 86527

Impedance ---------- > 50 ohms nominal
Frequency Range ---------- > 60 Hz to 800 MHz
VSWR = 60 Hz to 800 MHz ---------- > 1.1:1 max.

Connectors:

Model 86527-1* ---------- > 3 1/8 EIA swivel flange
Model 86527-2* ---------- > 3 1/8 unflanged recessed
Model 86527-3* ---------- > 3 1/8 unflanged flush

*** -115 after model number denotees 115 VAC 60 Hz**
*** -230 after the model number denotes 200-240 VAC 50 or 60 Hz**

Cooling Method ----------> Forced Air over Water-Heat Exchanger
Coolant Liquid Capacity ----------> Approximately 16 qts. (15.14 liters)
Coolant Type ----------> Potable water or 35% ethylene glycol mixture

Power Rating ---------- > 25 KW Cont.

Ambient Temperature vs. Power Ratings:

50KW continuous:
Potable water only---------- > +5°C to +30°C (41°F to +86°F)
35% Ethylene Glycol---------- > -20°C to +25°C (-4°F to +77°F)

40KW continuous:
Potable water only---------- > +5°C to +45°C (41°F to +110°F)
35% Ethylene Glycol---------- > -20°C to +35°C (-4°F to +95°F)

Fan Assembly---------- > 3/4 HP Centrifugal 1050 RPM
Pump ---------- > 3/4 HP Centrifugal 3450 RPM

AC Power Requirements:

115 VAC, 60 Hz, 1 Phase---------- > 24 Amp.
200-240 VAC, 50 or 60 Hz, 1 Phase---------- > 13Amp.

Finish---------- > Beige Splatter

Serial No._____Frequency_____Resistance_____

Model_____Inspected by_____Date_____

APPENDIX A

Shuttle-Type Flow Switches
Series FS-200/400
Instruction Bulletin No. 45523

Installation

Install FS-200 or FS-400 Series units in piping system using standard pipe fitting procedures. **Be careful to keep sealing compound out of the unit.** Be sure to observe direction of flow - marked **"IN"** and **"OUT"** on housing. **See chart below for port and wrench hex. sizes.**

Unless otherwise specified, standard FS-200 and FS-400 units are factory-calibrated with water. FS-200 and FS-200 Adjustable units are installed horizontally, in line, with lead wires up. FS-400 and FS-400 Adjustable units are installed vertically; lead wires up, as shown. **150 micron filtration is suggested for use with all units.**

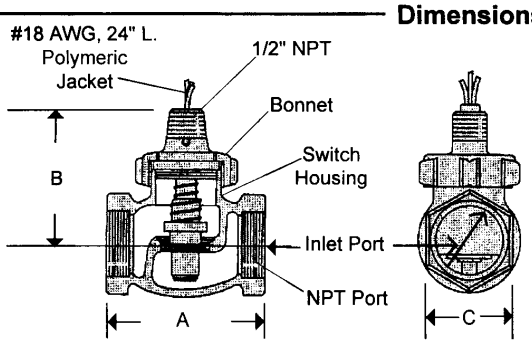
Specifications (FS-200 Series)

Wetted Materials	
Housing	
FS-200	Bronze or 316 Stainless Steel
FS-200 Adj.	Bronze
Shuttle	Teflon®
Bonnet	Bronze or Stainless Steel
Spring	316 Stainless Steel
Other Wetted Parts	Viton®, Ceramic
Pressure Rating	
Operating	400 PSIG @ 100°F (37.8°C)
Proof	800 PSIG @ 100°F (37.8°C)
Operating Temperature	
FS-200	-20°F to +300°F (-29°C to +148.9°C)
FS-200 Adj.	-20°F to +200°F (-29°C to +93.3°C)
Repeatability	1% Maximum Deviation
Set Point Accuracy	±10%
Set Point Differential	15% Maximum
Switch*	SPDT, 20 VA
Electrical Termination	No. 18 AWG, 24" L., Polymeric Lead Wires

Note: Bonnet and shuttle assembly should be removed from unit during welding or brazing. (See bonnet assembly removal under "Maintenance" on back of sheet.)

*See "Electrical Data" on inside pages

Dimensions (FS-200 Series)



Model	Port Size NPT	"A" Dim.	"B" Dim.	"C" Dim. (HEX)
FS-200 and FS-200 Adjustable	1"	3-1/4"	3"	1-25/32"
	1-1/4"	4"	3-3/16"	2-3/16"
	1-1/2"	4-1/2"	3-1/2"	2-1/2"
	2"	5-3/8"	4"	3-3/32"
	2-1/2"	6-5/16"	4-1/2"	3-5/8"
	3"	7-3/8"	5-5/32"	4-3/8"

Adjustable versions available in 1" port sizes only.

APPENDIX A

Specifications (FS-400 Series) . . .

Wetted Materials	
Housing	Bronze
Shuttle	Delrin®
Spring	316 Stainless Steel
O-Ring	Viton®
Other Wetted Parts	Ceramic
Pressure Rating, Max.	
Operating	400 PSI @ 100°F (+37.8°C)
Proof	800 PSI @ 100°F (+37.8°C)
Operating Temperature	-20°F to +180°F (-29°C to +82.2°C)
Repeatability	1% Maximum Deviation
Set Point Accuracy	±10%
Set Point Differential	15% Maximum
Switch*	SPDT, 20 VA
Inlet/Outlet Ports	3/4" NPT
Electrical Termination	No. 18 AWG, 24" L., Polymeric Lead Wires

*See "Electrical Data" below.

CE

This product is suitable for Class I and Class II applications only, per the requirements of standard EN60730 and any additional specific requirements for a particular application or medium being sensed. Class I compliance of metal bodied units requires a ground connection between the metal body and the earthing system of the installation. Class I compliance of plastic bodied units in contact with a conductive medium requires that the medium be effectively earthed so as to provide an earthed barrier between the unit and accessible areas. For Class III compliance, a supply at safety extra-low voltage (SELV) must be provided. Please consult the Factory for compliance information on specific part numbers.

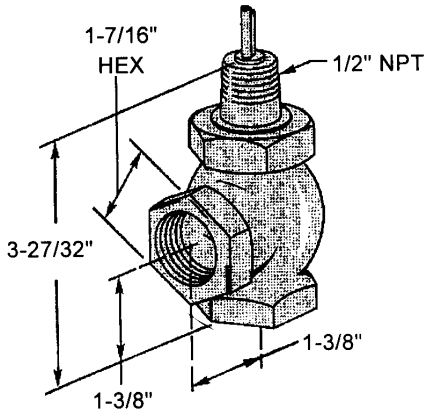
Electrical Data

Switch Ratings - Maximum Resistive Load

VA	Volts	Amps AC	Amps DC
10 General Use	0-50	.2	.13
	120	.08	N.A.
	100	N.A.	.3
20 Pilot Duty	0-30	.4	.3
	120	.17	.13
	240	.08	.06
50 General Use	0-50	0.5	0.5
	120	.4	.4
	240	.2	.2

APPENDIX A

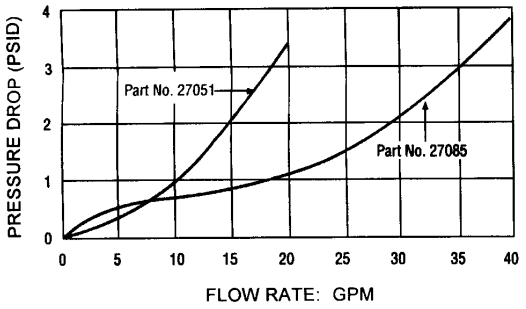
Dimensions (FS-400 Series)



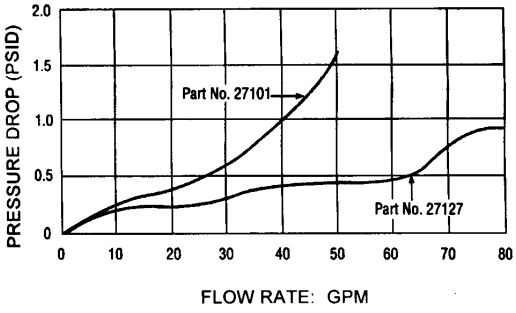
Pressure Drop Charts - Typical

FS-200 Series

1" NPT and 1-1/2" NPT Ports

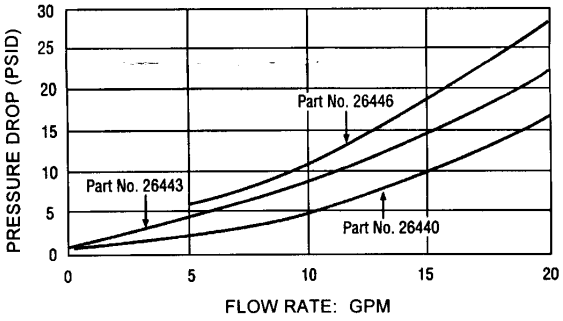


2" NPT and 3" NPT Ports



Note: Tests conducted with units in horizontal position (lead wires up) with water at +70°F (21°C).

FS-400 Series

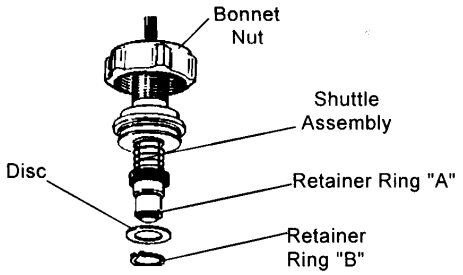


Note: Tests conducted with units in vertical position (lead wires up) with water at +70°F (21°C).

APPENDIX A

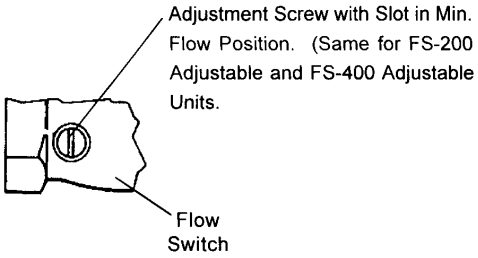
Electrical Connection . . .
Lead wires and 1/2" NPT or junction box with 1/2" NPT.

Maintenance . . .
Occasional cleaning when excessive contamination is present in the liquid is the only maintenance normally required. With system shut-down and no liquid in piping, remove bonnet nut to disassemble unit for cleaning. **It is not necessary to remove unit body from the system.** Remove retainer ring "A" for complete shuttle disassembly. Remove ring "B" to disassemble disc only.



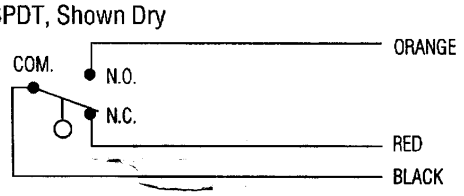
Flow Setting Adjustment . . .
(FS-200/400Adjustable and FS-400 Units.)

Standard units are normally supplied with adjustment set at "minimum flow" - adjustment screw slot (and vane within unit) in vertical position, as shown below. Adjustment may be made with unit on test stand or installed in system. With liquid flowing at desired rate, adjust screw in side of housing until unit just actuates. (Switch closes or opens, as desired.)



Typical Wiring Diagram . . .

FS-200/400 Series
(Fixed & Adjustable)



Important Points!

Product must be maintained and installed in strict accordance with the National Electrical Code and GEMS technical brochure and instruction bulletin. Failure to observe this warning could result in serious injuries or damages.

An appropriate explosion-proof enclosure or intrinsically safe interface device must be used for hazardous area applications involving such things as *(but not limited to)* ignitable mixtures, combustible dust and flammable materials.

Pressure and temperature limitations shown on individual catalog pages and drawings for the specified flow switches must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.

Selection of materials for compatibility with the media is critical to the life and operation of GEMS flow switches. Take care in the proper selection of materials of construction; particularly wetted materials.

Life expectancy of switch contacts varies with applications. Contact GEMS if life cycle testing is required.

Ambient temperature changes do affect switch set points, since the specific gravity of a liquid can vary with temperature.

Flow switches have been designed to resist shock and vibration; however, shock and vibration should be minimized.

Liquid media containing particulate and/or debris should be filtered to ensure proper operation of GEMS products.

Electrical entries and mounting points may require liquid/vapor sealing if located in an enclosed tank.

Flow switches must not be field repaired.

Physical damage sustained by the product may render it unserviceable.

Gems Sensors
One Cowles Road
Plainville, CT
06062.1198

tel 860.747.3000
fax 860.747.4244

P/N 45523
Rev. K

APPENDIX A

Operating Instructions & Parts Manual — **5C090C thru 5C094C, 5C197C and 5C198C**

Please read and save these instructions. Read carefully before attempting to assemble, install, operate or maintain the product described. Protect yourself and others by observing all safety information. Failure to comply with instructions could result in personal injury and/or property damage! Retain instructions for future reference.

Dayton® Direct-Drive Blowers

Description

Dayton direct-drive blowers are designed for heating, air-conditioning and ventilating systems where the blower is mounted within a cabinet or plenum chamber. They are field-interchangeable with most direct-drive blowers having the same horsepower rating. Reinforced motor mounting bracket has oversized rubber isolator to minimize vibration. Blowers are designed to be mounted in any one of four standard discharge positions. All motors are permanent split capacitor type (with appropriate capacitor attached) with automatic reset thermal protection. Steel housing and wheel have gray enamel finish.

Unpacking

1. Inspect for any damage that may have occurred during transit.
2. Shipping damage claim must be filed with carrier.

⚠WARNING ***Shipment retaining brackets on the side opposite the motor must be removed before operation. Failure to remove will cause premature failure.***

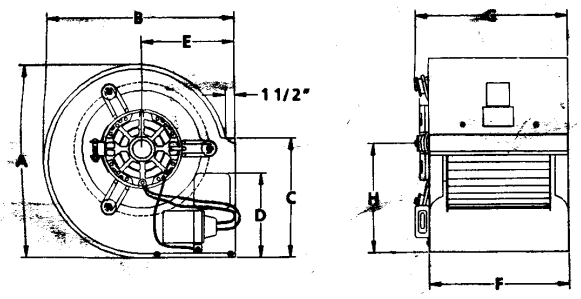


Figure 1 - Dimensions

Dimensions

Model	Wheel Dia. x W	A	B	C	D	E	F	G	H
5C090C	9 1/2 x 7"	12 13/16"	12 1/2"	7 3/4"	6 1/4"	7 13/16"	9 13/16"	10 3/8"	8 5/8"
5C091C	9 1/2 x 9 1/2	15 1/2	15	10 1/4	6 3/8	7 13/16	11 3/4	13 7/16	8 5/8
5C092C	9 1/2 x 9 1/2	15 1/2	15	10 1/4	6 3/8	7 13/16	11 3/4	14	5 5/8
5C093C	10 5/8 x 8	17 3/8	16 9/16	11 3/8	7	7 15/16	10 1/2	12 5/8	9 11/16
5C094C	10 5/8 x 10 5/8	17 3/8	16 9/16	11 3/8	7	7 15/16	13 1/8	15 3/4	9 11/16
5C197C	12 5/8 x 9 1/2	20 3/8	19 3/8	13 7/16	8 3/8	9 1/16	12 1/4	13 7/8	11 1/2
5C198C	12 5/8 x 9 1/2	20 3/8	19 3/8	13 7/16	8 3/8	9 1/16	12 1/4	13 7/8	11 1/2

General Safety Information

⚠WARNING ***Disconnect power source before installing or servicing. Failure to disconnect power source can result in fire, shock or serious injury.***

1. Blower should be installed and serviced by a qualified technician only.
2. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA) in the United States.
3. Motor must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system by using a separate ground wire connected to the bare metal of the motor frame , or other suitable means.
4. Always disconnect power source before working on or near a motor or its connected load. Lock it in the open position and tag to prevent unexpected application of power.
5. In accordance with OSHA requirements, guarding is required if blower is mounted less than 7 feet above floor or where workers have access.

Form 5S2447

05580
0597/136/VCPVP

11524001

Dayton®

APPENDIX A

Dayton® Direct-Drive Blowers

Specifications and Performance

Model	CFM Air Delivery @ Static Pressure Shown Free Air	0.3"	0.4"	0.5"	0.6"	0.7"	0.8"	0.9"	Blower w/1075 RPM Motor † No. Speeds	HP	60 Hz	Volts Type	FLA
5C090C	*	992	961	915	864	726	513	—	1	1/6	115	PSC	2.8
5C091C	*	1529	1517	1483	1416	1326	926	397	1	1/4	115	PSC	4.0
5C092C	*	1938	1798	1739	1656	1543	1407	1084	4	1/3	115	PSC	5.1
	*	1495	1492	1461	1406	1342	1122	803					
	*	1325	1325	1319	1284	1212	990	722					
	*	*	1165	1164	1142	1033	836	510					

Model	CFM Air Delivery @ Static Pressure Shown 0.7"	0.8"	0.9"	1.0"	1.1"	1.2"	1.25"	1.3"	Blower w/1075 RPM Motor † No. Speeds	HP	60 Hz	Volts Type	FLA
5C093C	*	*	*	1824	1704	1456	932	—	4	1/2	115	PSC	8.8
	*	1653	1616	1550	1470	1010	568	—					
	*	1430	1392	1341	1255	871	479	—					
	*	1266	1219	1159	1050	631	405	—					
5C094C	*	*	2374	2218	2021	1793	1643	1294	4	3/4	115	PSC	11.2
	*	*	2093	1991	1828	1499	1029	558					
	*	*	1819	1740	1587	981	678	526					
	*	*	1547	1467	1129	663	558	474					

Model	CFM Air Delivery @ Static Pressure Shown 1.1"	1.2"	1.3"	1.4"	1.5"	1.6"	1.7"	1.8"	Blower w/1075 RPM Motor † No. Speeds	HP	60 Hz	Volts Type	FLA
5C197C	*	2780	2775	2740	2660	2530	2170	1850	3	1	115	PSC	14.0
5C198C	*	2370	2360	2310	2200	2020	1815	1555	3	1	230	PSC	7.5
	*	1940	1910	1855	1805	1750	1650	—					

(*) Motor overload will result if blower is operated at static pressure below performance shown
(†) Includes capacitor with permanent split capacitor motor

General Safety Information (Continued)

6. Be careful when touching the exterior of an operating motor; it may be hot enough to cause injury. With modern motors, this condition is normal if operated at rated load and voltage and built to operate at higher temperatures.

⚠ CAUTION ***Do not touch motor. It may be hot enough to cause injury.***

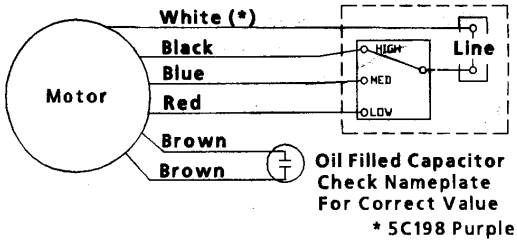
7. Protect power cable from coming into contact with sharp objects.
8. Do not kink power cable and never allow cable to come in contact with oil, grease, hot surfaces, or chemicals.
9. Make certain that the power source conforms to requirements of your equipment.

⚠WARNING ***Do not use in a flammable or explosive atmosphere.***

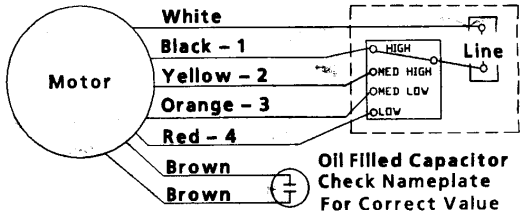
Installation

1. Attach the housing supports (ordered separately) to the housing in the desired discharge position.

3 Speed
Motor Connection Diagram
For Models 5C197 and 5C198



4 Speed
Motor Connection Diagram
For Models 5C092, 5C093 and 5C094



* 5C198 Purple on 230 VAC

Figure 2 - Wiring Diagram

APPENDIX A

Models 5C090C thru 5C094C, 5C197C and 5C198C

Installation (Continued)

2. If necessary, rotate the motor so the oil holes are facing up.

⚠ CAUTION ***For safety, a lockable disconnect switch should be located near blower so power can be positively disconnected while installing or servicing the fan.***

⚠ WARNING ***Blower frame and motor must be electrically grounded to a suitable electrical ground such as a grounded metallic raceway or ground wire system. Be sure the motor to housing ground wire is secure.***

3. Wiring connections:
   a. For Models 5C090C and 5C091C, connect the two leads to the appropriate power source.
   b. For Models 5C197C, 5C198C, 5C092C, 5C093C and 5C094C, refer to Figure 2 for wiring.

NOTE: The white or purple lead in the wiring diagrams must always be used as one of the electrical connections. All leads not used must be "dead ended" (taped off).

4. Unit is ready for operation.

Operation

After the blower is installed and all duct work is re-attached, measure the current input to the motor and compare with the nameplate rating of the motor (see "Specifications and Performance") to determine if the motor is operating under safe load conditions.

⚠ CAUTION ***Make certain that the blower is operating within the static pressure limits shown in the "Specification and Performance" chart, if not, motor overload will result.***

Maintenance

⚠ WARNING ***Always disconnect power supply before servicing. Secure the switch with a lock and tag.***

LUBRICATION

The motor bearings should be lubricated once a year with 10 to 20 drops of SAE 10W or 20W nondetergent oil (except for Models 5C197C and 5C198C which use permanently lubricated ball bearings).

Troubleshooting Chart

Symptom	Possible Cause(s)	Corrective Action
Excessive noise	1. Blower wheel striking housing	1. Realign or replace
	2. Foreign material inside housing	2. Clean
	3. Loose or leaking duct work	3. Repair and/or secure properly
Insufficient air flow	1. Motor speed inadequate	1. Make speed adjustment
	2. Leaks in duct work	2. Repair
	3. Shutters and/or registers closed	3. Open
	4. Obstruction in system	4. Remove
	5. Clogged filters	5. Clean or replace
Too much air flow	1. Filters not in place	1. Install filters
	2. Motor speed too fast (multi-speed units only)	2. Lower speed
	3. Registers or grilles not installed	3. Install to match system requirements
	4. Insufficient static pressure	4. Check your static pressure calculations and correct system accordingly
Unit fails to operate	1. Blown fuse or open circuit breaker	1. Replace fuse or reset circuit breaker
	2. Defective motor/motor capacitor	2. Replace

APPENDIX A

For Replacement Parts, call 1-800-323-0620

24 hours a day - 365 days a year

Please provide following information:
-Model number
-Serial number (if any)
-Part description and number as shown in parts list

Address parts correspondence to:
Grainger Parts Operations
P.O. Box 3074
1657 Shermer Road
Northbrook, IL 60065-3074 U.S.A.

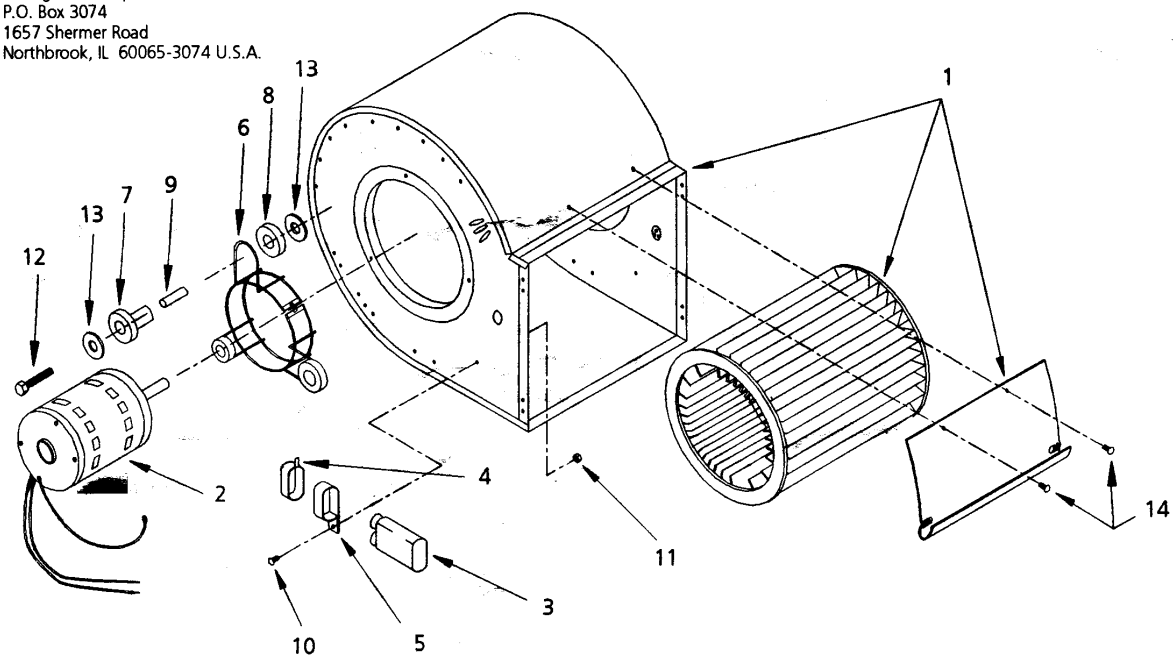


Figure 3 — Replacement Parts Illustration

Replacement Parts List

Ref. No.	Description	Part Number For Models: 5C197C	5C198C	5C090C	5C091C	5C092C	5C093C	5C094C	Qty.
1	Blower housing assembly (includes threaded inserts)	03381001	03381001	03382001	03383001	03383001	03384001	03385001	1
2	Motor	13329001	13330001	13332001	13333001	13334001	13335001	13336001	1
3	Capacitor	6X662	6X662	6X652	6X655	6X655	6X655	6X658	1
4	Capacitor cap	3X685	3X685	3X685	3X685	3X685	3X685	3X685	1
5	Capacitor strap	07700001	07700001	07701001	07701001	07701001	07701001	07700001	1
6	Motor mount ring	03342001	03342001	03343001	03343001	03341001	03340001	03340001	1
7	Rubber grommet inner	07748001	07748001	07748001	07748001	07748001	07748001	07748001	3
8	Rubber grommet outer	07749001	07749001	07749001	07749001	07749001	07749001	07749001	3
9	Steel liner	07750001	07750001	07750001	07750001	07750001	07750001	07750001	3
10	6-32 x 3/4" Screw	*	*	*	*	*	*	*	1
11	#6-32 Nut	*	*	*	*	*	*	*	1
12	1/4-20 x 1 1/2" HHC screw	*	*	*	*	*	*	*	3
13	1/4" ID x 1" OD Fender washer	*	*	*	*	*	*	*	6
14	10-32 x 5/16" Machine screw	*	*	*	*	*	*	*	2

(*) Standard hardware items, available locally

APPENDIX A

Dayton Operating Instructions and Parts Manual

Models 5C090C thru 5C094C, 5C197C and 5C198C

Limited Warranty

Dayton One-Year Limited Warranty. *Direct-Drive Blowers, Models covered in this manual, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from jurisdiction to jurisdiction.*

Limitation of Liability. *To the extent allowable under applicable law, Dayton's liability for consequential and incidental damages is expressly disclaimed. Dayton's liability in all events is limited to and shall not exceed the purchase price paid.*

Warranty Disclaimer. *Dayton has made a diligent effort to provide product information and illustrate the products in this literature accurately; however, such information and illustrations are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.*

Except as provided below, no warranty or affirmation of fact, expressed or implied, other than as stated in the "LIMITED WARRANTY" above is made or authorized by Dayton.

Product Suitability. *Many jurisdictions have codes and regulations governing sales, construction, installation, and/or use of products for certain purposes, which may vary from those in neighboring areas. While Dayton attempts to assure that its products comply with such codes, it cannot guarantee compliance, and cannot be responsible for how the product is installed or used. Before purchase and use of a product, review the product applications, and all applicable national and local codes and regulations, and be sure that the product, installation, and use will comply with them.*

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some jurisdictions do not allow a limitation on how long an implied warranty lasts, consequentially the above limitation may not apply to you; and (c) by law, during the period of this limited warranty, any implied warranties of implied merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

Prompt Disposition. *Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within limited warranty. For any product believed to be defective within limited warranty, first write or call dealer from whom the product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date, and number of dealer's invoice, and describing the nature of the defect. Title and risk of loss pass to buyer on delivery to common carrier. If product was damaged in transit to you, file claim with carrier.*

Manufactured for Dayton Electric Mfg. Co., 5959 W. Howard St., Niles, Illinois 60714 U.S.A.