Technical and New Product Review of Lamb Vacuum Motors
Vacuum Motor/Blower Designs

The Lamb vacuum motor product line incorporates both thru-flow and bypass designs to meet all requirements for the floorcare and many other industries.

Motors are available for operation on low voltage power supplies of 24, 36, 42 and 48 volts and normal AC power levels of 100, 120, 220, 230 and 240 volts (50/60 Hz).

Currently, there are over 600 active motor models in the Lamb product line.
**Product Review**

**Thru-Flow Vacuum Motors**

Thru-flow vacuum motors require flow of the vacuumed air moving through the fan system and over the motor components for cooling. These units should be used only in dry applications.

<table>
<thead>
<tr>
<th>Design Types</th>
<th>Fan System Diameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>5.7” (145mm)</td>
</tr>
<tr>
<td>High Efficiency</td>
<td>5.1” (130mm)</td>
</tr>
<tr>
<td>Cup</td>
<td>4.8” (122mm)</td>
</tr>
<tr>
<td>G-2000</td>
<td>4.2” (106mm)</td>
</tr>
<tr>
<td></td>
<td>4.0” (102mm)</td>
</tr>
</tbody>
</table>
The conventional Lamb thru-flow vacuum motor utilizes either aluminum or thermoset fan-end brackets, insulated brush holders and comes in a wide variety of performance and size options.
Lamb’s high efficiency vacuum motor designs utilize fan brackets that provide directional vanes to move the air through the fan system more efficiently and high air flow fans. This provides higher levels of air watts through the system. Fan brackets are either thermoset or aluminum.
Other Conventional Lamb Thru-Flow Vacuum Motors

4.2” (106mm) Diameter Motor 1&2 Stages

4.8” (122mm) Diameter Motor 1&2 Stages

5.1” (130mm) Diameter Motor 1&2 Stages
Lamb’s new thermoset cup design motors feature the directional vanes from the older, high efficiency motors, tapered fans and have the bearing seats molded into the commutator and diffuser brackets. This promotes better bearing alignment and the cup design improves cooling of the motor.
Other Cup Thru-Flow Vacuum Motors

5.1” (130mm) 1-stage motor--available in .8” and 1.1” stack heights and also in 2 fan stages

4.0” (100mm) single stage motor, available in .8” stack height only
The new Lamb G-2000 series of vacuum motors uses new construction techniques that enhance the manufacturing process. Features include all thermoset brackets, dual ball bearings, uninsulated brush holders and automatically produced fields. The field has blade terminals for power and brush lead connections.
Bypass vacuum motors have been designed to operate in environments requiring separation of working air and cooling air. Discharge of the working air is either through a tangential tube or through louvers peripherally placed around the fan housing.

### Design Types
- Peripheral
- Tangential
- ACUSTEK
- G-2000
- Hazardous Duty

### Fan System Diameters
- 7.5” (190mm)
- 7.2” (183mm)
- 5.7” (145mm)
- 4.8” (122mm)
Peripheral Bypass

These bypass motors have their working air discharge through louvers around the fan housing. Cooling air is provided by a ventilation fan at the top of the motor, shrouded by a plastic cover that directs air over the electrical portions of the unit. They are built in 1, 2 and 3 fan stage units.
5.7” (145mm) Diameter Bypass Vacuum Motors

Tangential Bypass

These bypass motors have their working air discharge directed through a tube that is molded as part of the fan-end bracket of the motor. The tube provides a convenient method of removing the working air from the cleaner enclosure.
5.7” (145mm) ACUSTEK® Bypass Vacuum Motors

The Lamb ACUSTEK® line was developed to reduce the overall noise levels of the vacuum motor. Significant reductions have been attained through this design. They are available in 2 and 3 stage models and have been applied in central and commercial vacuum units extensively. Vacuumed air is discharged through ports in the fan-end bracket.
4.8” (122mm) Diameter Bypass Vacuum Motors

The 4.8” (122mm) diameter bypass motors have been designed to meet the need for smaller units used in compact cleaning machines. They are built in 1 and 2 stage models.
The Lamb 7.2" (183mm) series of vacuum motors was developed nearly 40 years ago to meet a requirement for the central vacuum market. Since the introduction, this series has been the backbone of the commercial vacuum market as they have enhanced durability over the smaller, 5.7" (145mm) series. There are three base designs in this series:

- Series 61 (Original Design Series)
- Series 84 (Redesign Series)
- Series 91 (Premier Series)
These motors feature all aluminum brackets and both tangential and peripheral discharge designs. The fans in this series have been designed to operate effectively in cyclonic filtration central vacuum systems.
These motors feature thermoset plastic fan and commutator brackets and are available in both tangential and peripheral discharge designs. The series has 2 and 3 fan stage models and have been used in many commercial and central vacuum applications as well as hot water extractors for carpet cleaning.
This new series of motors incorporates all aluminum bracket construction and a completely redesigned fan system. The outer fan is tapered and the new design has improved the overall efficiency of the system. The three stage motors have a maximum air watt level in excess of 550. The design is available only with a tangential discharge.
The hazardous duty motors in the Lamb line are designed to operate in atmospheres that contain a number of flammable and explosive materials. The motor is totally enclosed to prevent ambient air from contacting electrical section. The fan system is made fully from aluminum.
The 7.5” (191mm) series of Lamb vacuum motors was designed to meet the early needs of the commercial floorcare and computer peripheral equipment markets. The motors are built in 2 and 3 stage models. The series is available only in peripheral discharge.
Applications for Lamb Vacuum Motors

Floorcare

**Household**
- Canister Vac
- Utility Vac
- Upright Vac
- Hand Vac

**Commercial**
- Tank Vac
- Upright Vac
- JHWE
- Auto Scrubber
- Car Wash
- Central Vac
Material Handling
Spa / Hot Tub
Dock Lift
Hoists/Cranes
HVLP
Welding Equipment
Musical Instruments
Air Moving Equipment

Pneumatic Tube Transfer
Animal Groomers
Agricultural Sprayers
Textile Equipment
Sand Blast Equipment
Photographic Equipment
Tennis Ball Server
Miscellaneous Industries
Market Applications

Material Handling

Most applications in this market area involve the use of a vacuum motor in a transfer system to move plastic pellets from a storage facility to the hopper loader on an injection molding machine.

Other applications include moving coins from a payment point to a collection area in a car wash. When the first coin is dropped, the blower turns on for a specified time and propels the coins to the collection area.
Typical Motors Used for Material Handling

- 7.5” Peripheral Discharge
- 7.2” Peripheral Discharge
- 5.7” Peripheral Discharge
In many spa / hot tub applications, the vacuum blower is used as a bubbling device to promote agitation in the water and the turbulence is very relaxing. Both thru-flow and bypass vacuum motors are used in this application. However, the thru-flow motors are predominant as the construction of such blower packages is less costly. Most blowers use thermally protected vacuum motors as a safety measure to guard against a blocked inlet condition (when the static head of the tub exceeds the output of the blower) or a locked rotor condition. The thru-flow motor needs air moving through it for proper cooling.
Typical Motors Used for Spa Market

5.7” 1-stage Thru flow

5.7” 2-stage Thru flow
Dock lift mechanisms have been developed that employ Lamb vacuum motors as pressure blowers. In operation, a boat is positioned over a cradle on top of the underwater air tank with no bottom (like putting an inverted bucket in the water). As the blower forces air into the tank, it rises and lifts the boat (now on the cradle) out of the water.

To lower the boat back into the water, a valve on top of the tank is opened, the air escapes and the boat settles back into the water.
Typical Motors Used for Boat Lifts

5.7” 2-stage Bypass

5.7” 3-stage Bypass
Loading Dock Lift

This application is similar to the boat dock lift except that in this device, the blower inflates a bladder that raises a ramp to the proper height that will allow driving a fork lift truck or similar material mover from the dock onto a truck to facilitate loading or unloading operations.

Blowers are used in a pressure mode and care must be taken to ensure that the cover cans for the fans do not come off due to back pressure in the system.
Typical Motors Used for Loading Dock Lifts

- 5.7” 2-stage Bypass
- 5.7” 3-stage Bypass
HVLP Paint Spray Systems

Vacuum motors are used as pressure blowers for high volume, low pressure paint spray systems. These units utilize the pressure of the air discharge of the motor plus the heating effect of air compression to propel paint drawn into the gun by a Venturi effect and deposited onto the surface being painted. HVLP systems have a benefit of having quite low overspray characteristics and this makes them popular for home and light duty commercial applications. They also are lower in cost and more easily transported than high pressure systems which require air compressors.
Typical Motors Used for HVLP Paint Sprayers

- 5.7” 2-stage Bypass
- 7.2” 3-stage Premier Bypass
- 5.7” 3-stage Bypass
- 5.7” 4-stage Bypass
Welding Fume Evacuators

Applications in this market area use either thru-flow or bypass vacuum motors to draw air and the dust and debris created during welding operations into a filter / bag arrangement to keep that material out of the air in the shop. These are sold to various industrial firms and help to keep the air quality at acceptable levels.
Typical Motors Used for Welding Fume Evacuators

- 5.7” 2-stage Bypass
- 5.7” 2-stage Thru flow
- 4.3” 2-stage Thru Flow
Musical Instruments

This small market covers player pianos. In these applications, the vacuum motor (usually a thru-flow style) is used as a pressure source to drive the bellows in the piano. The application requires very quiet operation and typically, the motor is placed in a well insulated housing and also run at reduced voltage as normal vacuum performance is not required. This is done either through a step-down transformer or by running a motor designed for 240 volt operation at 120 volts.
Typical Motor Used for Player Pianos

5.7” 2-stage
Thru flow
Air Moving Equipment

This application would cover a wide range of high pressure air moving requirements for industrial applications. The vacuum motor is a reasonably priced source of high pressure or vacuum air.

The full range of Lamb vacuum motor / blowers are potential candidates for these types of applications.
Pneumatic Tube Transfer Systems

In these applications, vacuum motors (usually high air flow thru-flow units) are used to provide the vacuum pressure required to move a carrier through a tube. Typical applications are in drive-in banking centers and more recently, in pharmacies with drive in windows. The carriers are designed to handle up to 25 pound (13 kilo) payloads. Other installations have been used to move money or documents to a central office in department stores and other establishments.
Typical Motors used in Pneumatic Tube Transfer Systems

- 5.7” 1-stage Pancake Bracket Thru-flow
- 5.7” 1-stage High Efficiency Thru-flow
- 5.7” 2-stage High Efficiency Thru-flow
Animal Groomers and Dryers

Thru-flow vacuum motors are frequently used in apparatus for the animal grooming market. The air discharge of a thru-flow motor is quite warm but not so warm as to create discomfort for an animal. Most often, supplemental heaters are not required. The motor is mounted in a housing with a discharge hose to direct the warm air to the area being dried, similar to a normal hair dryer.
Product Review

Typical Motors Used in Animal Groomers and Dryers

- 5.7” 1-stage High Efficiency Thru-flow
- 5.7” 2-stage High Efficiency Thru-flow
Agricultural Sprayers / Foggers

Vacuum motors are used as the pressure air source in these devices that provide a fog or mist of insecticide or other materials, including disinfectants over a wide area. The material being sprayed is drawn into the discharge nozzle through the Venturi effect and is then distributed in the desired area. Equipment of this type is manufactured to be used in stationary installations such as food storage areas and also as hand held devices for spraying in a specific area.
Typical Motors Used in Agricultural Fogger /Sprayers

5.7” 2-stage Bypass
5.7” 2-stage Thru flow
7.2” 3-stage Thru flow
Textile Equipment

Special vacuum systems have been developed in the textile market that normally use thru-flow vacuum motors to collect thread and other selvage during cutting and sewing operations in the textile markets. The requirements for these machines are not generally met through normal commercial floorcare equipment. The motor requirements are for long life and high air flow capabilities.
Typical Motor Used in Textile Equipment

5.7” 1-stage
Thru flow
Sand Blasting Equipment

Vacuum motors are used in the collection of abrasive material used in sand blasters and for propelling the same material in the cleaning process. These motors see quite a bit of abrasive dust going through the filters that typically etches the aluminum fans. If the filters are maintained properly and do not leak, the motor should give satisfactory life.
Typical Motors Used in Sand Blasting Equipment

5.7” 2-stage Tangential Discharge Bypass

5.7” 2-stage Peripheral Discharge Bypass
Vacuum motors are used in applications that will hold large sheets of paper or photographic material on a platen during the imaging process. Once the imaging is completed, the vacuum is released and the sheet can be further processed. This is normally used in large, stationary equipment.

The motors typically used in this type of application are larger, commercial units. Durability of the motor is a major concern in this type of application.
Product Review

Typical Motor Used in Photographic / Printing Equipment

7.2” 2-stage
Peripheral Discharge
Bypass
Tennis Ball Servers

The pressure developed by the discharge of high performance vacuum motors can propel tennis balls at very high velocity for use in practice of the game. The ball drops from a hopper into a chamber. The serving chamber is pressurized and when the proper level is reached, the ball is released and served over the net through a cannon-like tube.
Typical Motors used in Tennis Ball Servers

5.7” 2-stage High Efficiency Thru flow

5.7” 2-stage Pancake Bracket Thru flow
Lamb Technical Data Sources

Catalog
  • Binder with Individual Sheets
  • CD Catalog
  • Parts Bulletin CD

Internet Web Site
  • PDF / Excel / HTML Data Sheets
  • Parts Bulletins
  • New Product Introduction
Description
Provides a review of the basic design features of the motor

Application
Provides a general statement related to use of the motor. Lamb does not make any written recommendation for use of a model for any specific type of equipment

Special Features
Outlines the various special features specific to the model shown on the product bulletin
Cut-away drawing

This drawing is used to provide a good graphic view of the motor, its design and the internal alignment of the components used in construction.
Performance Data

Performance data for the model is shown in both ASTM (for North America) and Metric (for the rest of the world) formats. The data is presented in tabular as well as graphic formats. By including the ASTM and Metric data on the bulletin sheet, we are able to have a single sheet for each active model. This simplifies editing and keeping the product bulletin sheets up to date.
Orifice Test Points

Performance data for Lamb vacuum motors is stated in reference to a series of orifice diameters. Air is drawn into the test box by the fan system of the motor through a series of sharp-edge orifice plates that simulate various impedance levels to air flow.

The orifice plates are machined at various inch diameters for ASTM (North American) tests and in millimeter diameters for testing for the rest of the world.
Product Review

Product Bulletin Sheets

Performance Graph

Shows the curves for vacuum and air flow at the various orifice test points
Performance Data

The tabular presentation of data shows actual readings observed at each of the various orifice operating points during the test.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.000</td>
<td>5.9</td>
<td>1282</td>
<td>15417</td>
<td>3.5</td>
<td>97.8</td>
<td>40</td>
</tr>
<tr>
<td>1.750</td>
<td>5.9</td>
<td>1280</td>
<td>15377</td>
<td>6.1</td>
<td>99.2</td>
<td>72</td>
</tr>
<tr>
<td>1.500</td>
<td>5.9</td>
<td>1279</td>
<td>15351</td>
<td>10.9</td>
<td>95.4</td>
<td>122</td>
</tr>
<tr>
<td>1.250</td>
<td>5.9</td>
<td>1278</td>
<td>15358</td>
<td>18.9</td>
<td>87.4</td>
<td>195</td>
</tr>
<tr>
<td>1.125</td>
<td>5.9</td>
<td>1272</td>
<td>15419</td>
<td>25.0</td>
<td>81.2</td>
<td>238</td>
</tr>
<tr>
<td>1.000</td>
<td>5.8</td>
<td>1259</td>
<td>15550</td>
<td>32.9</td>
<td>73.3</td>
<td>283</td>
</tr>
<tr>
<td>0.875</td>
<td>5.7</td>
<td>1241</td>
<td>15719</td>
<td>42.9</td>
<td>63.9</td>
<td>323</td>
</tr>
<tr>
<td>0.750</td>
<td>5.5</td>
<td>1209</td>
<td>16005</td>
<td>54.7</td>
<td>52.7</td>
<td>338</td>
</tr>
<tr>
<td>0.625</td>
<td>5.3</td>
<td>1146</td>
<td>16526</td>
<td>65.8</td>
<td>40.0</td>
<td>309</td>
</tr>
<tr>
<td>0.500</td>
<td>4.9</td>
<td>1071</td>
<td>17221</td>
<td>77.1</td>
<td>27.6</td>
<td>250</td>
</tr>
<tr>
<td>0.375</td>
<td>4.5</td>
<td>984</td>
<td>18087</td>
<td>87.9</td>
<td>16.6</td>
<td>171</td>
</tr>
<tr>
<td>0.250</td>
<td>4.1</td>
<td>903</td>
<td>18983</td>
<td>97.7</td>
<td>8.1</td>
<td>93</td>
</tr>
<tr>
<td>0.000</td>
<td>3.7</td>
<td>835</td>
<td>19980</td>
<td>110.0</td>
<td>0.0</td>
<td>0</td>
</tr>
</tbody>
</table>
Product Bulletin Sheets

Motor Outline drawing provides the full dimensional information required for the customer’s design work.

NOTES:
1. LEADS TO GA. STRANDED. LEADS CAN BE ANY COLOR EXCEPT GREEN OR GREEN WITH YELLOW STRIPE.
2. GROUNDING OR EARTHING PROVISIONS USE HOLES AS INDICATED FOR GROUNDING OR EARTHING. REFER TO APPROPRIATE LISTING OR REGULATORY AGENCY FOR PROPER METHOD OF GROUNDING OR EARTHING.
The Lamb Electric Web Site, ameteklamb.com was established in 1998. The site features detailed performance information on approximately 150 different standard models in the Lamb product line. The site also provides information on new products that have recently been introduced.

This vehicle offers the opportunity to quickly update product information and provide customers with the most current data on Lamb motors. Shortly, parts bulletins for each model featured in the technical data section will be included on the site.
The basic operation and construction of the basic types of vacuum motors will be discussed in the following slides.

This data is very important to understand as it is essential to keep these considerations in mind when recommending a particular model or type to a customer or for planning the design of an appliance.

When keeping these considerations in mind during the design phase, a proper installation can be attained.
Typical Vacuum Motor Construction and Components

The following slides show a cut-away outline drawing of thru flow and bypass vacuum motors with the various component parts called out.
Basic Vacuum Motor Designs

There are two basic designs of vacuum motor blowers manufactured by Lamb Electric:

• **Thru-Flow**—the vacuumed air goes through the fan system and is discharged directly over the motor windings and this air provides cooling for the motor. Typical applications are dry vacuum units.

• **Bypass**—the vacuumed air is separated from the motor cooling air. The vacuumed air does not pass over the electrical portion of the motor. Cooling air is provided by a separate ventilation fan. Typical applications are wet/dry vacuum units where there is moisture in the vacuumed air.
Thru Flow Motor Construction

- Commutator End Bracket
- Brush Mechanism
- Commutator
- Armature
- Field Coil
- Load Spring
- Vacuum Air Discharge
- Ball Bearings
- Neoprene Washer
- Vacuum Air Discharge
- Stationary Fan
- Spacers
- Fan Shell
- Vacuum Air Inlet
- Fan Bracket
- Baffle
- Rotating Fans
- Fan Nut/Washer
The movement of air through a vacuum motor varies with the design of the unit. The following slides show the route of air through bypass and thru flow designs.

Single stage motors typically have the highest air flow and lowest vacuum levels. Adding fan stages increases the vacuum capability of the unit but reduces the air flow. This is because of increased impedance to air flow through the system, the result of additional fans (rotating and stationary) through which the air must pass.
Product Review

Single Stage Thru-Flow Vacuum Motors
Two Stage Thru-Flow Vacuum Motors
Product Review

Three Stage Bypass Vacuum Motors
Lamb vacuum motors require adequate ventilation in order to operate properly and meet their expected life targets. Improper ventilation will cause the motor to run hot and will contribute to reduced operating life.

• A minimum of 3 in² (19.4 cm²) area should be provided for ventilation air inlet and discharge.

• Cooling air should not be allowed to re-circulate.

• The path of cooling air in the cleaner or other appliance should not restrict the minimum areas. Otherwise, this will have an adverse effect on the unit.
Vacuum Motor Cooling

Cooling the Lamb vacuum motor is accomplished by two basic designs of the units—Thru flow and Bypass.

**Thru Flow Design:** The air going through the vacuum fan system is actually the cooling air for the motor. These units should only be used in dry applications.

**Bypass Design:** To cool the motor, a separate cooling fan is provided that blows cooling air that is separate from the vacuumed or working air. Bypass motors can handle moisture in the working air section of the unit.
The cooling air for the thru flow motor is the vacuumed or working air. It must not be allowed to re-circulate or have any debris, dirt or moisture. This will damage to the motor and possibly cause an electrical shock that could injure or even kill someone.

The air going through the motor will be quite warm. As the air is compressed, substantial heat is generated. It is further heated as it passes over the electrical portion of the motor, performing its cooling function.
Thru Flow Mounting Recommendations
Cooling Bypass Vacuum Motors

Bypass vacuum motors have an independent cooling fan that provides ventilation air that does not go through the working air section of the unit. It is essential that the inlet or discharge to the cooling fan not be blocked or restricted in any way as it could have a damaging thermal effect on the motor.

The housing enclosing the vacuum motor must be designed in such a manner that the discharge of the cooling and working air does not re-circulate. This will introduce heated air into the cooling system and lead to thermal problems with the motor.
Bypass Motor
Mounting Recommendations

NOTE: USE A SPACER BETWEEN MOTOR AND UNIT HOUSING TO PREVENT COMPRESSION OF FAN HOUSING.
Factors Effecting Performance Variation

Voltage
   Linear Relationship

Frequency
   Generally insignificant from 50 to 60 Hz

Barometric Pressure / Elevation
   Has significant effect on pressure. Airflow does not change with elevation.

Relative Humidity
   Has relatively minor effect

Temperature
   Will effect performance in similar fashion to barometric pressure / elevation.
The series wound motor responds to variations in voltage in a linear manner. As the voltage applied changes, the performance will respond accordingly as shown in this chart. Lamb has a spreadsheet that can be used to project the performance difference related to voltage.
When Lamb reports vacuum performance data, it is corrected to standard atmospheric conditions of 29.92” Hg and 68°F. This gives consistency in reporting. The elevation or barometric pressure at the reading point plus the air temperature must be considered in the correction process. Lamb has a correction factor calculator that may be used in converting the raw data to standard conditions.

The blower is a constant flow device so the volume of air going through the fan system will remain basically constant, regardless of pressure or elevation. With higher elevation, the volume of less dense air will create lower vacuum levels.
Lamb has a correction factor calculator that is available to customers. Through the calculator, raw as read performance data may be corrected to standard atmospheric conditions and may then be accurately compared to the published data in Lamb product bulletins.

To use the calculator, the barometric pressure and the temperature scales are aligned. Then, the corrected vacuum data is determined by reading the number opposite the uncorrected vacuum level of the motor.

Calculator wheels are available on request.
## Altitude Correction Table

Specific Gravity of Standard Air at Sea Level and 29.92” Hg = 1.00

<table>
<thead>
<tr>
<th>Elev</th>
<th>/SG</th>
<th>b= &quot;Hg</th>
<th>Elev</th>
<th>/SG</th>
<th>b= &quot;Hg</th>
<th>Elev</th>
<th>/SG</th>
<th>b= &quot;Hg</th>
<th>Elev</th>
<th>/SG</th>
<th>b= &quot;Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
<td>29.92</td>
<td>1500</td>
<td>0.947</td>
<td>27.5</td>
<td>3000</td>
<td>0.890</td>
<td>26.82</td>
<td>6000</td>
<td>0.801</td>
<td>23.98</td>
</tr>
<tr>
<td>100</td>
<td>0.996</td>
<td>29.81</td>
<td>1600</td>
<td>0.944</td>
<td>27.4</td>
<td>3200</td>
<td>0.883</td>
<td>26.62</td>
<td>6500</td>
<td>0.786</td>
<td>23.09</td>
</tr>
<tr>
<td>200</td>
<td>0.993</td>
<td>29.70</td>
<td>1700</td>
<td>0.937</td>
<td>27.3</td>
<td>3400</td>
<td>0.877</td>
<td>26.42</td>
<td>7000</td>
<td>0.772</td>
<td>22.96</td>
</tr>
<tr>
<td>300</td>
<td>0.989</td>
<td>29.60</td>
<td>1800</td>
<td>0.933</td>
<td>27.2</td>
<td>3600</td>
<td>0.870</td>
<td>26.23</td>
<td>7500</td>
<td>0.757</td>
<td>22.22</td>
</tr>
<tr>
<td>400</td>
<td>0.986</td>
<td>29.49</td>
<td>1900</td>
<td>0.926</td>
<td>27.1</td>
<td>3800</td>
<td>0.864</td>
<td>26.03</td>
<td>8000</td>
<td>0.743</td>
<td>21.80</td>
</tr>
<tr>
<td>500</td>
<td>0.982</td>
<td>29.38</td>
<td>2000</td>
<td>0.920</td>
<td>27.0</td>
<td>4000</td>
<td>0.857</td>
<td>25.84</td>
<td>8500</td>
<td>0.729</td>
<td>21.39</td>
</tr>
<tr>
<td>600</td>
<td>0.979</td>
<td>29.28</td>
<td>2100</td>
<td>0.916</td>
<td>26.9</td>
<td>4200</td>
<td>0.851</td>
<td>25.65</td>
<td>9000</td>
<td>0.715</td>
<td>21.00</td>
</tr>
<tr>
<td>700</td>
<td>0.975</td>
<td>29.17</td>
<td>2200</td>
<td>0.913</td>
<td>26.8</td>
<td>4400</td>
<td>0.845</td>
<td>25.46</td>
<td>9500</td>
<td>0.701</td>
<td>20.71</td>
</tr>
<tr>
<td>800</td>
<td>0.971</td>
<td>29.07</td>
<td>2300</td>
<td>0.912</td>
<td>26.7</td>
<td>4600</td>
<td>0.840</td>
<td>25.27</td>
<td>10000</td>
<td>0.688</td>
<td>20.58</td>
</tr>
<tr>
<td>900</td>
<td>0.968</td>
<td>28.96</td>
<td>2400</td>
<td>0.910</td>
<td>26.6</td>
<td>4800</td>
<td>0.833</td>
<td>25.08</td>
<td>10500</td>
<td>0.675</td>
<td>20.39</td>
</tr>
<tr>
<td>1000</td>
<td>0.964</td>
<td>28.86</td>
<td>2500</td>
<td>0.909</td>
<td>26.5</td>
<td>5000</td>
<td>0.827</td>
<td>24.90</td>
<td>11000</td>
<td>0.662</td>
<td>20.20</td>
</tr>
<tr>
<td>1100</td>
<td>0.961</td>
<td>28.75</td>
<td>2600</td>
<td>0.907</td>
<td>26.4</td>
<td>5200</td>
<td>0.822</td>
<td>24.71</td>
<td>11500</td>
<td>0.649</td>
<td>20.01</td>
</tr>
<tr>
<td>1200</td>
<td>0.957</td>
<td>28.65</td>
<td>2700</td>
<td>0.904</td>
<td>26.3</td>
<td>5400</td>
<td>0.817</td>
<td>24.52</td>
<td>12000</td>
<td>0.636</td>
<td>19.82</td>
</tr>
<tr>
<td>1300</td>
<td>0.954</td>
<td>28.54</td>
<td>2800</td>
<td>0.902</td>
<td>26.2</td>
<td>5600</td>
<td>0.812</td>
<td>24.34</td>
<td>12500</td>
<td>0.623</td>
<td>19.63</td>
</tr>
<tr>
<td>1400</td>
<td>0.950</td>
<td>28.44</td>
<td>2900</td>
<td>0.899</td>
<td>26.1</td>
<td>5800</td>
<td>0.807</td>
<td>24.16</td>
<td>13000</td>
<td>0.610</td>
<td>19.44</td>
</tr>
<tr>
<td>1500</td>
<td>0.947</td>
<td>26.0</td>
<td>3000</td>
<td>0.895</td>
<td>25.9</td>
<td>6000</td>
<td>0.802</td>
<td>23.98</td>
<td>13500</td>
<td>0.597</td>
<td>19.25</td>
</tr>
</tbody>
</table>

**Example:**

Blower operating at 2400 feet elevation.  Vacuum at sea level is 95.5” H2O.  At elevation, vacuum is **95.5” x .916 = 87.5”**
Temperature Correction Table
Specific Gravity of Standard Air at 70°F = 1.00

<table>
<thead>
<tr>
<th>t= °F</th>
<th>SG</th>
<th>t= °F</th>
<th>SG</th>
<th>t= °F</th>
<th>SG</th>
<th>t= °F</th>
<th>SG</th>
<th>t= °F</th>
<th>SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>1.178</td>
<td>50</td>
<td>1.039</td>
<td>80</td>
<td>0.982</td>
<td>125</td>
<td>0.906</td>
<td>200</td>
<td>0.803</td>
</tr>
<tr>
<td>-5</td>
<td>1.165</td>
<td>52</td>
<td>1.035</td>
<td>82</td>
<td>0.978</td>
<td>130</td>
<td>0.898</td>
<td>210</td>
<td>0.791</td>
</tr>
<tr>
<td>0</td>
<td>1.152</td>
<td>54</td>
<td>1.031</td>
<td>84</td>
<td>0.974</td>
<td>135</td>
<td>0.891</td>
<td>220</td>
<td>0.779</td>
</tr>
<tr>
<td>5</td>
<td>1.140</td>
<td>56</td>
<td>1.027</td>
<td>86</td>
<td>0.971</td>
<td>140</td>
<td>0.883</td>
<td>230</td>
<td>0.768</td>
</tr>
<tr>
<td>10</td>
<td>1.128</td>
<td>58</td>
<td>1.023</td>
<td>88</td>
<td>0.967</td>
<td>145</td>
<td>0.876</td>
<td>240</td>
<td>0.757</td>
</tr>
<tr>
<td>15</td>
<td>1.116</td>
<td>60</td>
<td>1.019</td>
<td>90</td>
<td>0.964</td>
<td>150</td>
<td>0.869</td>
<td>250</td>
<td>0.747</td>
</tr>
<tr>
<td>20</td>
<td>1.104</td>
<td>62</td>
<td>1.015</td>
<td>92</td>
<td>0.960</td>
<td>155</td>
<td>0.862</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1.093</td>
<td>64</td>
<td>1.011</td>
<td>94</td>
<td>0.957</td>
<td>160</td>
<td>0.855</td>
<td>260</td>
<td>0.736</td>
</tr>
<tr>
<td>30</td>
<td>1.078</td>
<td>68</td>
<td>1.007</td>
<td>98</td>
<td>0.953</td>
<td>165</td>
<td>0.848</td>
<td>270</td>
<td>0.726</td>
</tr>
<tr>
<td>35</td>
<td>1.060</td>
<td>70</td>
<td>1.003</td>
<td>100</td>
<td>0.946</td>
<td>170</td>
<td>0.841</td>
<td>280</td>
<td>0.716</td>
</tr>
<tr>
<td>40</td>
<td>1.043</td>
<td>72</td>
<td>1.000</td>
<td>105</td>
<td>0.938</td>
<td></td>
<td></td>
<td>290</td>
<td>0.707</td>
</tr>
<tr>
<td>42</td>
<td>1.036</td>
<td>74</td>
<td>0.997</td>
<td>110</td>
<td>0.930</td>
<td>180</td>
<td>0.835</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>1.029</td>
<td>76</td>
<td>0.994</td>
<td>115</td>
<td>0.922</td>
<td>185</td>
<td>0.828</td>
<td>310</td>
<td>0.668</td>
</tr>
<tr>
<td>46</td>
<td>1.022</td>
<td>78</td>
<td>0.989</td>
<td>120</td>
<td>0.914</td>
<td>190</td>
<td>0.822</td>
<td>320</td>
<td>0.680</td>
</tr>
<tr>
<td>48</td>
<td>1.015</td>
<td></td>
<td></td>
<td>125</td>
<td>0.906</td>
<td>195</td>
<td>0.815</td>
<td>330</td>
<td>0.671</td>
</tr>
</tbody>
</table>

Example:
Blower operating at sea level with vacuum of 89.3” H2O at ambient temperature of 76°F.
At this temperature, vacuum is 89.3” x 0.989 = 88.3”
Variation in frequency (50 vs. 60 Hz) has a relatively minor effect on the series wound motor. There will be a very slight increase in performance at 50 Hz as compared to 60 Hz operation. However, this is well within the motor to motor variations and is generally not considered.

Relative Humidity will have a minimal effect on corrections to standard conditions. While this is taken into account in correcting data in the Lamb laboratory, the effect is so small that it can be disregarded when conducting normal tests on vacuum motors.
Rating Methods for Vacuum Cleaners

- Watts
- Peak Horsepower (PHP)
- Amps
- Sealed Vacuum
- Air Watts (Air Power)
- Cleaning Effectiveness Per Amp
Watts

- Popular rating method in Europe and Asia
- Measure of the input watts to the cleaner at the Maximum Normal Load operating point
- Agencies typically allow up to a 15% variance in input watt levels
- This is a measure of the input power to the cleaner, not the output or the work done.
- Rule of thumb to calculate cleaner rating watts
  - Determine input watts at 13mm orifice
  - Divide that number by .85 to determine estimate of cleaner rating using that motor
Peak Horsepower

• Has been a popular rating method for canister cleaners in North America
• Tests the motor only, no fans installed
• Peak torque of motor is measured at a point where the motor never operates
• Peak torque level normally occurs during the first few cycles of input power when inrush current is highest.
• Speed at which this occurs is approximately 7500 RPM
Amps

- Popular rating method for upright cleaners in North America
- Similar in concept to using watts for rating
- Agencies typically allow a 15% variance in establishing the rating point
- Measures the input power to the cleaner only
Sealed Vacuum

- Has been a popular rating method for central vacuum cleaners in North America
- This is the amount of suction at the sealed inlet condition
- Artificial method as there is no air movement and, hence, no work is being done by the cleaner
- Easy to demonstrate and explain
- Very frequently misunderstood by the consumer
Air Watts

• This method measures the work being done by the motor in the appliance.
• It is the measure of the air power available to perform cleaning functions at the normal operating point.
• The term is not at all well understood by either:
  • The floor care industry
  • The consumer
• It is very confusing since it cannot easily be explained or demonstrated.
• Air Watts is calculated by the following formula:
  • Air Watts = vacuum X CFM X constant factor of 0.118
Cleaning Effectiveness per Amp

• This method was developed by Hoover in the USA as a means of reporting a more meaningful measure of actual vacuum performance.
• The rating is a combination of input power (in Amps) and the air watts generated by the fan system.
• The resultant number rating is typically higher than the input power at the Maximum Normal Load rating point.
• The method has proved to be somewhat confusing to consumers who interpret the rating number as the actual power (amps) consumed by the appliance.
Manufacturers sometimes use combinations of vacuum motors to enhance the performance capabilities of their appliances over those using a single motor.

**Air Series** applications have one vacuum motor feeding its discharge air into the inlet of the second motor. This configuration typically increases the vacuum level over a single motor.

**Air Parallel** applications have two motors drawing air from a single plenum chamber and typically increases the air flow over that of a single motor.
Air performance Comparison: Single Motor plus 2 motors in air series and air parallel

(Projection of motors only, not in cleaner)
Air Watts Comparison: Single Motor plus 2 motors in air series and air parallel

(Projection of motors only, not in cleaner)
The vacuum motor must be protected from dirt and debris being ingested into the fan system. Lamb does not recommend one method over another as that is dependent on the design of the manufacturer’s appliance.

Evidence of excessive dirt, debris or moisture in the fan system or elsewhere on the motor will result in the unit being declared out of warranty. It is the appliance manufacturer’s responsibility to provide a system that will adequately protect the motor.
Filtration Requirements

In order to get the maximum life from a Lamb vacuum motor, it is essential that adequate filtration methods be employed in the appliance. Dirt and other debris getting into the fan system will create problems that will contribute to premature failure and lead to the following:

- Damage to the fan system
- Imbalance of the fan system
- Loss of performance
- Bearing problems
- Commutation problems
Filtration Methods

Paper Bags: used extensively in upright, canister and in some central vacuums. They are convenient and easy to use as the bag is simply thrown away when full.

Self Cleaning Cloth Filters: Popular in central vacuum systems, these filters provide a level of self cleaning as the bag rises and falls when the vacuum is turned on and off during operation.

Cyclonic Filtration: Popular in central vacuums and in some newer uprights and canisters. The cyclone system causes the larger particles to drop out of the air into the collection tank while fine dust will pass through the motor.
The ACUSTEK® Low Noise Bypass line of vacuum motors incorporates a number of innovations from the Lamb engineering group that significantly lowers and changes the audible noise levels emitted by the motor.

The design features a special fan bracket and diffuser plus a baffle. This arrangement directs the air in an orderly manner out of the fan housing. The reduction in turbulence of the air contributes to lower noise.

A special grid design of the vent fan cover inlet area reduces noise generated by that component. That cover has been incorporated on all 5.7” bypass motors.
Product Review

ACUSTEK Low Noise Bypass Components

- Ventilation Cap Air Inlet
- Diffuser
- Baffle
- Fan Bracket
Inrush Current / Locked Rotor Current

Inrush current:
The current level when a series wound universal motor is initially energized is very high. The current level at this point reaches levels approximately 10 times the level of normal operation at the 1/2” orifice point. This inrush lasts for only a few cycles (AC power) but can cause nuisance tripping of circuit breakers.

Locked Rotor Current:
The current level in a series wound universal motor reaches levels of approximately 5 times that of normal operation at the 1/2” orifice point. This would occur in cases of a fan failure where the armature seized.
Vacuum cleaners used to clean aircraft utilizing the 110 volt, 400Hz power on board require special brushes and a rectifier to convert the 110 volt AC power to 110 volts DC. If normal brushes developed for use on 110 volt 50/60 Hz power are used, life will be poor and the customer will not be satisfied. Typically, one brush will wear more quickly than the other and this will lead to premature failure. Special brushes are required for use on high voltage (110) DC power that have a high copper content. Use of the Lamb kit 815737 will assure normal life in applications running on 400 Hz AC power.
Lamb motor model numbers can be expressed in several different ways:

- Abbreviated
  - 115961 could be marked **961**
  - 116213-00 could be marked as **6213-00**

  OR

- Full model number
  - 116213-00 would be marked as **116213-00**
Motor Date Codes

On the body of the motor, the production date code is marked. The code is 6 digits, followed by the letter “F”.

380999F

The first 2 digits, 38, identify the final inspector on the line. The next 4 digits, 0999, indicate the month and year of production. The motors are post dated by three months. Therefore, this motor would have been built in June of 1999. The letter F indicates that the motor is component recognized by Underwriters Laboratories. Lamb does not put other agency approval markings on its products.
Lamb’s patented air seal bearing protection system was developed to protect the fan-end bearing from moisture and detergents in the vacuumed air system of bypass vacuum motors. The need for such a system came with the development of the JHWE carpet cleaning market.

By providing a positive pressure in the area of the lower bearing, contaminants that are in the vacuumed air are kept away from the bearing. This system has been proven to enhance overall life of the bearing.
Air Seal Bearing Protection Operation

Air enters through a hole in the fan bracket, drawn in by a separate fan. This creates a positive pressure around the lower (fan end) bearing of the motor and keeps moisture and foam away from the bearing during operation.

The air enters behind a baffle and as it exits, the velocity and pressure in that area keeps moisture away from the bearing.

A rubber check valve keeps moisture from getting back into the motor in static conditions. This system has been very effective in extending bearing life in wet applications.
Air Seal Bearing Protection

- Armature
- Fan Bracket
- Bearing
- Baffle
- Air Seal Fan
- Air Entry
- Check Valve
- Screen to keep debris out of fan
- Air seal fan discharge
Power is transferred from the field to the commutator through the carbon brushes in a series wound universal motor. There are many different grades of carbon that are utilized in Lamb vacuum motors.

The type and grade of carbon selected for each model is determined by a number of factors, including:

- Power level of the motor
- Supply voltage
- Life requirements
- Duty Cycle
Commutation
Some level of sparking is tolerable and normal in series wound universal motors.

A thin line of white or yellow sparks at the trailing edge of the brush is normal.

There is concern if the sparks:

• extend under the brush
• cover more that half a bar on the commutator
• changes in intensity
• have the color change to blue or green
• extend around the commutator
Carbon Brushes

Commutation

• Excessive sparking causes heat. High temperatures will cause the system to fail.
• During normal operation, a film of carbon is deposited on the commutator. This film is continually being deposited and worn away.
• The uniformity of the film color is more important than the color of the film.
• Streamers of pink sparks will not cause problems.
• Orange or red sparking indicates that the brush is in an over load condition, possibly caused by design, low humidity or bad commutating conditions.
Interrupter Brush Mechanism

This brush has an auto-stop device that stops the motor before damage is done to the commutator. There is a nylon plunger and spring in front of the shunt that breaks the electrical connection before the shunt contacts the commutator.
# Product Review

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Acceptable</td>
</tr>
<tr>
<td>1</td>
<td>Acceptable</td>
</tr>
<tr>
<td>2</td>
<td>Acceptable</td>
</tr>
<tr>
<td>3</td>
<td>Acceptable</td>
</tr>
<tr>
<td>4</td>
<td>Acceptable Minimum</td>
</tr>
<tr>
<td>5</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>6</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

**Scale 0:** Block Entirely Free of Sparks

**Scale 1:** Fine Blue or White Pinpoint Sparking, Just Perceptible

**Scale 2:** Fine Blue or White Pinpoint Sparking, Includes Continuous Sparking that Waves from Point to Point on Brush Face (Approximately 1/32 inch in Length)

**Scale 3:** Moderate Blue or White Intermittent Sparking (Approximately 1/32 inch in Length)

**Scale 4:** Moderate Blue or White Continuous Sparking (Approximately 1/16 inch in Length)

**Scale 5:** Heavy Blue or White Intermittent Sparking (Approximately 1/8 inch in Length)

**Scale 6:** Heavy Blue or White Continuous Sparking (Approximately 1/4 inch in Length)
Colors of Nylon Brush Holders

The colors of the nylon brush holder insulators used in Lamb Vacuum Motors help identify the specific brush in production. There are a number of different colors and paint dots employed for this purpose.

Occasionally, it may be necessary to use a different base color if there is a problem with the supply of the proper color of nylon holder. In such cases, a deviation is authorized by engineering. If there is any concern about a motor if the color of the brush holder is different from normal, please contact Lamb for clarification.
Carbon Brushes

Changing Brushes

In changing carbon brushes, care must be taken to ensure that the brushes are fully seated prior to application of full power. To seat the brushes, the following steps must be taken:

• Run the motor at half voltage for approximately 20 minutes. This can be accomplished by using a Variac or other transformer or by connecting two motors in electrical series during the run in period.

• After the brushes are seated, full power may be safely applied
Product Review
Carbon Brushes
Connecting Motors in Electrical Series for Run In

To Power Source
Today, there have been many new grades of carbon introduced for production motors than were available in the past. While it may have been acceptable to use virtually any brush as a replacement part in repair of Lamb vacuum motors in the past, today, it is more important to replace brushes with the original part.

There may be cases of incompatibility between grades of carbon which can hinder life of the replacement brushes. If another grade must be used, the original brush track must be removed prior to run in with the new brushes.
Lamb uses several means of thermal protection in its motors. Normally there are three types used:

**Thermal Protector** (Texas Instruments 2AM device)
- Protects motor for 18 day locked rotor test
- Senses both current and temperature

**Thermostat** (Texas Instruments 7AM Device)
- Primarily used for enclosure protection
- Senses temperature primarily but current is also a factor

**One-Shot Protector**
- Senses both current over load
- Operates one time only, cannot be reset
Thermal Protection in Lamb Motors

Typical Protection Devices

The devices used by Lamb have nominal opening points, usually between 105°C and 130°C.
Thermal Protection in Lamb Motors

The thermal protection device is mounted on the field, in contact with the windings to sense the temperature. The protector is connected in series with one of the power leads and is an automatic reset device. One shot devices are also connected in series with one of the power leads.
Lamb Vacuum Motor Laboratory

The vacuum motor laboratory is the bridge between the engineer’s concept of a motor design and a piece of hardware that is capable of being tested in a customer’s appliance to determine its suitability for meeting the requirement. On the following slides, some of the test equipment is shown to give an idea of what is used at Lamb to test motors.
Lamb Vacuum Motor Laboratory

Vibration test station is used to check the vibration levels of motors. The equipment is similar to that used in production to check motors.
Lamb Vacuum Motor Laboratory

Box Test Station
In this area, Lamb will test the performance characteristics of a vacuum motor. We check the vacuum level and input watts and amps at various orifice points and then calculate curve data.
Lamb Vacuum Motor Laboratory

Dynamometer Test Station is used to evaluate the mechanical characteristics of a motor. In this area, Lamb performs speed-torque testing of various motors.
New Products From Lamb

On the following slides, new product developments from Lamb will be reviewed. They include:

• Infin-A-Tek Switched Reluctance Blowers
• G2K 5.7” Thru Flow and Bypass Motors
• Air Watt Series Bypass and Thru Flow Motors

Plus a number of enhancements to the overall product line.
Switched Reluctance Blowers

The concept of the switched reluctance motor has been known for many years. The motor speed is controlled by switching coils in the stator on and off, thus causing the rotor to move. In early days, the switching was controlled by relays and contact points. It was a cumbersome and relatively unreliable system. With the advent of microprocessor controls, the switching sequence is much more rapid and reliable. Motor speeds of 20,000 RPM are possible with the coils in the stator being switched on and off at rates in the range of 70 times per second.
Motor Torque is produced by maximizing the inductance across an air-gap between salient poles in alternating phases.

Electronic microprocessor control switches the motor phases to control the timing, shape and duration of the current pulses.

Power control electronic advancements allow high power/speed switched reluctance circuits.

Commutation is controlled with a optical transducer which supplies rotor position and speed information to the control.

Software is programmed in the PIC section of the control board and determines the nature of the motor output.
SR—Most Simple Brushless Approach

Rotor
- Rotor consists of a lamination stack on the shaft with no windings
- No magnets are required
- Rotor lamination constitutes two of the salient poles

Stator
- Stator consists of two pairs of bobbin wound coils mounted on a lamination core provide stationary salient poles
- Bobbin provides continuous cylinder around rotor for noise reduction
Electronics

- Electronics design more simple than PM with fewer switches per phase
- Overall electronic component count much less than PM

Software

- Software management reduces size of external devices required to meet European harmonics requirements.
- RFI emissions not fully analyzed
- Software simplifies addition of special control features
Switched Reluctance Blowers

Mother / Daughter Board Control Approach

- Primary Control Features on Main Electronic Board
- Basic Intelligence for Features Located on the Main Control Board
- Certain Control Features on Plug-in Daughter Board
- Special Control Features for the Industrial and Commercial Vac markets will be included in an add-on package to be mounted on the outside of the motor/blower assembly
Switched Reluctance Blowers

Control Features

The following control features are being considered for incorporation into the blower design:

- Low Voltage (on/off for central vacuum)
- Speed Control (remote)
- Maintenance timer (signal user when time for service)
- Full bag sensor
- Vibration sensor
- Performance curve shaping (match blower output to the application)
- Power burst
- Speed output signal
Product Review

7.2” Switched Reluctance Blower

Basic System Design
Switched Reluctance Blowers

**Stator**

The switched reluctance stator has 4 wound bobbins placed at 90° around the core. The poles are offset slightly from being square with the core. This helps to improve the noise and performance of the blower during operation.
The switched reluctance blower motor rotor is very different from a series universal motor armature. It does not have any magnet wire but is simply a core of laminations stacked on a shaft. The special shape has been designed to improve noise characteristics.
Switched Reluctance Blowers

Controller

The electronic controller uses a microprocessor to switch power to the coils in the stator at up to 70 times per second to run the blower in the range of 17,000 RPM. The basic operation is controlled from the main board and special features can be included in the design.
Product Review

Controller

Daughter Board

Main Control Board

Heat Sink

Power Leads
Switched Reluctance Blowers

7.2” (183mm) Infin-A-Tek® Bypass Blowers

Structure
Inside Rotor Infin-A-Tek® Motor & Control, Three Stage Version of Premier model 117500, Control Features & Protection Features

Performance
150” Sealed, 565+ Air Watts, >5,000Hr

Markets
Central Cleaning Systems, Industrial Cleaners, Dust Collection Systems
Switched Reluctance Blowers

230 Volt 7.2” (183mm) Infin-A-Tek® Bypass Blowers

Structure
Inside Rotor Infin-A-Tek® Motor & Control, Three Stage Version Premier model 117501, Control Features & Protection Features

Performance
132” Sealed, 425 Air Watts, >5,000Hr

Markets
Central Cleaning Systems, Industrial Cleaners, Dust Collection Systems
Please note that the performance level of the 230 volt SR blower is somewhat below that of the 120 volt unit discussed earlier. The level of EMC emissions from the blower is the principal reason that the performance has been lowered from that of the 120 volt design. If the performance at 230 volts were at the same level as the 120 volt blower, it would not be possible to suppress the emission levels effectively with an add-on package that is included with the blower.
Vac / Flow
230 Volt SR
vs.
117728-00
and
117501-12

Vacuum / Airflow comparison
E-11963-2A; 117501-12; 117728-00
Switched Reluctance Blowers

Air Watts
230 Volt SR

vs.
117728-00

and
117501-12

Air Watts Comparison
E-11963-2A; 117501-12; 117728-00
Vacuum / Airflow comparison
120 V vs. 230 V
SR Blowers

120 V SR
119389-13

230 V SR
E-11963-2A
Product Review

SR Air Watts--120V vs. 230V

Air Watt Comparison
120 V vs. 230 V SR Blowers
Switched Reluctance Blowers

Low Voltage Bypass Blowers
5.7” (145mm) and 7.2” (183mm)
Infin-A-Tek ®

Structure
Inside Rotor Infin-A-Tek® Motor & Control, Three Stage
5.7” Bypass, Two Stage 7.2” Bypass

Performance
80” Sealed, 250 Air Watts, 5,000Hr, 24 and 36 Volts

Markets
Automatic Scrubbers, Riding Floor Machines, Other DC Powered Vacuum Applications
Product Review

5.7” Low Voltage Switched Reluctance Blower

Features:
- ACUSTEK Fan Bracket
- Steel Mounting Flange
- 24 or 36 Volt DC input
- 3 Fan Stages
Vacuum/Airflow Performance
Low Voltage Series Mtr. Vs. SR

Vacuum / Airflow comparison
Model E-11516-2 SR blower vs.
Model 116514-13 (at 24 Volts DC)
Air Watt Performance
Low Voltage Series Mtr. Vs. SR

Air Watts Comparison--
116514-13 vs. E-11616-2 (24 Volt SR)

Orifice Diameter (Inches)
Air Watts
Model 116514-13
Model E-11516-2
7.2” Low Voltage Switched Reluctance Blower

Features:
- Tangential Discharge
- Mounting same as 7.2”
- 24 or 36 Volt DC Input
- 2 Fan Stages
Vacuum/Airflow Performance
Low Voltage Series Mtr. Vs. SR

Vacuum / Airflow comparison
Model E-11912-2 SR blower vs.
Model 117504-13 (at 24 Volts DC)
Product Review
Air Watt Performance
Low Voltage Series Mtr. Vs. SR

Air Watts Comparison--
117504-13 vs. E-11912-2 (24 Volt SR)
The new Lamb G-2000 series of vacuum motors includes both thru flow and bypass designs. They employ thermoset fan and commutator brackets, dual ball bearings, leadless automated field construction and uninsulated brush holders.
**Product Review**

**GO2K**
Generation 2000 Vacuum Motors

- Thermoset Commutator Bracket
- Uninsulated brush mechanism
- New brush connection
- Leadless terminal for power connection
- Ground connection through top bearing
- Terminal board automated field construction
- Thermoset Fan Bracket
Product Review

G2K and Conventional Motor Designs
Ground / Earth Connection:

In the G-2K series of Lamb vac motors, the connection to earth or ground is made through the top bearing of the motor to the armature. This method is the same as is used on the Lamb Series 84 (Redesigned) 7.2” (183mm) motors. The method has been approved by regulatory agencies world wide.
Brush Connection:

in the new G2K series of motors is made by means of a brass tab that contacts the uninsulated brush holder and attaches to a tab terminal on the field terminal board. This method provides a more positive connection than that used on the conventional Lamb motor designs.
Conventional fields are wound on manual or automatic equipment. Finishing is manual and includes lead attachment, forming and taping. Varnish is done by dipping and baking.

The new G-2K fields are made on automatic equipment and eliminate the need for the hand finishing operations. Varnish is accomplished by use of special coated wire that is heated to fuse the wires.
Commutator Brackets and Brush Mechanisms

Thermoset comm and fan end brackets are used in the G2K series as well as uninsulated brush mechanisms. This picture shows the comparison of G2K and conventional commutator brackets, brush mechanisms, connectors and retainers.
Low Voltage G2K Motors

The low voltage models in the G2K series incorporate a thermoset commutator bracket, uninsulated brush mechanisms and modified field construction. The armature utilizes a tang-wound construction which improves manufacturing productivity and magnet wire connection. Life expectancy is equal to older designs.
Brush Connection

In the low voltage G2K motor construction, the clamp that retains the brush is crimped to the field coil making a very positive connection that is able to handle the high current levels of these motors. The uninsulated brass of the brush mechanism promotes cooling of the brushes during operation.
While the G2K design incorporates an uninsulated brush mechanism, there may be applications which will require protection of the entire brush mechanism with insulating material. Lamb has tooled a protective cover that slides over the brass which locks under the vent fan cover. With these covers in place, it will not be possible to touch live electrical parts of the motor with the UL probe.
To facilitate introduction of the G2K series of motors, Lamb has prepared agency advisory letters which outline the electrical characteristics of the new models in comparison to the models that they are intended to replace. Typically, agencies such as UL and CSA accept the testing and statements from Lamb and waive the requirements for any in-product testing prior to approving use of the new models. Agency activity generally only involves updating your approval file(s) and is normally done at minimal cost.
Lamb’s new **Air Watt Series** of vacuum motors has been developed to provide a significant increase in the air watt performance of vacuum motors plus reduce the number of fan stages in the motor.

A tapered fan system, along with the enhanced efficiency of the new design of the fan bracket has made this new series of motors feasible. It is now possible to provide motors that deliver substantially higher air watts in smaller packages.

The following slides outline the design and performance capabilities of this new line of motors.
Product Review

Air Watt Series Fan Bracket (Top)
Product Review

Air Watt Series Fan Bracket (Bottom)
Model 116765-00 is Lamb’s most popular three-stage vacuum motor used in the central vacuum and other markets. Lamb has developed a new, two-stage, tapered fan unit that surpasses the air watt and efficiency levels of model 116765-00.

Sealed vacuum of the new two-stage motors does not equal that of the three-stage motor but vacuum and air flow performance at the normal working orifice points within the cleaner is significantly above that of model 116765-00.
Product Review

Air Watt Series Bypass Motors

3-stage 5.7” Tangential Discharge Vac Motor

Air Watt Series
2-stage 5.7” Tangential Discharge Vac Motor
Vacuum / Airflow comparison--model 116765-00 (3-stg) vs. E-11976-2A (2-stg)
Air Watts Comparison--116765-00 (3-Stg) v s. E-11976-2A (2-Stg)

- **Orifice Diameter (Inches)**
- **Air Watts**

Graph showing the comparison between E-11976-2A and 116765-00 for different orifice diameters.
Model 116472-00 is a very popular two-stage vacuum motor used in the central vacuum and other markets at the lower end of the performance range. Lamb has been able to build a new, single-stage, tapered fan unit that surpasses the air watt and efficiency levels model 116472-00.

Sealed vacuum of the new single-stage motors does not equal that of the two-stage motor. However, vacuum and air flow performance at the normal working orifice points within the cleaner is significantly above that of model 116472-00.
Product Review

Air Watt Series Bypass Motors

2-stage 5.7” Tangential Discharge Vac Motor

Air Watt Series
1-stage 5.7” Tangential Discharge Vac Motor
Vacuum / Airflow comparison—model
116472-00 (2-stg) vs.
E-11975-2 (1-stg)

Air Watt Series
Air Watts Comparison--116472-00 (2-Stg) v s. E-11975-2 (1-Stg)
The concept of the air watt series of bypass vacuum motors has also moved into the low voltage product line. Lamb has developed a single stage motor that is able to surpass the vacuum / airflow performance of a 2-stage model 116157-00 while maintaining relatively constant input power. The air watts performance of this new model is significantly higher than the older 2-stage unit, providing an advantage in increased cleaning power in the application.
Low Voltage Air Watt Series

145mm Bypass--2-stg vs 1-stg

Flow-cfm

Vacuum-in. H2O

36vdc

2 stage
Ref. 116157

1 stage
Ref. 116158-ST

5/8" orifice

3/4" orifice

7/8" orifice

1" orifice

1 1/8" orifice
Low Voltage Air Watt Series

145mm Bypass--2 stage vs. 1 stage

36vdc

1 stage

2 stage

input amperage-amps

flow-cfm
145mm Bypass--2 Stage vs. 1 stage

Output Air Watts

2 Stage Ref. 116157
1 stage Ref. 116158-ST

36vdc

2 Stage Ref. 116157
1 stage Ref. 116158-ST

flow-cfm

Low Voltage Air Watt Series
New 1-stage BP

Conventional 2-stage BP
Lamb has developed a new line of high performance single stage Thru Flow vacuum motors that offer the following advantages for use in Back Pack Cleaner designs:

- High air flow and suction performance
- Lighter weight than some other conventional models
- Tapered fan system provides improved air watts and overall efficiency over standard models
- Available in 120 /230 / 240 volt designs
- Present product offering is in 5.7” (145 mm) diameter fan system but, other diameters can be produced
Product Review

High Performance Single Stage TF Motors

Model 119489-00
High Performance Single Stage TF Motors

Model 119489-00 vs. Model 115923
New Single Stage TF Motor--Vacuum / Airflow

Vacuum / Airflow comparison E-11625-2A (1-stg TF) vs 2-stg 115923 and 116311-00/01
New Single Stage TF Motor--Air Watts

Air Watts Comparison
1-stg E-11625-2A vs. 115923 and 116311-00/01 (2-stg)
Lamb is in the development stage of a new extruded inlet tube for its vacuum motors. The tube and fan shell will be one piece and will eliminate the secondary operation to attach a separate tube. Both the tube and the attachment operation are quite costly. Designs for both flat and tapered fan shells are planned.
Contact us to ask information about our products:

Rotina Group
E-Mail: info@rotinagroup.com
Internet: www.rotinagroup.com
Tel: +65 – 6383 8511
Fax: +65 – 6383 8611