A.O.Smith Motor Master y University

HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION MOTORS

GENERAL PURPOSE MOTORS

SPECIAL PURPOSE MOTORS

APPLICATION

INCLUDES:

APPLICATION INFORMATION

TROUBLESHOOTING

OTHER MODULES INCLUDE:

PUMP MOTORS

NOTICE: *The information contained in this booklet is general in nature and is drawn from sources believed to be reliable. It is intended for general information purposes only. The descriptions in this booklet may not apply to a particular motor or a particular application. No warranties are intended to be created by this information.*

Contents

Heating, Ventilating, Air Conditioning & Refrigeration (HVAC&R): General Purpose & Special Purpose

Introduction

This application guide is not intended to be a repair manual for any of the equipment described. It is intended to provide general knowledge to persons working in fields related to electric motors and to provide service information to qualified persons.

Motors are of little use by themselves. They are designed to be coupled to some other part and convert electrical energy into mechanical energy.

The selection of a replacement motor for a specific application would be a very involved process if it were necessary to start with the basics of magnetism, electricity, and motor construction each time a replacement was required. In order to present replacement motor offerings in a logical, orderly manner, the motors are grouped by type, construction, and often, the application for which they are intended.

Motors in original applications are designed to be operated under specific conditions. If the equipment or installation is modified, the motor may be overloaded. For example, if a furnace designed for use in a home with duct work is placed in a shop and has little or no supply duct work, it may be close to a free blow condition (no static pressure or resistance to air flow). The motor may become overloaded.

A.O. Smith's replacement motor selections are identified by applications where possible. This makes it easier to narrow the choices in the selection process.

Heating , Ventilating , Air Conditioning & Refrigeration (HVAC&R)

HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION (HVAC&R)

Heating and air conditioning applications often use the same types of motors or share the same motors if the systems are combined. Heating systems using motors heat either air or water. Once heated, the air or water is moved by a motor and blower or motor and pump.

All air conditioning systems using motors within the scope of this manual use essentially the same principles. The components may look different depending on the system capacity and configuration.

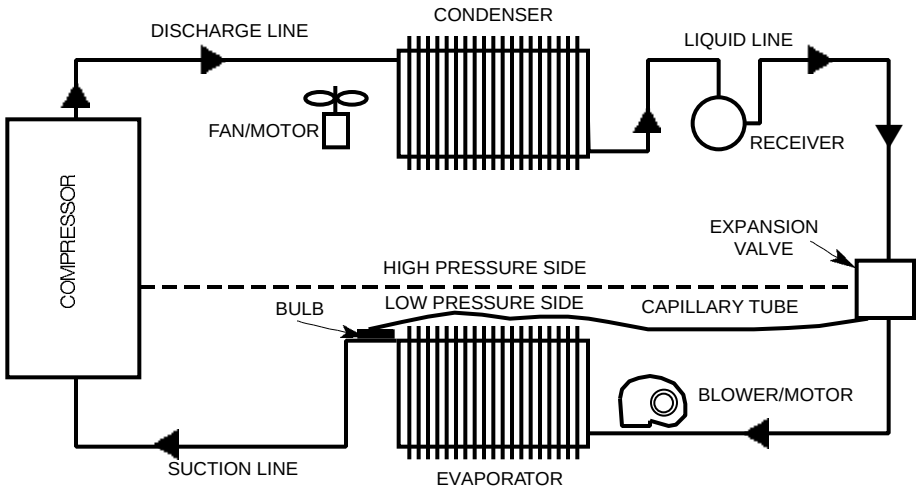
The Refrigeration Cycle

THE REFRIGERATION CYCLE

The refrigeration cycle involves a number of physics principles to convert energy from one form to another, and to transfer that energy from one point to another.

One of the principles in the change of state. Just as it takes energy to change ice at 32 degrees fahrenheit to water at the same temperature, energy transfer is required to change the state of a refrigerant.

The diagram below describes the refrigeration cycle. Simply stated, electrical energy in the case of an electrically driven compressor, compresses the refrigerant gas and causes it to move through the system where it changes from a gas to a liquid and back. In addition to the changes in gas volume, heat is added or taken away at different points in the process.



REFRIGERATION DIAGRAM

Hermetic Compressor s

Hermetic Stator/Rotor

Electrical energy is converted to mechanical energy by the compressor motor. The compressor draws a refrigerant gas from the evaporator, compresses it and sends it to the condenser where it is liquefied. Refrigerant gas entering the condenser is full of heat picked up from the previous cycle plus heat from the compression cycle. In the condenser, heat is removed from the refrigerant and it returns to the liquid state. An expansion valve controls the flow of refrigerant between the condenser and evaporator. The temperature of the gas entering the evaporator is lower than that of the air to be cooled. Heat is removed from the air to be cooled. This heat is absorbed into the liquid refrigerant causing a change of state back to a vapor. The cycle continues until a thermostat senses that the desired temperature has been reached and shuts the system down.

HERMETIC COMPRESSORS

The motors and other components of the system operate in a closed system and must be compatible with each other. Compressors are designated as hermetic or semi or accessible hermetic depending on the type of construction. The word hermetic means an airtight seal or sealed from outside elements. Typically, home refrigerator, room air conditioner, home air conditioner, and small commercially applied compressors are in a welded shell, leading to the hermetic designation. Larger commercial compressors use castings and other parts, similar to an automobile engine, which are bolted together and get the designation accessible hermetic.

The function of both types is essentially the same. Due to the initial cost of the larger systems, parts may be salvaged and used in rebuild or remanufacturer operations.

Hermetic motors are used in hermetic compressors. The sealed system contains a refrigerant gas and lubricating oil.

Hermetic motors are functionally the same as other types of motors except that the housing, bearings and shaft are provided by the compressor manufacturer. These motors are often referred to as rotor/stator kits. Single phase versions are often of the permanent split capacitor (PSC) type which does not require a starting switch. Systems using PSC compressor motors often have “Dual Can” capacitors which are two separate capacitors in one housing. One capacitor is used for the compressor and one for the fan motor.

A.O. Smith has a selection of hermetic rotor/stator kits for rebuild and remanufacture operations.

HVAC&R Application Basics

HVAC&R APPLICATION BASICS

Many motors for heating, ventilation, air conditioning and refrigeration applications are designed special purpose. Knowing the application makes it possible to begin the selection process at a point where the possible replacement will likely be found. An understanding of the application will help assure that the best possible selection is made.

A heat pump performs the same functions as an air conditioning system, but contains a valve which changes the refrigerant flow and in effect changes the evaporator into the condenser and vice versa. In heat pumps the coils are commonly called the indoor and outdoor sections. In the heat pump mode, heat is removed from the indoor coil and added to indoor air, and heat is added in the outdoor coil. Heat is present in all substances including air and water until absolute zero is reached at which point all molecular activity stops. As an example, air at 30 degrees fahrenheit may seem cold but it is warmer than air at 20 degrees fahrenheit because it contains heat.

Because they incorporate a change of state of the refrigerant, it is possible for heat pumps to be more efficient than straight resistance heat. This efficiency is expressed as a measure of watts input to BTU output. A heat pump's efficiency decreases as the outside temperature decreases. Electric resistance strip heat is often incorporated into heat pump systems and is activated when the heat pump cannot meet the demand for heat.

Some systems use water instead of air as the heat transfer medium in the outdoor section. The water may be a constant source in a drilled well or a flowing source. Heat pumps are also used to transfer heat to swimming pools.

In systems using air as the heat transfer medium, fans driven by electric motors are used to move air over the evaporator and condenser coils, facilitating heat transfer. Propeller fans are the norm on the outside sections with blower wheels used indoors.

OUTDOOR SECTIONS—RESIDENTIAL

Enclosed motors are widely used in new outdoor installations. The use of enclosed replacement motors has risen dramatically in recent years. The service person may use one motor for both enclosed and open applications, reducing inventory dollars. Even though a motor is totally enclosed, it still needs to breathe and have a place for moisture to drain. Replacement motors typically have drain holes in both end frames. A plug is required in the hole on the top of the motor as installed. If a motor has two plugs, the one on the bottom should be removed. If only one plug is provided, it should be installed in the top hole.

If it is possible for rain or other moisture to accumulate on the motor leads, the leads should be placed to form a drip loop so the moisture will not drain into the motor's other components.

Almost all units being built today have 60 degrees celsius (140 degrees fahrenheit) fan motors on the hot side of the coil. The ambient or outside air is pulled through the coil, picking up additional heat before it passes over the motor. If the ambient air is first drawn over the motor and then pushed through the coil, the motor has a lower operating temperature.

If a motor rated 40 degrees celsius (104 degrees fahrenheit) is installed on the hot side of the coil, nuisance tripping may occur, especially in high ambient situations.

Motors used on residential systems are usually sleeve bearing. Light commercial units which look just like the residential units may have ball bearing outdoor motors. The motor should definitely be a special ball bearing design if a speed control device is used.

Outdoor Section—Residential

FSE1036
Totally Enclosed Outdoor Sleeve Bearing Fan Motor

FE1036
Totally Enclosed Outdoor Ball Bearing Fan Motor

FS1037S
Closed Except Lead End
Outdoor Sleeve Bearing
Fan Motor

Motor usage is heavily weighted to six pole (1075 RPM) designs, followed by eight pole (825 RPM) then four pole (1625-1725 RPM) units. Two speed motors are used on some units to reduce operating speeds and costs when lower ambient temperatures do not require as much air flow over the coil.

Since the horsepower required for the fan varies directly as the cube of the speed, a six pole motor cannot be used to replace an eight pole motor. Depending upon the static conditions, the same fan blade may require almost three times the horsepower to run at 1100 RPM as it does at 825 RPM.

Lug Mount Adapter Bracket

Typical mountings are lug, belly band or extended motor thru bolts. Some motors use screws in tapped holes in the main frame to attach mounting strips or cables.

Blocked coils reduce air flow to cool the motor and can cause an overload condition.

Fans may be statically balanced, but dynamically out of balance due to bent blades. This condition may lead to bearing failure.

The term split system refers to units with separate indoor and outdoor sections connected by refrigerant line. Packaged units as the name implies, have all the components in one place. Room air conditioners, commercial rooftop units, PTACS (Packaged Terminal Air Conditioners) and mobile home packs are examples of packaged units. Even though packs and commercial units are entirely outside and only ducted to the inside, they have a physical barrier between the inside and outside sections.

Commercial systems whose components and configurations differ from basic home and commercial packaged and split systems may also use fractional horsepower motors in either indoor or outdoor sections. Fan coil units with a motor and blower wheel(s) are used in systems where chilled/heated water or refrigerant is piped through a building instead of using a central blower and duct work. Some chillers use the same type outdoor fans and motors as rooftop and packaged units.

Motors used in commercial applications such as condensers usually have ball bearing construction because the loads are heavier. Sleeve bearing motors typically are quieter than ball bearing motors and are favored in indoor air moving applications.

Ball bearing motors may be used to replace sleeve bearing motors but not vice versa unless you are certain they will meet all application requirements.

FC1106
"Patented" Fan Canopy
Deluxe Commercial
Condenser Fan Motor

FY3106
56 Frame, 3Ø Totally Enclosed
Ball Bearing Commercial
Condenser Fan Motor

FB3056
Base Mounted, 3Ø
Outdoor Ball Bearing
Condenser Fan Motor

BK1072
Commercial Indoor
Blower Motor

Furnaces

FURNACES

Furnaces generally use motors for three functions: move either heated or cooled air, move fuel, and provide air for combustion. A specific furnace may use more than one motor. High efficiency furnaces capture more of the heat of combustion and use a motor and blower to provide combustion air and exhaust flue gases. These motors are commonly called draft inducer motors. "C" frame and 3.3" are the most common motors used in this application.

EL2002
Reversible Switch Model Oil Burner Motor

Natural gas and propane flow through control valves into the burner area of a furnace under pressure. Oil furnaces use a motor and pump to spray the oil into the burner area. NEMA standard M and N flange motors are common in oil burner applications. Rotation, horsepower and flange type are key elements in motor replacement.

A furnace burns substances such as natural gas, oil, propane, wood and coal. The heat exchanger separates the combustion process from the air in the space being heated. The motor and blower circulate air through the heat exchange in a continuous cycle until the desired temperature is reached. In most cases, a thermostat and control circuit is used to operate the cycle.

The thermostat controls the combustion cycle. The control circuit senses the plenum temperature within the furnace and signals the blower motor to start and stop. This same control circuit also shuts off the combustion process if the blower motor fails to start.

Furnaces are designed as hi-boy or up-flow, counterflow or downflow, low-boy and horizontal, depending upon the space in which they are applied. The motor/blower performs the same basic function in all designs.

A squirrel cage blower wheel powered by a direct drive PSC motor is the most common system now used in residential systems because they are efficient and compact. Six pole (1075 RPM) multi speed motors are now the norm. Some eight pole (825 RPM) motors are also used. Belt driven blowers were common in the past and many are still in use. Four pole (1725 RPM) motors are the most common. Some two speed motors are used in conjunction with electronic air cleaners to provide continuous air movement to reduce drafts. Two speed belt driven motors may have one of two different types of internal switches. One type requires an external relay to switch from high to low and low to high speeds.

FDL1036
High Efficiency Indoor Blower Motor

GF2034
Belt Drive Blower Motor

As mentioned above, three speed, direct drive, permanent split capacitor, 1075 RPM motors are the most common. The speeds are available so that the air flow may be tailored to the installation. Different speeds are needed to move the air depending upon the static pressure in a system. High speed may be used if the system has air conditioning since more work is required to move the cold air which is heavier. Medium speed could be used to move air in the heating mode.

The wire lead from any speed(s) not being used should be insulated separately and secured so that it does not cause a short.

Furnace blower motors are available in both 115 and 230 volt versions. The 115 volt versions are a throwback to the days when most homes did not have 230 volt systems. 230 volt versions are more common today, especially on electric furnaces.

Electric furnaces are a combination of wire strips and an air handler. The resistance of electricity flowing through the wire strips creates heat. The strips heat air which is circulated by the air handler. Electric furnaces use the same type of air handlers and motors as other types of furnaces.

Some furnaces use variable speed motors run continuously. This feature prevents air from becoming stratified and drafts are reduced. Also, with an electronic air cleaner, the air is constantly being circulated.

DL1036
Standard Efficiency Indoor
Blower Motor

Furnace motors are normally of an open construction since they are in a relatively clean, dry and protected environment.

Multi speed direct drive blower motors are normally designed to have at least 100 RPM difference between speeds. It is not possible to know exactly where a given motor will operate on one of the lower speeds unless a loading point is determined. Multiple horsepower ratings and speeds shown on stock motors are offered as a guide and are not exact. It is not possible to determine speed on a bench with a strobe since the motor is not loaded and will operate close to the same speed on all taps. These motors may trip the overload on a bench test since they are not loaded and will run faster than in an application, and do not have the necessary cooling air being drawn over them.

FM1036
Fleximount Indoor
Blower Motor

Most HVAC&R direct drive motors have non-NEMA standard mountings and shafts and have frame suffixes of “Y” or “Z”. This does not mean that stock replacements are not readily available.

In many cases, stock motor shafts will need to be shortened for specific applications. Care must be taken to avoid bearing damage.

FAN COIL UNITS

Fan Coil Units

These units are a combination of a fan, motor and coil in one package. While a package containing these components in a residential, cooling only system could technically be called a "fan coil", usually the term refers to commercial and institutional applications where chilled or hot water is sent through the coil.

A wide variety of product configurations is available. The motor and blower wheel principles discussed under the furnace section also apply here.

One common variety is the classroom type which uses a double shaft extension motor and two blower wheels whose length is large compared to the diameter. Using the small diameter wheels, the desired amount of air may be moved, but the unit does not protrude too far into the room. The same type of motor and blower combination is also found in hotel room units which look like PTACs.

Five inch diameter (42 frame) motors are very popular, but some 48 frame motors are also used. Larger commercial direct drive units typically utilize ball bearing motors.

DBL6409
1050 RPM, 5 Speed Fan Coil Motor, 42 Frame

Room Air Conditioners

Lug Mount Bracket

End Frame Length Adapter Kit

SA1016
Room Air/PTAC Motor

ROOM AIR CONDITIONERS

Like PTACs, room units have all the components in one package. Semi-enclosed motors are common, but many units use totally enclosed motors because of the condensate water coming off the coils. Belly band lug mount kits and resilient mount length adapters are often used with replacement motors.

Motors are single voltage and mostly 230V in units above 9,000 BTU. Some units have a 277 volt rating (sometimes marked 265 volt) which is a single phase power source from a three phase system. The largest percentage of motors are six pole (1075 RPM) permanent split capacitor designs. Some shaded pole motors will be found in the lower BTU unit, but their use has been declining due to low efficiency.

Some 60 cycle units use four pole (1725 RPM) motors which are designed to operate at a slipped down speed in the 1300-1425 RPM range. The unit design requires speeds higher than 1075, but operation at true four pole speeds is not required or desirable from a noise standpoint. These units require a direct OEM replacement.

Be aware that motors rated for both 60 and 50 cycle will have RPMs listed as 1725/1425. The 1425 RPM in this case is at 50 cycle operation, so this motor is not an acceptable replacement for a 60 cycle motor with the RPMs listed as 1425.

PTACS

PTACs

Packaged terminal air conditioning units are similar in construction to room air conditioners. All of the components are in one package. They are common in hotel/motel rooms, small offices and apartments. Strip electric heat is a common option. Heat pump versions are available. Many different manufacturer's units have the same dimensions so they may be used interchangeably in a standard size wall sleeve.

Some PTAC designs use two single shaft motors (one for the condenser side and one for the blower wheel). Designs with one double shaft motor are more common.

Typical blower motors require air over the motor for cooling. The blower motor used on two motor PTACs is on the other side of the unit bulkhead from the blower wheel and does not get the same air flow as a furnace blower motor. An exact replacement should be used, or the unit should be tested at the maximum ambient condition to insure the motor will not overheat.

AIR CURTAINS

Air Curtains

Air curtains move a thin, high volume stream of air from top to bottom in an open doorway to keep the air on the opposite side from mixing. Double shaft motors with blower wheels are commonly used.

Evaporative Cooler s

V2054
Evaporative Cooler Motor

EVAPORATIVE COOLERS

These units which are also referred to as swamp coolers are an alternative to air conditioning in areas where the relative humidity is low enough that the process is effective. They are common in the desert southwest and high desert areas such as Salt Lake City and Denver. Dry air moves over a media pad saturated with water. The moisture laden air is blown through the area to be cooled and exhausted through vents or slightly open windows. As the moisture evaporates inside the space, a cooling effect occurs. This is the same as the cooling effect on your skin when water evaporates after stepping out of the shower.

Most motors used in home units mount in a resilient base and have the same ring to ring dimensions. Replacement motors are often sold without bases since the base doesn't normally fail. Single and two speed units are available.

The motors are connected to the blower wheel with a drive belt. Proper belt tension is 1/2 to 3/4 inch deflection at the center of the belt span.

The motor pulley must be of the type and size recommended by the cooler manufacturer. If an adjustable pulley is used, the pulley should be set by a technician with the necessary electrical test equipment. The adjustable pulley allows the load (blower) to run at a speed compatible with the motor.

To set an adjustable pulley:

1. Open pulley to maximum width and tension belt.
2. Read recommended motor amp rating at the highest speed.
3. Using an ammeter, measure the amps at the highest speed.
4. Stop motor, close pulley one-half turn and retention belt.
5. Repeat step 4 until the amp reading meets but does not exceed the motor's rated amperage.

IMPORTANT: If the amperage exceeds the motor's rating, the motor will overheat and stop.

CAUTION: The motor will restart automatically after it cools and the overload resets.

NOTE: Cooler installations not using duct work will require a smaller diameter pulley than the same cooler using duct work. The duct work creates static pressure or resistance to air flow which reduces the motor load and amp draw.

An easy rule to follow is to check the motor amperage while running on high speed. It should not exceed the nameplate amps.

Motors with all copper windings or a combination of copper and aluminum windings are available. With advances in connection methods and winding insulation, there is little difference in the reliability of either type.

Many motors are sold at retail with the homeowner doing the replacement.

Unit Heater s

UH1036
Ball Bearing, Mounted
Capacitor, Unit Heater Motor

UNIT HEATERS

Unit heaters are the ductless furnaces that hang from the ceilings of factories, warehouses and garages. The motor and propeller fan are usually visible. Enclosed motors are common due to the often dusty environment.

Motors may be either belt drive or more commonly, direct drive. The direct drive are usually 42 or 48 frame designs using thru bolt/extended stud or resilient ring mounts. Replacements are available with and without bases, and PSC types often have the capacitor mounted on the motor.

Hot Water Circulator s

OBG2002

HOT WATER CIRCULATORS

Heating systems that have hot water boilers use a motor driven pump to circulate the water.

These motors have special shaft extensions and mounting brackets.

Whole-House Ventilator s

WHOLE - HOUSE VENTILATORS

The units normally mount in the ceiling, pulling air in through open windows and exhausting it to the attic where it exits through vents. Many older units used open drip proof motors, but most new designs have totally enclosed motors or some type of metal shield to reduce the fire hazard. Belt drive motors are generally four pole (1725 RPM), and direct drive are mostly six pole (1075 RPM).

PEDESTAL FANS

Pedestal fan motors are used to circulate air with a propeller type blade mounted directly on the motor shaft.

Some motors are base mounted, but more common is the yoke mount which is a bracket welded or bolted to the motor frame. Extended motor thru bolts for mounting a fan guard are common.

MISCELLANEOUS

Many applications using small (1/8 HP or less) motors do not have replacement motors available since the unit cost is low. Examples include ceiling or "paddle" fans and window and box fans.

Other applications such as humidifiers, hood exhaust fans, bathroom fans, refrigerators, small room air conditioners and furnace draft inducers may use 3.3" diameter motors. Four pole shaded pole and two pole permanent split capacitor motor with thru bolt mountings are common.

Pedestal Fans

YA2020
Yoke Mount

Miscellaneous

AO1154, 3.3"

AO120, 3.3"

Fan Blade and Blo wer Wheel Basics

FAN BLADE AND BLOWER WHEEL BASICS

The horsepower needed to drive a propeller fan or blower wheel varies directly with the cube of the speed if the static pressure or discharge area does not change.

The propeller fan needs more horsepower if the discharge area is reduced (assuming speed does not change) and the blower wheel needs less. The reverse of these principles also apply.

The principles above have great importance for installed motors,and when selecting a replacement motor. As examples:

- Blocked or dirty coils on an outdoor unit reduce air flow and put more load on the fan motor, possibly causing the thermal overload to trip.
- If a 1075 RPM motor is used in place of an 825 RPM motor, the loading is too high and the motor will not operate.
- It may be impossible to determine if a replacement furnace motor is properly loaded if the access panel(s) is not in place - static conditions have changed.

ROTATION

The selection of a replacement motor obviously requires one that turns in the proper direction for the application. Many single phase replacement motors are dual rotation. Some product groups have motors that are identical except for rotation and other groups or specific motors have the rotation which matches the original OEM offering.

Rotation

Rotation on some double shaft motors may effectively be changed by rotating the motor 180˚. The rotation of any three phase motor is reversed by switching any two of the three line leads.

There are several ways to identify the rotation of a motor in the application.

1. Look at the motor nameplate, connection diagram and physical connection.
2. If the motor has not failed completely and is still operable, observe the rotation and mark the end frame or main frame.
3. Look for a rotation arrow on a propeller fan and blower wheel or housing.
4. Determine which way the air must flow in the unit and then look at the propeller or wheel and housing.

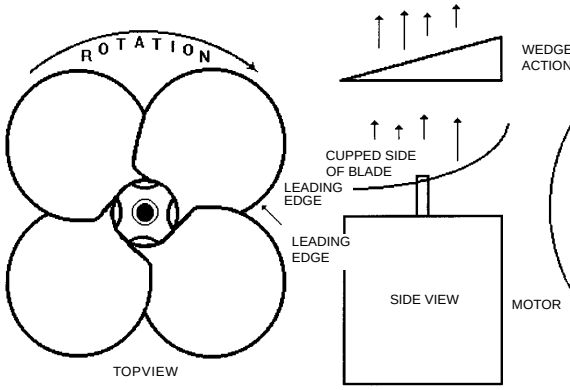


Diagram A

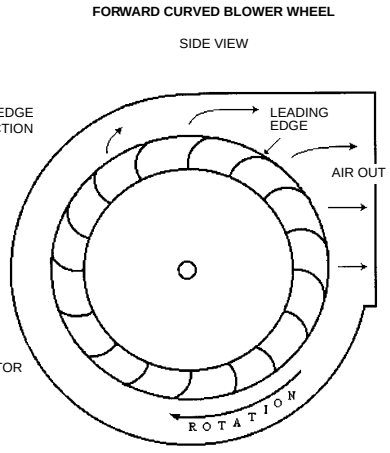


Diagram B

The propeller fan moves air by the wedge action of the blades. If the blades are cupped, air will move away from the cupped side. If the blades are flat (normally they are not) as in Diagram C, air will move in either direction depending upon motor rotation.

The lower edge of the fan blade, as related to the wedge action, is the leading edge just as the thinnest part of a wedge goes in first to split a log.

Blower wheels are centrifugal fans. As with any centrifugal action, the speed is greatest at the outermost portion of the device, in this case, the wheel's outside diameter. The fins may be slanted in the direction of the air flow, but this is not always the case. If the motor and wheel are not together, it will be necessary to determine on which side the motor mounts.

If the motor applied to the blower wheel in Diagram B ran in the opposite direction, air would move in the same direction as shown but not efficiently.

Replacement motors often have rotation letters such as CWLE (clockwise, looking at the lead end) or CCWLE. The letters CWPE (clockwise, looking at the pulley or shaft extension end) are also used on some motors.

Drawing a simple sketch of the motor, fan and unit often helps in the orientation process.

Gener al Purpose Motors

EB3104
3Ø Enclosed
Industrial Duty

RB1074
Capacitor Start
Resilient Base

General purpose motors as their designation indicates may be used in a variety of applications. The designer of a piece of equipment can tailor the load so that a general purpose motor may be applied. The system consisting of the motor and the driven load often has a rating which indicates the standard and maximum amount of work it can do. The ratings may or may not include an overload or safety factor. As an example, a hydraulic pump system used to power a lift has a limit to the amount of pressure it can develop and transfer to other system components. If the lift is rated for 10,000 pounds, and the load is 20,000 pounds, a relief valve must open or the weakest link in the system will fail. The replacement motor should be equivalent to the original design. A weaker motor would not allow the system to operate as designed. And, a stronger motor may create an unsafe condition. In the case of a table saw, the load varies depending upon the type of wood being cut, and the speed of the cut. A 1/2 horsepower motor may be suitable to start and run the saw and cut pine, but it may be okay to apply a 1-1/2 horsepower motor to the same saw in order to cut oak.

The important point here is to select a replacement motor equivalent to the original unless you have enough knowledge of the application to be certain that a stronger, weaker or different type of replacement motor is acceptable and safe.

POWER TOOLS

Pow er Tools

General Purpose NEMA 48 and 56 frame, 2 pole and 4 pole motors are common on contractor and home type tools such as drill presses, jointer planners and table saws. Motors should have manual overloads or no overload. There are no exceptions to this rule - EVER! If a motor had an automatic overload and tripped, it could start unexpectedly after cooling and cause injury.

The information and procedures described in the replacement module of this series will assist in determining that you are dealing with a general purpose motor. Catalog listings of general purpose motors are organized by physical and electrical characteristics to aid in the selection process.

Special Purpose Motors

Following are some examples of special purpose motor applications. Keep in mind that the original equipment was tested to insure that the motor would operate safely and properly under the conditions for which it was designed. Modification or misapplication may be unsafe and detrimental to the motor or equipment.

There are literally thousands of applications using general purpose type motors with mechanical and electrical variations. Each of these variations must be evaluated to determine if a stock motor will work, possibly with modifications, or if a replacement must be obtained from the OEM.

Glass Washers

GLASS WASHERS

Sump pump motors are often used on glass washers used in bars. This use is not condoned by motor manufacturers. A motor designated for glass washer duty should be used and wiring must be done in accordance with all applicable codes and include a ground fault device.

GARAGE DOOR OPENER MOTORS
COMMERCIAL DOOR OPENER MOTORS
GATE MOTORS

Garage Door Opener Motors/ Commercial Door Opener Motors/ Gate Motor s

In general, these motors are excellent examples of good design and application and provide testimony to the reliability of today's motor production processes. If a motor does have a defect that will lead to failure, that failure is most likely to occur early in the warranty period at which time the entire unit is replaced. If a motor fails at some later time, it is usually less expensive to replace the entire unit.

Commercial units utilize reversing switches and are usually serviced by door firms who get their motors from the original equipment manufacturers.

AIR COMPRESSORS

Air Compressor s

Motors used in air compressor applications may be belt drive or direct drive. On direct drive units, the compressor housing usually provides support for the shaft extension end bearing. As such, these are partial motors and replacements are not available in a stock motor line. Belt drive compressors use a more conventional motor with a base and single shaft extension. Horsepower, service factor and RPMs are the keys to identifying a replacement motor. The horsepower and CFM (cubic feet per minute of air) characteristics of compressors are often advertised. Commercial/industrial compressors use NEMA frame motors with identifiable service factors. Hobby compressors often have motors with the service factor marked as special. Special means less than one.

CP1502M

Also, keep in mind that there is a range of performance within the same horsepower rating, depending upon motor type and manufacturer. Check the replacement motor amps after installation to verify selection.

Some electric compressor horsepower ratings have been determined by comparing the CFM to a compressor using a gasoline engine. Since the gasoline engines are not as efficient as electric motors, a compressor may be called five horsepower even though the motor does not actually develop five horsepower. Amps are important in the final motor selection since they determine the required circuit capacity to which the compressor will be connected. A replacement motor with the equivalent horsepower and service factor may not be acceptable due to the efficiency of the original motor. Some motors are capacitor start and run, with more than one run capacitor. A replacement capacitor start only motor may have running amps which are too high.

Carbonator Pump

CB2024A

CARBONATOR PUMP

These motors are used in beverage dispensing systems. The shaft extension is special and designed to mate to the pump. Carbonator pump motors are also used in hydraulic pump applications. Even though the mounting is special, it is uniform among motor manufacturers.

Sump Pump

SP2030A

SUMP PUMP

Motors used on sump pumps may be of the pedestal type and mounted on the end of a support column (1-1/2”ID or 1-3/4”OD), or the immersible type. Most smaller immersible types are not repairable. Key factors in selecting a pedestal type replacement are horsepower, service factor, enclosure, protector/overload and hub dimensions.

Sewage/ Effluent Pumps

SEWAGE/EFFLUENT PUMPS

Motors used in these applications are sealed in a housing and may or may not be repaired or replaced by a qualified service person. The electrical designs are generally similar to stock type motors, but their mounting is special. The original equipment manufacturer should be contacted regarding replacement.

EXPLOSION PROOF APPLICATIONS

Explosion Proof Applications

Motors used in hazardous environments such as flour mills and gas pumping applications require special construction features so that a short or spark in the motor will not ignite flammable liquids, vapors or dust that may be present. The design, manufacturing and application of these motors is subject to Underwriter's Laboratory rules and many other local and national codes.

Many OEM gasoline pump motors have special mounting flanges and on/off switches and are not replaceable by stock type motors.

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Due to the liability potential, recommendations should not be made as to the application of these motors. The person making the purchase should have the training and qualifications to know the exact motor required.

POULTRY DUTY FAN MOTORS

Poultry Duty Fan Motor s

Commercial poultry house fans use both aluminum and steel propeller blades, direct or belt driven, mainly by base mounted motors. The designs are usually totally enclosed, air over (TEAO), meaning they rely on the blade's air movement for cooling air.

It is essential to the chicken's survival that hot, stale air is exhausted.

TRANSFORMER COOLING FAN MOTORS

Tr ansformer Cooling Fan Motor s

These are very specialized direct drive propeller fan motors used to cool large electric utility transformers. They are sometimes referred to as "fin fan" motors. The design is very robust, employing ball bearings and stainless steel shafts. Replacement motors are normally secured through the original equipment channel.

WARNING!
This is not a guide for the do-it-yourselfer.

Motor Troubleshooting Guide

Some procedures require special tools and specific product knowledge which is beyond the scope of this module.

These tips and suggestions are offered for persons with proper qualifications and necessary test equipment, and as information of general interest to persons in the replacement motor distribution channel.

There is not a single listing of motor troubleshooting procedures to be followed in a given order. The procedures will also differ for new and existing installations and motors that are being bench checked. As with anything dealing with electricity, personal safety is the prime concern.

Bench Check

BENCH CHECK

First, consider what symptom lead to the motor's removal from service. Examples: "It was noisy," "it wouldn't start when the power was applied," "it tripped the breaker," "it runs for several minutes then shuts off," "it just hums when power is applied," "smoke came out when it was turned on."

Knowing why a motor failed may be important in selecting the proper replacement motor, and insuring a good service life.

Try to determine the age of the installation and if the motor is the original. If the motor is a replacement, how long has it been in service? Does it appear to have been properly installed? What is the duty cycle or service period?

Having some indication of the problem often indicates items to check first. A bench check is usually a confirmation of a suspected problem. The type of motor and its construction will dictate which items may be checked without disassembly.

The following tips and suggestions are by no means complete, but offer some of the basics relating to a motor and its application. Other modules cover some subjects in more detail, and specific knowledge from other sources may be needed.

- To the degree possible, check the same areas in the application as would be done in a bench test.
- Is there any evidence of water damage?
- Does the shaft turn freely?
- On sleeve bearing motors, check end play (.01-.06" normal). Lack of end play could cause motor to bind when hot.

- On belt driven loads with sleeve bearing motors, check to see that the motor is oriented properly in relation to the bearing's oil wick window.
- Excess heat is the enemy of a motor. If the motor has been operating properly, has anything changed? Is the voltage too high or too low? Is the ambient too high for the motor? Are internal or external fans clean and intact? Has foreign material gotten into the motor? Is normal air flow around the motor blocked, causing recirculation?
- Is there any evidence of physical damage or overheating?
- In applications such as direct drive furnace blowers, the motor needs system air for cooling. There is not a general rule of thumb, but use of a replacement motor significantly stronger than the original may result in overheating. Speed will be up and the system may not provide enough air for cooling. Select a close replacement and check amps after installation.
- Check windings for continuity.
- Check for continuity between motor leads or terminal board and frame as indication of short to ground.
- Check capacitor if capacitor start and/or run.
- Check the overload if accessible.
- If a single phase motor with a mechanical start switch starts but does not come up to speed, check the switch for proper operation. If this same type motor just hums and does not start, check the switch and start winding.

- If motor appears to run okay it may be okay. Or, it may have an internal problem such as loose or plugged cooling fan. It is possible for a winding coil to be shorted onto itself without indicating an open condition. The motor would be weak and probably overheat under load. If the motor has a terminal board, connections could be loose causing intermittent operation.
- Check for phase imbalance on three phase systems.
- Checking a motor in its application is the only practical method for most people to determine performance under load. If the motor is defective, the application provides many clues to help determine the cause . Did the motor fail due to a defect or old age. Or, was its failure hastened by the application or environment? The application is the only place an attempt may be made to check voltage.
- On permanently installed equipment, the voltage may vary depending upon the total system load. It can also vary with the total load on the power company grid.
- Mobile equipment such as rental units are often abused through the use of inadequate extension cords or undersized generators.
- Was the motor misapplied or has the application load change? Dirty or blocked coils may overload a condenser motor. Reduced static pressure may overload a motor driving a blower wheel.
- Is the belt driven load free to turn, and in proper operating condition?

- Most motor applications have service manuals whose procedures, especially those involving safety, should be followed. Within the scope of this discussion, the assumption must be made that the procedures have been followed to the point where the motor is suspected, and proper voltage (nameplate as connected ±10%) is available to the motor.
- In addition to the electrical hazard, an applied motor could be very hot if a start was attempted during other test procedures.
- Always ground motor and secure so starting torque will not cause it to move in bench test.
- Always use the proper tools (not a hammer) to remove fans and pulleys from a motor that is to be reinstalled. Likewise, never pound anything onto a motor shaft. A ball bearing can easily become brinelled or work hardened leading to eventual failure.
- In a new installation of new equipment that does not start, follow the established procedures to the point where a motor check is recommended. The procedure is basically the same for a replacement motor on an existing application except the case where the motor burned out as soon as the power was applied. In this case, the motor was probably hooked up wrong.
- On a replacement motor there is slight possibility that the wrong nameplate was applied. Does the connection information physically match the motor? Are other motors with the same part number but different date codes the same? Specific resistance values from the manufacturer may be required for positive confirmation.

NOTES:

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