SECTION I
AIR MOTORS
AIR TOOL MANUAL

REVISIONS

KEEP YOUR AIR TOOL MANUAL UP-TO-DATE

As our family of Professional Tools grows and evolves, we will issue timely revisions to the AIR TOOL MANUAL. In order to make it easy for you to keep your MANUAL up to date, these revisions will be published as complete sections. Simply insert the revised section following the appropriate tab and discard the old section.

For historical purposes, revisions made to the AIR TOOL MANUAL were published as shown below:

Revision No.	Date	Description
1	November, 1981	Impactools
2	December, 1981	Grinders.
3	December, 1982	Air Motors, Impactools, Angle Wrenches, Screwdrivers, Small Drills, Grinders, Percussion Tools, Pumps, Overhead Hoists, Winches.
4	April, 1990	Air Motors, Impactools - including Equi-Pulse Nutrunners, Angle Wrenches, Screwdrivers - including Delvo DC Electric.

IMPORTANT

A large percentage of our Power Tool Division products are powered by an air motor—either a vane-type motor or a radial piston motor. In addition, many of these same motors are marketed as power units for incorporation in equipment produced by other manufacturers or as a power unit to operate a conveyors, jacks, elevators, pumps, valves etc. But regardless of the application, the following pages describing "How an Air Motor Works", "Characteristics of an Air Motor" and "Design of the Multi-Vane® Air Motor" apply to air motors in general and not to air motors used for specific applications.

Later on in the section when we discuss the air motors marketed as power units, we will refer to them as "stationary motors" as opposed to the air motors being used in our portable tools, hoists and winches.

HOW AN AIR MOTOR WORKS

Basically, an air motor operates by the force of compressed air against the vanes or pistons. The compressed air expands only about 25% before it is exhausted. There are two reasons for this:

1. If air were expanded through an air motor at anywhere near the initial compression ratio of 7.12 to 1 for a line pressure of 90 psig, the rapid expansion would quickly freeze any moisture in the motor, clogging exhaust ports and reducing power and speed.
2. Designwise, it is highly impractical, if not impossible in the vane motor, to make the expansion chamber large enough to allow full expansion of the air prior to exhaust.

The following illustrations show how a typical vane type air motor works.

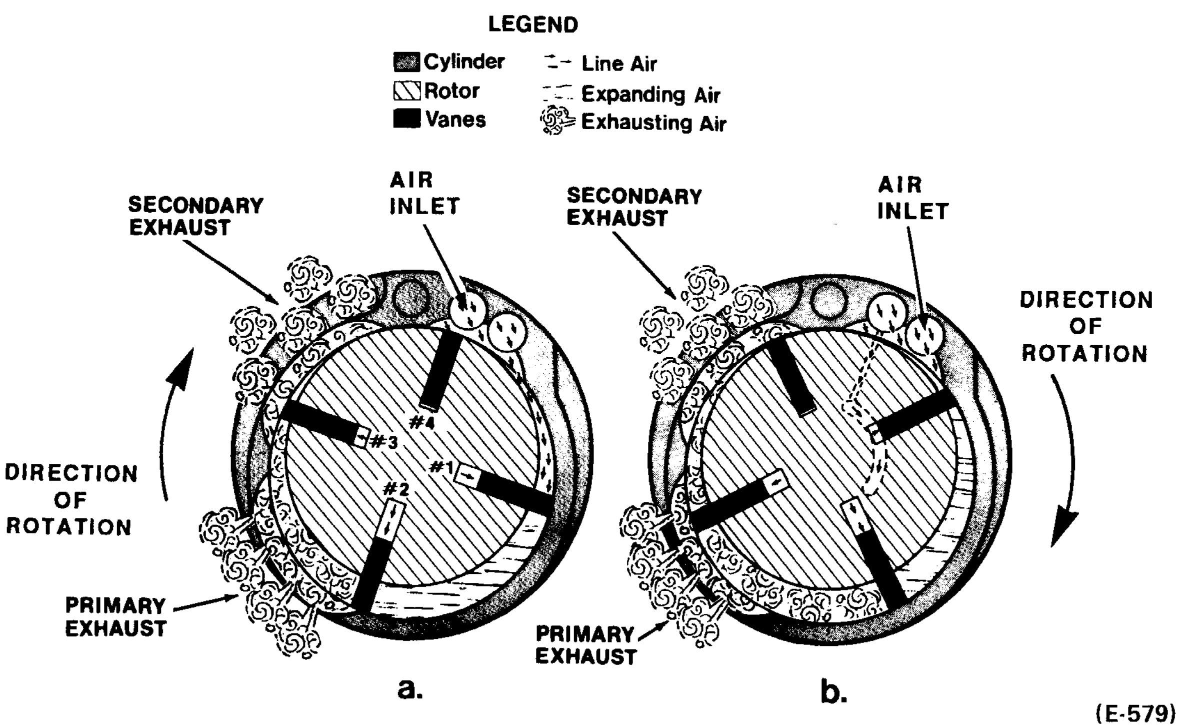

Figure 1

Figure 1 shows a nonreversible vane-type motor. In the left-hand view (a) you can see the live air coming through the cylinder ports against vane No. 1. The air between vane No. 1 and vane No. 2 is expanding, and is exerting more pressure against vane No. 2 than against vane No. 1 because vane No. 2 is extended further from the rotor and exposes a greater area for the compressed air to act upon than vane No. 1.

HOW AN AIR MOTOR WORKS (Continued)

The expanded air between vane No. 2 and vane No. 3 is being exhausted, most of it through the primary exhaust ports and some through the secondary exhaust ports. THe expanded air between vane No. 3 and No. 4 that was unable to escape through the primary exhaust ports is being expelled through the secondary exhaust ports. Vane No. 4 has just passed the lap point and is ready to pick up a fresh charge of live air at line pressure.

In the right-hand view of Figure 1 you will note a small dotted port connecting the live air port to a crescent-shaped port at the bottom of the vane. This small port and the crescent-shaped port, called air starting grooves, are located in the end plate and route live air under the vane to push it out against the wall of the cylinder and guarantee positive starting.

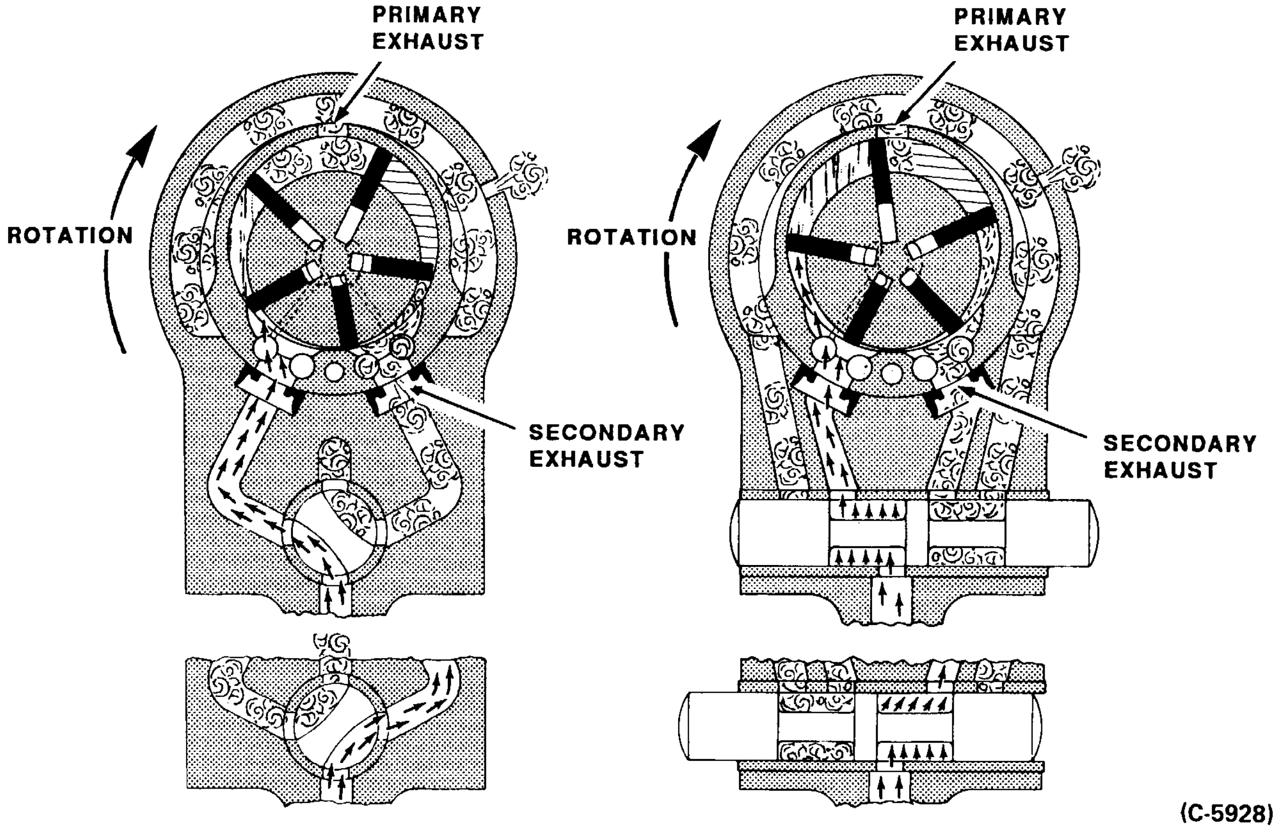

Figure 2

Figure 2 shows a typical reversible vane motor in an Impactool. The left-hand view illustrates the 180° rotary reverse valve, while the right-hand view shows the push-through reverse valve. Shifting of either reverse valve changes the direction of air flow from one side of the motor to the other.

If you will refer back to Figure 1, you will note that the primary exhaust port is located somewhat greater than 180° beyond the lap point. This gives the nonreversible motor full advantage of live air. Now look at Figure 2 and note that the primary exhaust in the cylinder is located exactly 180° from the lap point, and that the secondary exhaust is routed back through the reverse valve to the exhaust expansion chamber.

The location of the primary exhaust port in a vane-type motor helps determine the torque and horsepower of that motor for a given direction of rotation. For example, in the illustration of the reversible motor having the primary exhaust 180° from the lap point, this gives the motor equal horsepower and torque in either direction of rotation. If we shift the primary exhaust port of a reversible vane motor to either side of 180° from the lap point, then we increase the power and torque in one direction of rotation and decrease the power and torque in the opposite direction of rotation. These are called biased motors and are used in our large drills and hoists.

HOW AN AIR MOTOR WORKS (Continued)

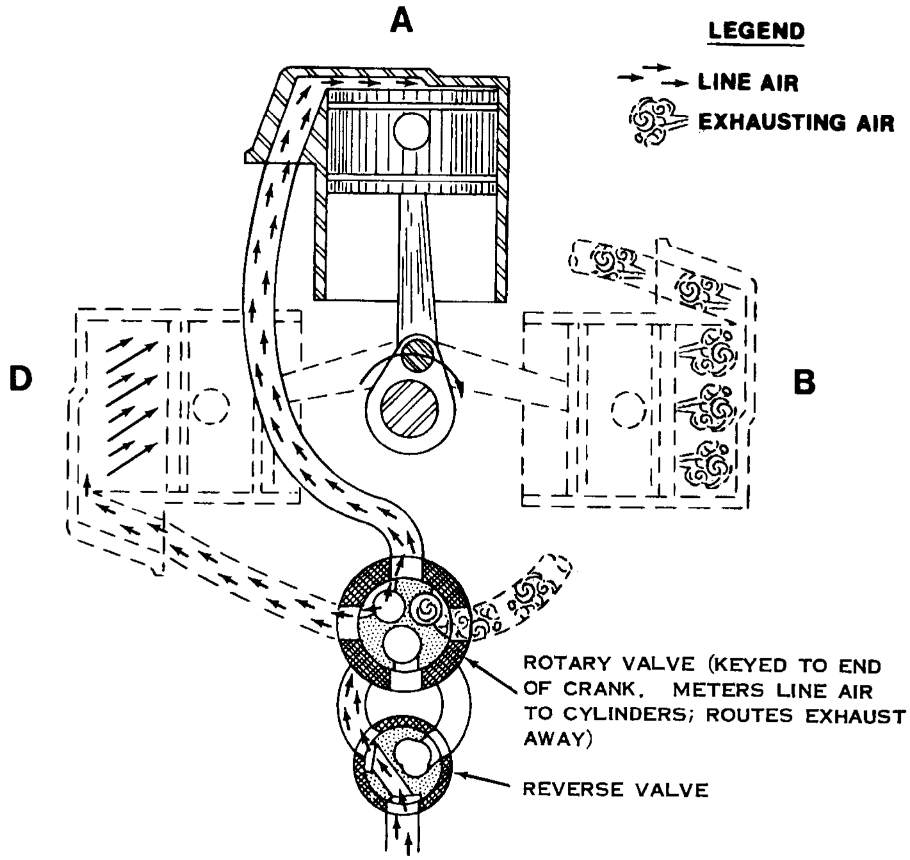

Figure 3

Figure 3 shows a typical piston-type air motor. Although we are showing only three cylinders here, you have to visualize the fourth cylinder as being at bottom dead center. The principle of operation is the same regardless of the number of cylinders.

In a piston air motor, the rotary valve is keyed to and rotates with the crank and serves the function of distributing air to each cylinder at a precise time. The reverse valve is manually operated to direct live air to either side of the rotary valve, thus controlling the direction of rotation. The sequential operation of the piston motor shown in Figure 3 is as follows:

Cylinder D: With the rotary valve rotated to the position shown, live air at line pressure is admitted to cylinder D. Since the piston is about 60% through its stroke, the angle of the connecting rod relative to the crank determines the direction of crank rotation. When the piston completes approximately 75% of its stroke, live air to cylinder D will be shut off and the piston will complete its power stroke on expanding air.

Cylinder A: Live air is just being admitted to cylinder A. It will continue to be admitted for about 75% of the piston's power stroke.

Cylinder B: The piston in cylinder B has just completed about half of its exhaust stroke with the primary exhaust being expelled through the rotary valve. After completing about 75% of its exhaust stroke, the remaining exhaust is expelled through a secondary exhaust port in the reverse valve. The amount of restriction in the exhaust ports determines the amount of recompression of air which serves as a braking force when the piston motor is used on a hoist and the hoist is lowering a load.

Cylinder C (not shown): The piston in cylinder C has just completed its power stroke on expanding air, and is now commencing its exhaust stroke.

HOW AN AIR MOTOR WORKS (Continued)

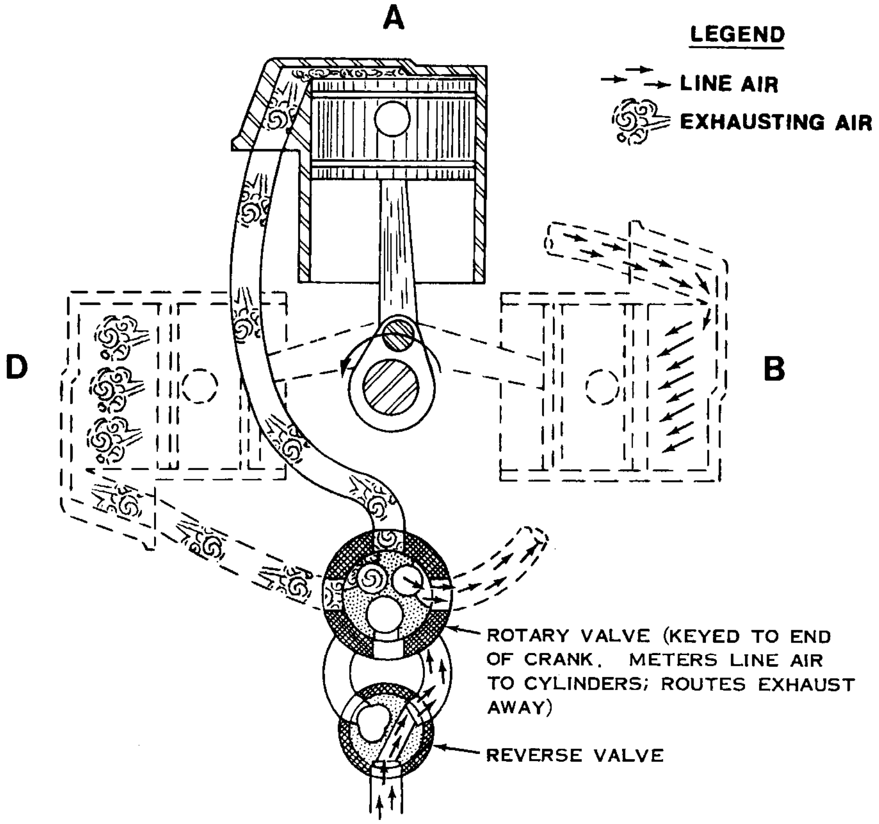

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Figure 4

Figure 4 shows the piston motor operating in the reverse direction of rotation. Following is the sequence of operation.

Cylinder B: When the reverse valve is shifted to the position shown, live air is admitted to cylinder B. Again, the angle of the connecting rod relative to the crank determines crank rotation.

Cylinder A: The piston in cylinder A is almost at top dead center, and the exhaust cycle for this cylinder is nearly completed.

Cylinder D: The piston in cylinder D is about halfway through its exhaust stroke.

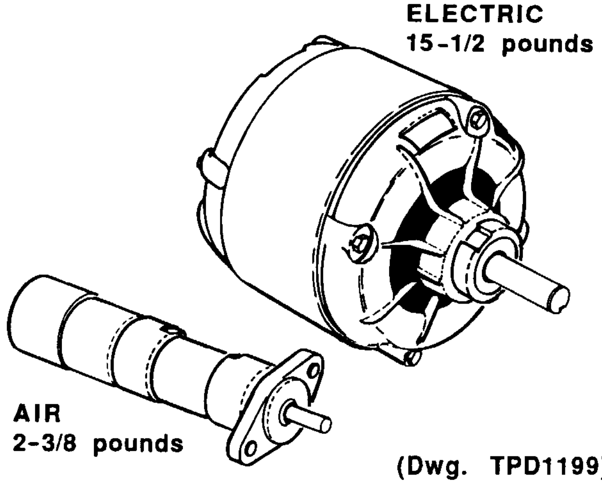
Cylinder C (not shown): The piston in cylinder C is just completing its power stroke on expanding air.

On piston motors, the configuration of the ports in the rotary valve determines the amount of power and torque the motor delivers for a given direction of rotation. For most of our piston motors, we have rotary valves that will deliver equal power and torque in either direction of rotation; maximum power and torque in the clockwise direction, or maximum power and torque in the counterclockwise direction of rotation.

CHARACTERISTICS OF AN AIR MOTOR

Air motors have certain characteristics that make them an ideal choice for hand-held power tools, hoists, winches and stationary power units. These characteristics are:

1. High torque per pound of weight.
2. High horsepower per pound of weight.
3. Maximum torque at stall or near-stall speeds.
4. No heat build-up when the motor is stalled for a considerable length of time.
5. Air motors can operate in environments where other types of motors present definite hazards. Corrosive, hot and wet atmospheres do not affect air motors. No protection is needed for outdoor use. They are explosion resistant in gaseous atmospheres, and present no shock hazard in wet locations. With proper installation they are ideal for underwater use.
6. Air motors start and stop instantly. Infinite speed and power control is obtained without expensive, space consuming equipment. Air motors can be rapidly reversed an unlimited number of times with no damage or heat build-up to the motor.
7. Should an air motor be overloaded to the point where it stalls, it will return to normal operation with no harmful effects the instant the overload is removed. An air motor cannot overheat or burn out due to overloading or stall periods of indefinite length. In fact, about the only way you can damage an air motor is to permit an **ungoverned** motor to operate for a lengthy period of time in an **unloaded** condition.
8. In addition, low pressure air lines (100 psig to 200 psig) are less expensive to install and maintain than high pressure hydraulic lines (1500 to 10000 psi), and the cleanup problems caused by a leak are considerably less. Hydraulic fluid escaping at a pressure of 10 000 psi can be extremely dangerous.



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Two 1/3 Horsepower Motors

Power characteristics of air motors are similar to those of series-wound d-c motors. At constant inlet air pressure, power is zero at zero speed, increasing with increasing speed until it peaks at approximately 50 percent of free speed. It then decreases to zero again at free speed (maximum speed under no-load condition).

Torque reaches its highest value slightly beyond zero speed and falls off rapidly, almost in a straight line, until it reaches zero at free speed. Torque at stall is approximately twice the torque at rated power. Starting torque is the maximum torque the motor can produce when starting under load; its value is approximately 75 percent of stall torque. Because static friction at the vane tips exceeds dynamic friction, it takes more force to start a vane motor than to keep it running. If the load on the motor exceeds its starting torque, the motor will not start. Operating or running torques at any speed can be approximated from motor performance curves—or calculated using the formula:

$$\text{Torque (ft-lb)} = \frac{\text{Horsepower} \times 5250}{\text{speed (revolutions per minute)}}$$

$$\text{Torque (Nm)} = \frac{\text{Kilowatts} \times 9550}{\text{speed (revolutions per minute)}}$$

Comparisons can be made among motors at different pressures by allowing 14 percent change in power for each 10 psig (69 kPa) pressure change. For example, a motor rated at 8 hp (6 kw) at 90 psig will deliver 6.9 hp (5.1 kw) at 80 psig. By the same rule, a 10 psig (69 kPa) increase in air inlet pressure will let this same motor deliver 9.1 hp (6.7 kw). This directly affects cost and productivity. (See page 9 for performance characteristics table.)

CHARACTERISTICS OF AN AIR MOTOR (Continued)

Control of air pressure supplied to the motor is the simplest and most efficient method of changing the operating characteristics of an air motor. Conversely, failure to maintain the desired air pressure at the motor inlet is the most certain way to nullify the design characteristics of the motor.

If a motor is rated at 90 psig (620 kPa), it is not enough to determine that there is 90 psig (620 kPa) at the compressor. There must be 90 psig (620 kPa) at the motor inlet for it to perform at its rated torque and power.

Free speed is the maximum speed under a no-load condition. For a governed motor, the term free speed actually means free governed speed, that is, the maximum speed at which the motor will run with the governor operating.

Design speed, that point at which rated or maximum power is reached, is approximately one-half of free speed for a nongoverned motor and about 80 percent of free speed (free governed speed) for a governed motor. Governed air motors produce maximum power at approximately 80% of free governed speed. For the most efficient operation, a motor should run at design speed.

Increasing the load will decrease the speed of an air motor, slowing it down until its torque equals the load requirements. By opening the throttle to increase the air pressure, the motor then can be brought up to rated speed.

Most air motors, of necessity, are geared motors. Gearing is used to reduce the high speeds of vane motors to more usable speeds. Since maximum power normally occurs at approximately one-half of free speed, reducing free speed also reduces design speed. But gearing also reduces efficiency, so the less gearing the more efficient the motor.

One of the major advantages of an air motor is its ability to come up to full speed almost instantly. Vane motors with no connected inertia come up to speed in one-half revolution. Piston motors are even faster and reach full speed in milliseconds.

Air consumption varies with speed and motor size. Two motors operating at 90 psig (620 kPa) may consume anywhere from 21 cfm (.59 m^3/min) to 45 cfm (1.27 m^3/min) per horsepower, with the larger models having the lower consumption-to-power ratios because of better porting.

Regardless of the torque or power generated, each vane sweep or piston stroke requires a given amount of compressed air. As the speed increases, so does the air consumption per minute. It is minimum at zero speed and maximum at free speed where it is approximately 60 percent of the consumption at rated speed.

When estimating air consumption per minute, allow 34 to 40 cfm (.96 to 1.13 m^3/min) per horsepower at maximum power for motors below 1-1/2 hp (1.1 kw) and 25 to 30 cfm (.7 to .85 m^3/min) per horsepower for larger motors. To estimate air consumption for a particular speed, determine the consumption at rated speed, at one quarter free speed and at free speed. Once air consumption at the three speeds has been determined, fit a smooth curve through them. To ascertain total air consumption for a particular operation, multiply consumption per minute at the operating speed by cycle time (working time).

VANE MOTORS

Vane-type air motors are essentially high-speed units with rotor speeds up to 60 000 rpm, and they deliver more power per pound of weight than the piston air motor. Vane motors have from three to ten vanes, and the greater the number of vanes used, the less internal leakage or blown-by they have. As the number of vanes increases, starting torque and reliability are improved. With only three vanes, if one vane sticks, the unit may not start under a heavy load. The use of four, five or six vanes—plus air pressure under the vanes—overcomes this problem. Vane motors generally require more servicing than piston-type air motors.

PISTON MOTORS

Piston-type air motors have more positive starting, better low-speed operating characteristics, and slightly better start-and-stop characteristics than vane motors. The overlap of power strokes in the radial piston air motors provides even torque and full power in either direction of rotation. As least two pistons are always on a power stroke. They are available with either four, five or six cylinders.

CHARACTERISTICS OF AN AIR MOTOR (Continued)

Power developed in piston-type air motors is dependent upon inlet pressure, number of pistons, piston area, stroke and speed. The speed limiting factor in a piston air motor is the inertia of the reciprocating parts. These motors should be operated under load. It is not recommended that they be operated at speeds greater than 75% of free speed.

Radial piston air motors are inherently low-speed devices operating with free speeds generally under 4000 rpm. They have excellent lugging characteristics under heavy loads at all speeds, and are particularly adaptable to slow-speed operation and applications requiring high starting torques. Piston motors have built-in, splash-type lubrication, and normally require infrequent servicing. They are normally installed with the crankshaft horizontal, and special provision must be made for lubrication of non-horizontally mounted units.

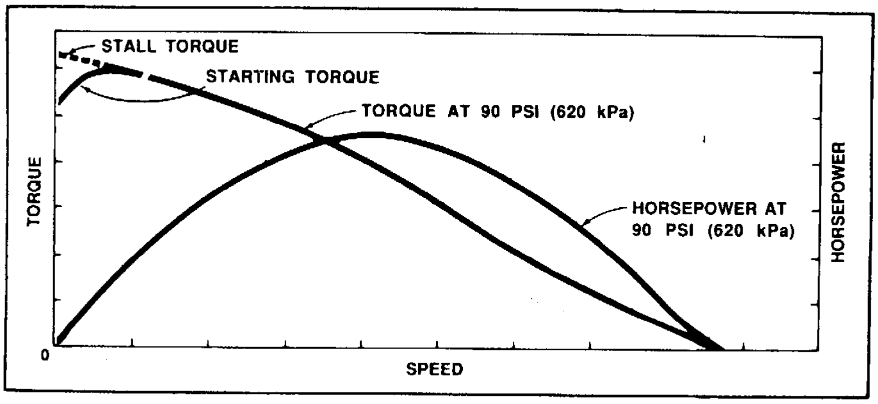


Figure 1

Typical torque and horsepower curve for a piston motor. Torque is maximum at zero speed and zero at free speed; any load will slow the motor. Horsepower is maximum at 1/2 free speed.

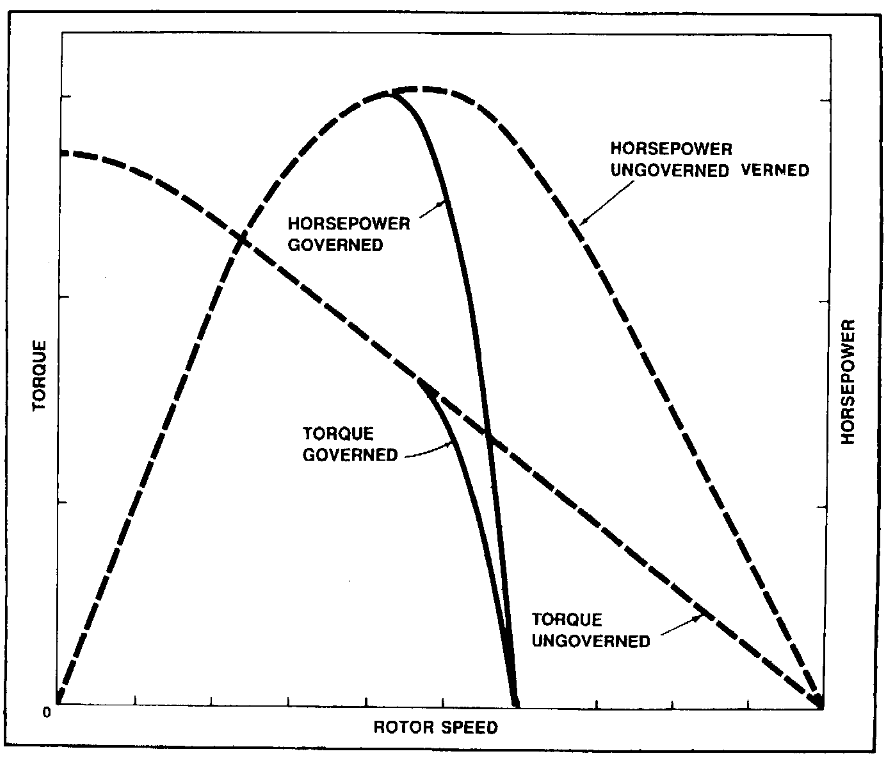


Figure 2

Typical torque and horsepower curve for a motor which is both governed and ungoverned. Rated power is obtained at 50 percent of free speed for ungoverned motor, 80 percent for governed.

CHARACTERISTICS OF AN AIR MOTOR (Continued)

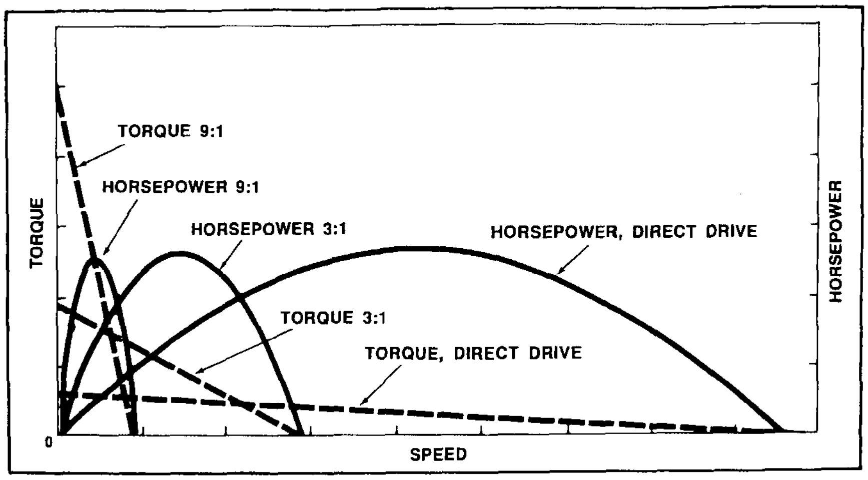


Figure 3

Typical torque and horsepower curves for geared motors. Note that as the gear ratio is increased, output torque is increased, while speed is decreased. Horsepower is not affected by gear ratios.

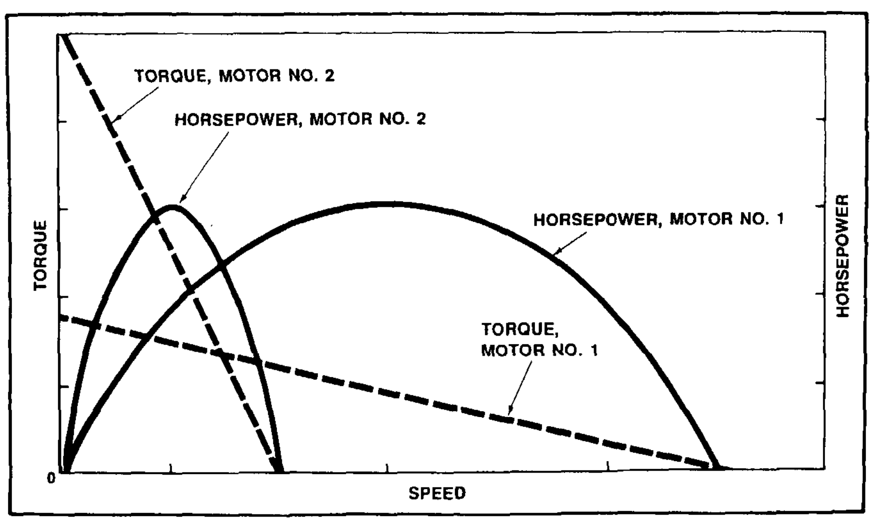


Figure 4

Typical torque and power curves of two vane motors with same horsepower rating. Speed dropoff with increased load is greater on a high speed motor since its torque curve is flatter.

HOW TO DETERMINE AIR MOTOR PERFORMANCE AT AIR PRESSURES OTHER THAN 90 PSI

Example: If you know that a specific governed motor has a free speed of 6000 rpm at 90 psig, you can determine its free speed at 110 psig by multiplying 6000 x 1.03 = 6180 rpm.

Nongoverned Motors

Air Pressure, psig	Free Speed, rpm	CFM Air at Free Speed	Maximum Horsepower	Speed at Maximum Horsepower, rpm	Torque Maximum Horsepower, ft-lb	CFM Air at Maximum Horsepower	Maximum Torque, ft-lb
40	80	45	30	80	37.5	45	45
50	84	56	44	84	52.4	56	56
60	88	67	58	88	65.9	67	67
70	92	78	72	92	78.3	78	78
80	96	89	86	96	89.6	89	89
90	100	100	100	100	100	100	100
100	104	111	114	104	109.6	111	111
110	108	122	128	108	118.6	122	122
120	112	133	142	112	126.8	133	133
130	116	144	156	116	134.5	144	144
140	120	155	170	120	141.6	155	155
150	124	166	184	124	148.4	166	166
160	128	177	198	128	154.8	177	177
170	132	188	212	132	160.6	188	188
180	136	199	226	136	166.2	199	199
190	140	210	240	140	171.4	210	210
200	144	221	254	144	176.4	221	221

Governed Motors

Air Pressure, psig	Free Speed, rpm	CFM Air at Free Speed	Maximum Horsepower	Speed at Maximum Horsepower, rpm	Torque Maximum Horsepower, ft-lb	CFM Air at Maximum Horsepower	Maximum Torque, ft-lb
30	91.0	70	16	47.0	34	34	34
40	92.5	75	30	66.7	45	45	45
50	94.0	80	44	78.6	56	56	56
60	95.5	85	58	86.7	67	67	67
70	97.0	90	72	92.3	78	78	78
80	98.5	95	86	96.7	89	89	89
90	100	100	100	100	100	100	100
100	101.5	105	114	102.8	111	111	111
110	103.0	110	128	104.9	122	122	122
120	104.5	115	142	106.7	133	133	133
130	106.0	120	156	108.3	144	144	144
140	107.5	125	170	109.7	155	155	155
150	109.0	130	184	110.8	166	166	166

HOW TO DETERMINE AIR MOTOR PERFORMANCE USING SUPPLY OR EXHAUST REGULATION

Reducing or restricting the amount (cfm) of air supplied to the motor has an effect similar to reducing the air pressure (psi). Choking or restricting the exhaust has a somewhat different effect, as summarized in the table below:

Air Regulation	Speed	Torque
Reduced air pressure (psi) or restricted air volume (cfm) to motor	Reduced	Greatly Reduced
Choked or restricted exhaust	Greatly Reduced	Reduced

Exact variations in performance with "choked" motors are not tabulated; however, "on the job" tests will usually produce the desired results; sometimes from a combination of pressure adjustments and inlet and exhaust restrictions.

DESIGN OF THE MULTI-VANE AIR MOTOR

Vanes

Vanes are the key part of the multi-vane motor. They must be light for minimum friction against the cylinder wall, strong and rigid, resistant to splitting or delamination, and yet must not be brittle to the extent they will chip or crumble. The vanes must be durable without wearing away either cylinder or rotor, and the properties of the material, including dimensional stability, must not be unduly affected by heat, cold, wet or dry air, or any recommended lubricant.

The development of the bronze vane by Ingersoll-Sergeant Drill Co. to the present engineered composite vane is the result of a great amount of experimental work under all types of conditions in all climates. We have tried various metals, molded plastics, carbon base products and other materials. Although some of these were ideal in many respects, they also had serious disadvantages.

Our present vanes are made from either a linen base laminated phenolic material, or an engineered composite, and are excellent in most of the desirable properties. Our continuing experimental work is concentrated on the engineered composites. Vanes will wear out in time, but under good conditions of operation, vanes have been known to last two years in severe service.

Vane length is important. If a vane is too long, slight swelling due to moisture will cause binding against end plates. If too short, power and efficiency will be low. They should be the same length as the rotor, or .004" to .006" shorter than the cylinder.

Nearly all Ingersoll-Rand vane-type motors use air-thrown vanes for positive starting. This means that compressed air is routed through ports in the end plates to a pair of crescent grooves adjacent to the bottom of the vane slots in the rotor. Thus, when the throttle is first cracked, compressed air builds up pressure under the vanes to force them outward against the cylinder wall.

Other ways of insuring positive starting have been tried over the years. In 1932 we introduced the 25 sump pump which used a vane-type motor with spring-loaded vanes. The spring used was a shallow-curve leaf spring located under each vane with the ends of the spring slightly recurved. This design was unsatisfactory as the continuous flexing of the spring resulted in rapid spring breakage, while the force and weight of the spring against the vane accelerated vane wear and deterioration.

We soon discontinued the use of vane spring, and initiated a new design using a sliding vane pin located in a cross hole between two diametrically opposite vanes. Again, centrifugal force acting on the combined weight of the pin and vane created excessive vane wear, and in October, 1934, we announced a redesign of the 25 sump pump with air-thrown vanes in the motor.

However, history has a way of repeating itself and with new technology and materials, a newly designed spring loaded vane was incorporated in the MRV Motor Series introduced in June, 1982. Then in November, 1986, still another spring loaded vane design was added to select MLK Hoists. This was done to insure positive starting under low pressure conditions which result when minimal throttle actuation is used to achieve minimal movement of the load.

Rotors

Most rotors are machined from steel, some from aluminum. The steel rotors are hardened and ground to close tolerances. Special attention is paid to the length of the rotor body as clearance between it and the end plates is highly important. Some larger rotors are drilled longitudinally to lighten them.

Originally all nonreversible rotors had four vane slots and reversible rotors had five. But in the interest of interchangeability, the five-vane rotor was adopted for those sizes of drills that are furnished in both reversible and nonreversible. This does not appreciably affect the performance of the nonreversible tools. The swastika vane motor is used in grinders to provide maximum power for a given size motor and to decrease vane wear. These motors are nonreversible.

Generally speaking, the body of the rotor is ground about .002" to .004" shorter than the cylinder within which it operates. This is to provide proper running clearance between the rotor and end plates. In tools where there is no axial thrust on the rotor, such as drills, screwdrivers and Impactools, the rotor readily "floats" between the end plates. However, some applications demand a design in which the axial thrust on the rotor will not force the rotor body into the end plate. Although the axial thrust can be due to an external force, such as grinding with a vertical grinder, or an impeller, worm drive or feed screw, it always occurs in a governed motor as a result of air pressure against the governor valve working through the governor lever. Damage to the end plate due to rotor thrust can be prevented by one of two methods.

In some cases, particularly stationary motors, the rotor body and rotor shaft are two separate components. The rotor body is keyed to the shaft for driving purposes, but is free to "float" axially between the end plates.

DESIGN OF THE MULTI-VANE AIR MOTOR (Continued)

The other method of preventing end plate scoring due to axial thrust is to positively locate the rotor body between the end plates by means of a rotor spacer.

The rotor spacer is normally located on the rear hub of the rotor between the rotor body and the inner ring of the rear rotor bearing. The spacer is about .001" to .002" longer than the thickness of the end plate, and with the bearing in a fixed location, the rotor body cannot contact the end plate. This construction was commonly used in our grinders and large drills.

Cylinder

Cylinders for small vane-type motors are made from steel, while those for most intermediate and large sizes are from a cast iron alloy. Parts from both materials are heat treated.

Steel is used where wall sections are very thin, but cast iron is preferred where the wall sections are thick enough to permit. This is because cast iron wears more evenly and has less tendency to develop a wavy, washboard surface. Fortunately, this tendency is not troublesome on the smaller sizes where steel must be used.

Vane and cylinder wear are influenced considerably by the finish given to the cylinder bore. The length, of course, is as important as it is on rotors, so all are surface ground and held to a very close tolerance.

To get the most out of a vane-type air motor, it is obvious that air leakage and blow-by must be kept to a minimum. This is particularly true at the lap point—the point which the circumference of the rotor body just clears the cylinder wall. Ideally, the clearance at this point is .00025" to .0005".

In order to maintain this amount of clearance and at the same time obtain a better air seal, we developed what we term as a "ground lap". That is, we grind the lap point to a radius equal to the radius of the rotor, so that we actually increase the width of the seal between rotor and cylinder form a line contact to an area 3/8" wide or wider, and running the length of the cylinder.

End Plates

The precision tolerance necessary in a vane motor dictate that the air must be clean. Even very small particles of dirt admitted with the air can cause scoring of cylinder, rotor and end plate. A hard, sharp particle might get in and out of a motor quickly without doing damage, but if it gets between either end plate and the rotor, there is a chance that it will score the end plate. This has led to the belief that a metal, such as bronze, in which the speck can become embedded quickly, will serve best as an end plate.

Even though bronze is the ideal end plate material, it is expensive, sometimes short in supply, and on some applications can be replaced by a more economical material. Over the years we have successfully used hardened steel end plates, "Parco-Luberized" cast iron end plates, plain cast iron end plates and aluminum/bronze laminated end plates. As machining methods improve and we find it easier to hold dimensions to closer tolerances, we have also found it more feasible to use materials other than bronze for end plates.

Cast iron is the most likely candidate for replacing bronze. It is economical and easy to machine, though it does have one particularly bad characteristic. If the rotor rubs the end plate with any amount of pressure, small particles of the end plate weld themselves to the rotor. Then there is a rapid build-up of additional particles and, finally, such severe galling that the end plate and rotor are ruined. Despite this, cast iron end plates can be and are used to good advantage on intermittent operation applications such as air starters, and in stationary motors where the rotor is positively located by rotor spacers.

The "Parco-Luberized" end plate is simply a cast iron end plate faced with a porous coating of phosphate applied by a special process. Being very absorbent, this coating holds considerable lubricant which increases its quality as a bearing surface and serves as a barrier between the rotor and end plate.

Hardened steel end plates will take more contact pressure with less galling than cast iron, but steel is more difficult and more expensive to machine. We use steel end plates for some applications as a compromise between bronze and cast iron.

The most recent development in end plates is the aluminum/bronze lamination. Here we use an aluminum casting, which is economical to produce, and face it with sheet bronze to provide a durable non-galling surface. End plates of this design have proved very successful, and can be used for most motor applications. However, they are not as economical as the cast iron end plates.

STATIONARY AIR MOTORS—M & A SHEET

The markets and applications for stationary air motors are limited only by your imagination. To arrange this M & A Sheet as we have the following M & A Sheets, and list the individual markets and applications by Standard Industrial Classification code, would be either far too restrictive to adequately cover the market, or there would be so many pages that you would soon throw them aside. Ingersoll-Rand offers a stationary air motor for virtually every application where a power unit is needed and compressed air is available. This means replacement of electric motors on existing equipment or implementation of an air motor on new equipment or installations.

Most of our stationary air motors today are marketed to original equipment manufacturers who are incorporating the motor on equipment they are producing. Such equipment might be on a regular production basis, or it might be a one-time piece of customized equipment.

Many stationary air motors are installed on equipment during periods of modernization or repair, sometimes as a replacement of an electric motor and sometimes a new innovation.

Following are some of the applications where Ingersoll-Rand stationary air motors have been installed.

Application	Air Motor Advantages
Opening and closing valves in marine and industrial machinery.	Compact size and lightweight. Ability to stall without damage at predetermined torques. By varying air pressure, required torques can be accurately obtained
Tightening and loosening threaded fasteners in single or multiple spindle operation.	
Tensioning steel straps on packaging machinery.	
Powering concrete saws and earth augers.	Compact size, lightweight speed and torques adjust as loads vary
Powering clamping devices	Ability to stall without damage
Powering portable carpet trimming tools	Compact size and weight
Powering prelube pumps on large diesel engines and turbines	Compact size. No other power required since compressed air is usually available in engine areas.
Barring or Slowly turning over diesel engines	Good low speed control while developing high torques
Operation in potentially hazardous environments	No electric sparks
Operation in hot, dusty or wet locations	Will not overheat. Can be operated in ambient temperatures to 150°F and twice that high with the use of special lubricants. No air required for cooling.
Powering trimming blades in meat packing industry	Compact size and lightweight
Operating lifting, pulling and positioning devices such as hoists, winches turntables and conveying equipment	Infinite speed and torque variation. No damage to motor if overloaded or stalled. Safe operation in hazardous environments. Instant starting, stopping and reversing

We should mention here that some of the stationary air motors that we market were designed specifically for that purpose and are offered with a foot, face and/or flange mounting. This allows the motor to be mounted as a direct replacement for an electric motor, or adapted to original equipment. Motors in this category include the Series 17RA, 17RB, 34RA, 34RB, 48NB, 48RA, 48RB, 92RA, 92RB, M0V0 and MVA.

All cataloged stationary piston motors are base mounted; however, flange mounted models can be furnished on special order.

STATIONARY AIR MOTORS—FBI SHEET

FEATURE	BENEFIT	INCENTIVE
Wide selection of models **Vane** Max. HP 0.11 to 10.5 Max. Torque 0.18 to 1010 ft-lb Speed @ Max. HP 23 to 12250 rpm **Piston** Max. HP 1.6 to 25 Max. Torque 8.3 to 600 ft-lb Speed @ Max. HP 92 to 1900 rpm	Availability of a motor for virtually any application.	In many cases, if a customer has an application for one stationary motor, he has applications for others. With our broad line of motors, this means a single source of supply for the original motor and for spare parts. There is considerable interchangeability of parts in our line of motors, particularly vanes, end plates, rotors, cylinders and bearings. This interchangeability also extends over into our various power tools, thus decreasing the number of different repair parts a customer should keep on hand. This in itself is an economical savings.
Heavy-duty, rugged housings and mountings	Durability	The heavy-duty housing members provide more than adequate protection for the internal rotor, cylinder and gearing. This translates into less downtime and less costs for repairs.
Compactness	Permits installation in limited space locations. Reduces weight of final product where motor is used as the power unit.	Electric motors of comparable speed, horsepower and torque are much larger and heavier than their air motor counterpart. When an air motor is used in place of an electric motor, especially on original equipment, the reduction in weight and space could mean a corresponding reduction in equipment costs and shipping costs.
Long, reliable service	Low maintenance	On a properly installed air motor, about the only thing that ever wears out is the vanes, and even this is an infrequent occurrence. In many instances, where a stationary air motor replaced an electric motor on equipment that was being repaired or modernized, one of the primary reasons for replacement was the high cost of maintenance required for the electric motor as compared to the low cost of maintenance for the stationary air motor.

STATIONARY AIR MOTORS—FBI SHEET (Continued)

FEATURE	BENEFIT	INCENTIVE
Different mounting available 1. Face mounting 2. Flange mounting 3. Foot mounting	Helps adapt specific model to various applications.	By offering different mountings for a given motor, we broaden the application range and again make it possible for the customer to have a single source of supply with maximum interchangeability of repair parts. This incentive has far greater significance than is apparent. For example, our MVA motors are available with a foot mounting, face mounting or a NEMA flange mounting—all on the same motor. A customer who has two or three different applications for the same horsepower motor can rely on the Ingersoll-Rand line as his single source of supply.
Motors are capable of operation in contaminated atmosphere or, where properly installed, under water.	Eliminates need of specially protected motor.	In order to use an electric motor in a hot, humid, corrosive atmosphere, or under water, a specially sealed and specially cooled motor would be required. The inherent characteristics of standard air motors are such that they can be used under these adverse conditions with no ill effects and **no extra cost**. Air motors can be operated in volatile atmosphere with no danger of "sparking" such as there would be with an electric motor.
Motors can be operated on natural gas.	Permits installation on applications where natural gas of sufficient pressure is available.	Although the use of a flammable gas offsets some of the safety advantages of air motors, it can result in a significant savings in the proper environment.
Motors are usable over extreme temperature range.	Permits installation in extremely cold or hot environments.	Standard motors operate from-30°F to 150°F. with special lubricants temperatures can go as low as -100°F to as high as 350°F.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION

Model	Maximum Horsepower	Speed @ Maximum Horsepower, rpm	Starting Torque, ft-lb	Stall Torque, ft-lb	Air Consumption @ Maximum Horsepower, cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft						
M002RHR000AR3	0.25	12,250	0.15	0.20	12.0	non-reversible (rotation is counterclockwise facing shaft end); 3/8" diameter keyed shaft; flange mounted; rear exhaust.
M002RHR004AR3	0.22	3250	0.45	0.61	11.9	
M002RHR006AR3	0.22	2060	0.72	0.96	11.9	
M002RHR008AR3	0.22	1520	0.98	1.31	11.9	
M002RHR013AR3	0.19	880	1.36	1.82	11.8	
M002RHR021AR3	0.19	555	2.16	2.88	11.8	
M002RHR028AR3	0.19	410	2.92	3.90	11.8	
M002RHR044AR3	0.19	262	4.61	6.15	11.8	
M002RHR101AR3	0.16	112	*8.32	*11.10	11.7	
M002RHR159AR3	0.16	71	*13.10	*17.50	11.7	
M002RVR000AR3	0.20	11,500	0.13	0.18	9.8	reversible; 3/8" diameter keyed shaft; flange mounted
M002RVR004AR3	0.17	3045	0.40	0.54	9.7	
M002RVR006AR3	0.17	1930	0.64	0.86	9.7	
M002RVR008AR3	0.17	1425	0.87	1.16	9.7	
M002RVR013AR3	0.14	820	1.17	1.56	9.6	
M002RVR021AR3	0.14	520	1.85	2.47	9.6	
M002RVR028AR3	0.14	385	2.50	3.34	9.6	
M002RVR044AR3	0.14	240	3.96	5.28	9.6	
M002RVR101AR3	0.11	104	6.78	9.05	9.5	
M002RVR159AR3	0.11	66	*10.70	*14.20	9.5	
M004RHR000AR3	0.50	10,000	0.40	0.53	20.0	non-reversible (rotation is counterclockwise facing shaft end); 3/8" diameter keyed shaft; flange mounted
M004RHR004AR3	0.47	2470	1.46	1.94	19.5	
M004RHR006AR3	0.47	1490	2.42	3.22	19.5	
M004RHR011AR3	0.44	825	3.92	5.22	19.0	
M004RHR015AR3	0.44	610	5.32	7.10	19.0	
M004RHR023AR3	0.44	395	8.10	10.80	19.0	
M004RHR033AR3	0.44	280	11.50	15.40	19.0	
M004RHR050AR3	0.41	175	16.50	22.10	18.5	
M004RHR083AR3	0.41	106	†27.50	†36.70	18.5	
M004RHR167AR3	0.41	53	†55.00	†73.30	18.5	

* Applications with these models must be limited to 12 ft-lb torque.
† Applications with these models must be limited to 33 ft-lb torque.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft (Continued)						
M004RVR000AR3	0.40	8000	0.32	0.42	19.0	reversible; 3/8" diameter keyed shaft; flange mounted
M004RVR004AR3	0.37	1975	1.13	1.51	18.5	
M004RVR006AR3	0.37	1190	1.88	2.51	18.5	
M004RVR011AR3	0.34	660	3.00	4.00	18.0	
M004RVR015AR3	0.34	485	4.07	5.43	18.0	
M004RVR023AR3	0.34	315	6.23	8.30	18.0	
M004RVR033AR3	0.34	225	8.85	11.80	18.0	
M004RVR050AR3	0.31	140	12.30	16.50	17.5	
M004RVR083AR3	0.31	84	†20.60	†27.50	17.5	
M004RVR167AR3	0.31	42	†41.30	†55.00	17.5	
M007RHR000AR4	0.85	11,000	0.58	0.77	36	non-reversible (rotation is counterclockwise facing shaft end); 1/2" diameter keyed shaft; flange mounted
M007RHR004AR4	0.82	2445	2.39	3.19	36	
M007RHR006AR4	0.82	1675	3.50	4.66	36	
M007RHR009AR4	0.82	1230	4.76	6.34	36	
M007RHR012AR4	0.79	870	6.19	8.25	36	
M007RHR015AR4	0.79	685	7.80	10.40	36	
M007RHR021AR4	0.79	470	11.50	15.30	36	
M007RHR027AR4	0.79	370	14.50	19.30	36	
M007RHR037AR4	0.79	270	19.70	26.30	36	
M007RHR044AR4	0.79	232	23.20	30.90	36	
M007RHR063BR6	0.79	161	33.50	44.70	36	non-reversible (rotation is counterclockwise facing shaft end); 3/4" diameter keyed shaft; flange mounted
M007RHR086BR6	0.79	118	45.70	60.90	36	
M007RHR119BR6	0.76	82	60.50	80.70	36	
M007RHR151BR6	0.76	65	76.50	102.00	36	
M007RHR188BR6	0.76	52	96.00	128.00	36	
M007RHR275BR6	0.76	35	‡140.00	‡187.00	36	
M007RHR374BR6	0.76	26	‡191.00	‡254.00	36	
M007RVR000AR4	0.70	10,000	0.47	0.63	33	reversible; 1/2" diameter keyed shaft; flange mounted
M007RVR004AR4	0.67	2225	1.94	2.59	33	
M007RVR006AR4	0.67	1520	2.84	3.78	33	
M007RVR009AR4	0.67	1120	3.86	5.14	33	
M007RVR012AR4	0.64	790	4.97	6.63	33	

† Applications with these models must be limited to 33 ft-lb torque.
‡ Applications with these models must be limited to 224 ft-lb torque.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft (Continued)						
M007RVR015AR4	0.64	625	6.29	8.38	33	reversible; 1/2" diameter keyed shaft; flange mounted
M007RVR021AR4	0.64	425	9.20	12.20	33	
M007RVR027AR4	0.64	335	11.60	15.50	33	
M007RVR037AR4	0.64	245	15.80	21.10	33	
M007RVR044AR4	0.64	210	18.60	24.80	33	
M007RVR063BR4	0.64	146	26.90	35.90	33	reversible; 3/4" diameter keyed shaft; flange mounted
M007RVR086BR6	0.64	107	36.70	48.90	33	
M007RVR119BR6	0.61	74	48.10	64.10	33	
M007RVR151BR6	0.61	58	61.00	81.30	33	
M007RVR188BR6	0.61	47	76.50	102.00	33	
M007RVR275BR6	0.61	32	‡111.00	‡148.00	33	
M007RVR374BR6	0.61	23	‡152.00	‡202.00	33	
1801N	1.40	918	10.50	14.00	46	non-reversible (rotation is counterclockwise facing end of shaft); 5/8" diameter keyed shaft; flange mounted
1801P	1.35	500	17.20	23.00	46	
1801Q	1.35	300	30.00	40.00	46	
1801U	1.35	205	41.00	55.00	46	
1801W	1.35	175	52.00	70.00	46	
1841N	1.20	800	9.30	12.50	43	reversible; 5/8" diameter keyed shaft; flange mounted
1841P	1.10	430	15.00	20.00	43	
1841Q	1.10	260	27.00	36.00	43	
1841U	1.10	175	37.00	50.00	43	
1841W	1.10	150	45.00	60.00	43	
3800M	1.55	520	24.00	33.00	48	non-reversible (rotation is counterclockwise facing end of shaft); 3/4" keyed diameter shaft; flange mounte i
3800P	1.45	285	42.00	56.50	48	
3800Q	1.45	180	62.00	83.50	48	
3800S	1.45	120	88.00	118.00	48	
3800U	1.45	105	105.00	140.00	48	

‡ Applications with these models must be limited to 224 ft-lb torque.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft (Continued)						
3840M	1.40	390	23.00	31.50	44	reversible; 3/4" diameter keyed shaft; flange mounted
3840P	1.35	215	40.00	53.50	44	
3840Q	1.35	130	60.00	80.00	44	
3840S	1.35	100	86.00	115.00	44	
3840U	1.35	83	100	134	44	
4800M	3.7	560	51	69	95	non-reversible (rotation is counterclockwise facing end of shaft); 1" diameter keyed shaft; flange mounted
4800P	3.5	260	98	131	95	
4800Q	3.5	195	129	173	95	
4800S	3.5	145	178	238	95	
4800U	3.5	97	265	354	95	
4840M	3.2	485	48	65	95	reversible; 1" diameter keyed shaft; flange mounted
4840P	3.0	228	93	125	95	
4840Q	3.0	167	123	165	95	
4840S	3.0	125	161	215	95	
4840U	3.0	83	225	300	95	
17RA005	2.3	562	27.5	37.0	103	reversible; base or face mounted; 1" diameter keyed shaft; special shafts and NEMA mounting flanges available. Refer to catalog
17RA008	2.3	383	41.0	54.5	103	
17RA011	2.3	254	61.0	82.0	103	
17RA014	2.3	201	77.0	104.0	103	
17RA017	2.3	169	92.0	124.0	103	
17RA022	2.3	129	120.0	163.0	103	
17RB029	2.2	97	150	201	100	reversible; base or face mounted; 1-1/2" diameter keyed shaft
17RB036	2.2	79	185	248	100	
17RB045	2.2	62	230	312	100	
17RB078	2.2	36	400	545	100	

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft (Continued)						
34RA005	4.1	560	51	69	183	reversible; base or face mounted; 1 " diameter keyed shaft; special shafts and NEMA mounting flanges available. Refer to catalog.
34RA008	4.1	385	75	101	183	
34RA011	4.1	255	102	152	183	
34RA014	4.1	201	140	192	183	
34RA017	4.1	168	165	229	183	
34RA022	4.1	128	220	301	183	
34RB029	4.0	99	270	374	180	reversible; base or face mounted; 1-1/2" diameter keyed shaft
34RB036	4.0	80	330	462	180	
34RB045	4.0	63	420	581	180	
34RB078	4.0	36	730	1010	180	
48RA005	3.1	930	26	35	95	reversible; base or face mounted; 1" diameter keyed shaft; special shafts and NEMA mounting flanges available. Refer to catalog.
48RA008	3.1	638	38	51.5	95	
48RA011	3.1	423	57	77.5	95	
48RA014	3.1	332	72	98	95	
48RA017	3.1	278	86	117	95	
48RA022	3.1	213	112	154	95	
48RB029	3.0	162	135	189	90	reversible; base or face mounted; 1-1/2" diameter keyed shaft
48RB036	3.0	131	167	234	90	
48RB045	3.0	105	205	295	90	
48RB078	3.0	60	360	513	90	

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Round, Keyed Shaft (Continued)						
92RA005	8.15	910	56	75.0	230	reversible; base or face mounted; 1" diameter keyed shaft; special shafts and NEMA mounting flanges available. Refer to catalog.
92RA008	8.15	620	80	109.0	230	
92RA011	8.15	415	120	164.5	230	
92RA014	8.15	327	152	208.0	230	
92RA017	8.15	274	180	248.0	230	
92RA022	8.15	209	225	326.0	230	
92RB029	7.9	160	280	402.0	225	reversible; base or face mounted; 1 1/2" diameter keyed shaft
92RB036	7.9	130	345	497.0	225	
92RB045	7.9	103	440	626.0	225	
92RB078	7.9	59	770	1090.0	225	
22N51-W/RC	1.75	208	49	66	55	reversible; base mounted 3/4" diameter keyed shaft
551SM51-W/RC	5.6	95	400	545	160	reversible; base mounted; 2" diameter keyed shaft
551SO51-W/RC	5.6	59	650	885	160	
92RM1	9.9	2095	33.0	45	240	non-reversible (rotation is clockwise facing end of shaft); face mounted; 7/8" diameter keyed shaft
92RM2	10.0	2020	33.5	45	260	non-reversible (rotation is counterclockwise facing end of shaft); face mounted; 7/8" diameter keyed shaft
992RM1	8.15	1730	29	39	230	reversible; face mounted; 7/8" diameter keyed shaft

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Square Shaft						
M002RHR008AS3	0.22	1,520	0.98	1.78	11.9	Non-reversible (counterclockwise rotation facing shaft end); 3/8" square drive shaft; flange mounted
M002RHR013AS3	0.19	880	1.36	1.82	11.8	
M002RHR028AS3	0.19	550	2.16	2.88	11.8	
M002RHR021AS3	0.19	410	2.92	3.90	11.8	
M002RHR044AS3	0.19	262	4.61	6.15	11.8	
M002RHR101AS3	0.16	112	*8.32	*11.10	11.7	
M002RHR159AS3	0.16	71	*13.10	*17.50	11.7	
M002RVR008AS3	0.17	1,425	0.87	1.16	9.7	Reversible; 3/8" square drive shaft; flange mounted
M002RVR013AS3	0.14	820	1.17	1.56	9.6	
M002RVR021AS3	0.14	520	1.85	2.47	9.6	
M002RVR028AS3	0.14	385	2.50	3.34	9.6	
M002RVR044AS3	0.14	240	3.96	5.28	9.6	
M002RVR101AS3	0.11	104	6.78	9.05	9.5	
M002RVR159AS3	0.11	66	*10.7	*14.2	9.5	
M004RHR006AS3	0.47	1,490	2.42	3.22	19.5	non-reversible (counterclockwise rotation facing shaft end); 3/8" square drive shaft; flange mounted
M004RHR011AS3	0.44	825	3.92	5.22	19.0	
M004RHR015AS3	0.44	610	5.32	7.10	19.0	
M004RHR023AS3	0.44	395	8.10	10.80	19.0	
M004RHR033AS3	0.44	280	11.50	15.40	19.0	
M004RHR050AS3	0.41	175	16.50	22.10	18.5	
M004RHR083AS3	0.41	106	†27.50	†36.70	18.5	
M004RVR006AS3	0.37	1,190	1.88	2.51	18.5	reversible; 3/8" square drive shaft; flange mounted
M004RVR011AS3	0.34	660	3.00	4.00	18.0	
M004RVR015AS3	0.34	485	4.07	5.43	18.0	
M004RVR023AS3	0.34	315	6.23	8.30	18.0	
M004RVR033AS3	0.34	225	8.85	11.80	18.0	
M004RVR050AS3	0.31	140	12.30	16.50	17.5	
M004RVR083AS3	0.31	84	†20.60	†27.50	17.5	

* Applications with these models must be limited to 12 ft-lb torque.
† Applications with these models must be limited to 33 ft-lb torque.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Square Shaft (Continued)						
M007RHR006AS4	0.82	1,675	3.50	4.66	36	non-reversible (rotation is counterclockwise facing end of shaft);1/2" square drive; flange mounted
M007RHR009AS4	0.82	1,320	4.76	6.34	36	
M007RHR012AS4	0.79	870	6.19	8.25	36	
M007RHR0154S4	0.79	685	7.80	10.4	36	
M007RHR021AS4	0.79	470	11.5	15.3	36	
M007RHR027AS4	0.79	370	14.5	19.3	36	
M007RHR037AS4	0.79	270	19.7	26.3	36	
M007RHR044AS4	0.79	232	23.2	30.9	36	
M007RHR063BS5	0.79	161	33.5	44.7	36	non-reversible (rotation is counterclockwise facing end of shaft); 5/8" square drive; flange mounted
M007RHR086BS5	0.79	118	45.7	60.9	36	
M007RHR119BS5	0.76	82	60.5	80.7	36	
M007RHR151BS5	0.76	65	76.5	102	36	
M007RHR188BS5	0.76	52	96	128	36	
M007RHR275BS5	0.76	35	‡140	‡187	36	
M007RHR374BS5	0.76	26	‡191	‡254	36	
M007RVR006AS4	0.67	1,520	2.84	3.78	33	reversible; 1/2" square drive; flange mounted
M007RVR009AS4	0.67	1,120	3.86	5.14	33	
M007RVR012AS4	0.64	790	4.97	6.63	33	
M007RVR015AS4	0.64	625	6.29	8.38	33	
M007RVR021AS4	0.64	425	9.20	12.2	33	
M007RVR027AS4	0.64	335	11.6	15.5	33	
M007RVR037AS4	0.64	245	15.8	21.1	33	
M007RVR044AS4	0.64	210	18.6	24.8	33	
M007RVR063BS5	0.64	146	26.9	35.9	33	reversible; 1/2" square drive; flange mounted
M007RVR086BS5	0.64	107	36.7	48.9	33	
M007RVR119BS5	0.61	74	48.1	64.1	33	
M007RVR151BS5	0.61	58	61.0	81.3	33	
M007RVR188BS5	0.61	47	76.5	102	33	
M007RVR275BS5	0.61	32	‡111	‡148	33	
M007RVR374BS5	0.61	23	‡152	‡202	33	

‡ Applications with these models must be limited to 224 ft-lb torque.

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Vane-Type Geared Motors with Square Shaft (Continued)						
1801P2	1.35	500	17.2	23.0	46	
1801Q2	1.35	300	30.0	40.0	46	non-reversible (rotation is counterclockwise facing end of shaft); 1/2" square drive; flange mounted
1801U2	1.35	205	41.0	55.0	46	
1801W2	1.35	175	52.0	70.0	46	
1841P2	1.10	430	15.0	20.0	43	
1841Q2	1.10	260	27.0	36.0	43	reversible; 1/2" square drive; flange mounted
1841U2	1.10	175	37.0	50.0	43	
1841W2	1.10	150	45.0	60.0	43	reversible; 5/8" square drive; flange mounted
3800M2	1.55	520	24.0	33.0	48	
3800P2	1.45	285	42.0	56.5	48	
3800Q2	1.45	180	62.0	83.5	48	non-reversible (rotation is counterclockwise facing end of shaft); 5/8" square drive; flange mounted
3800R2	1.45	151	72.0	96.0	48	
3800S2	1.45	120	88.0	118	48	
3800U2	1.45	105	105	140	48	
3840M2	1.40	390	23.0	31.5	44	
3840P2	1.35	215	40.0	53.5	44	
3840Q2	1.35	130	60.0	80.0	44	reversible, 5/8" square drive; flange mounted
3840R2	1.35	122	69.0	92.0	44	
3840S2	1.35	100	86.0	115	44	
3840U2	1.35	83	100	134	44	
4800M2	3.70	560	51.0	69.0	95	
4800P2	3.50	260	98.0	131	95	non-reversible (rotation is counterclockwise facing end of shaft); 3/4" square drive; flange mounted
4800Q2	3.50	195	129	173	95	
4800S2	3.50	145	178	238	95	
4800U2	3.50	97	265	354	95	non-reversible (rotation is counterclockwise facing end of shaft); 1" square drive; flange mounted
4840M2	3.20	485	48.0	65.0	95	
4840P2	3.00	228	93.0	125	95	reversible; 3/4"square drive; flange mounted
4840Q2	3.00	167	123	165	95	
4840S2	3.00	125	161	215	95	
4840U2	3.00	83	225	300	95	reversible; 1" square drive; flange mounted

STATIONARY AIR MOTORS—PRODUCT DESCRIPTION (Continued)

Model	Maximum Horsepower	Speed @ Maximum Horsepower rpm	Starting Torque ft-lb	Stall Torque ft-lb	Air Consumption @ Maximum Horsepower cfm	Description
Reversible Vane-Type non-Geared Motors with Round, Keyed Shaft						
M0V005AA	0.75	3,300	1.6	2.2	30	Foot and face mounted; 5/8" diameter shaft
MVA008B	0.96	3,000	2.0	3.1	37	NEMA C face 56C frame size; 5/8"
MVA017A	1.93	2,800	4.5	7.0	76	diameter shaft foot and face mounted
MVA017B	1.93	2,800	4.5	7.0	76	NEMA C face 56C frame size; 7/8"
MVA034A	4.15	3,000	8.3	12.8	181	diameter shaft foot and face mounted;
MVA034B	4.15	3,000	8.3	12.8	181	7/8" diameter shaft
M0V075AA	10.50	2,600	22.5	30.0	260	NEMA C face 182C frame size; 7/8 diameter shaft
						Foot and face mounted; 5/8" diameter shaft
MRV003	0.33	7,600	0.29	0.38	17	hub mounted: 3/8" diameter shaft
MRV015	1.47	3,000	2.60	4.10	67	face mounted; 5/8" diameter shaft
MRV040	3.60	3,000	5.30	8.7	120	face mounted; 5/8" diameter shaft
MRV050	4.80	2,500	10.00	14.0	152	face mounted; 7/8" diameter shaft
Direct Drive Reversible Piston-Type Air Motors with Round, Keyed Shaft						
AAM	1.6	1,900	5.8	8.3	62	base mounted; 3/4" diameter shaft
CCM	2.0	1,075	13.2	18.8	97	}
DD6M	2.6	750	24.0	34.2	79	}
EEM	4.4	735	41.0	59.0	137	} base mounted; 1-1/8" diameter shaft
EE5M	7.8	950	60.0	80.0	220	}
HHM	11.3	730	106.0	152.0	270	} base mounted; 1-3/8" diameter shaft
HH5M	15.2	750	146.0	195.0	400	}
KK6M	25.0	755	260.0	325.0	680	base mounted; 1-5/8" diameter shaft
Gear Drive Reversible Piston-Type Air Motors with Round, Keyed Shaft						
EE3G	5.0	275	122	175	155	} base mounted; 1-1/4" diameter shaft
EE53G	6.8	305	154	205	220	}
EE9G	4.7	92	357	510	155	} base mounted; 1-1/2" diameter shaft
EE59G	6.5	100	450	600	220	}

HOW TO SELECT A STATIONARY AIR MOTOR

Selecting a stationary air motor for a customer's application can range from a simple operation like replacing an electric motor of known horsepower, speed and torque to a more complex operation of selecting a motor based on the requirements of the application. Before we start on this selection, let's review the basic truths of an air motor.

1. The speeds shown on the **Product Description** sheets are speeds at maximum horsepower. On all Ingersoll-Rand motors **except** the 22N51 and 551S motors, this speed is about 50% of free speed. Since 22N51 and 551S motors are governed motors, this speed for these motors is about 80% of free governed speed.
2. In general, nongoverned motors should be operated with sufficient load to prevent exceeding the speed at maximum horsepower by 10%. Performance curves in the Air Motor Catalog identify each motors maximum allowable speed.
3. Low speed geared motors have a very steep power and torque curve; high speed non-geared motors have a relatively flat power and torque curve. Speed drop off with increased load is greater on a high speed motor since its torque curve is flatter. (See figure 4 on page 8, Characteristics of an Air Motor.)
4. The stall torque listed on the **Product Description** sheets is approximately twice the torque at maximum horsepower. Starting torque is about 75% of stall torque.
5. All motor ratings listed on the **Product Description** sheets are at 90 psig air pressure at the motor.
6. A change of 10 psig air pressure will cause a corresponding change of about 14% in the horsepower. (refer to page 9, **How to Determine Performance at Air Pressures Other Than 90 psi**.) All air motor specifications at 90 psig represent only <u>one</u> set of performance figures. When selecting an air motor, the cataloged speed, torque or horsepower should serve only as a guide toward the initial consideration of a motor. Because air motors can be operated over such a wide range of pressures, a wide range of performance is available from a single motor making it especially desirable for many applications. Conversely, several different air motors can be selected for one particular set of operating specifications.

The following two examples illustrate the air motor selection process, the first using cataloged specifications and the second using performance curves.

Example No. 1

Now that we have refreshed our memory on the basics of an air motor, let's select a stationary air motor based on the requirements of an application. Let's assume our customer wants an air motor to drive an overhead conveyor that is used to paint a variety of parts by alternately immersing and heating the parts in a series of solvents, paint baths, and heating ovens. The drive must be spark-free, hence the use of an air motor instead of an electric motor. Because the parts to be painted are different in size and weight, the conveyor has to be run at different speeds to assure the proper amount of time the parts are to be in the heating oven.

Here are the specifications for this application:

1. Conveyor speed will range from 6 to 14 feet per minute.
2. The maximum load of the parts is 13 000 pounds.

Now to find the horsepower required to handle this, we use the following formula:

$$\text{Horsepower required} = \frac{\text{Maximum Load x Maximum Speed}}{33\,000}$$

$$\text{Horsepower required} = \frac{13\,000 \times 14}{33\,000}$$

$$\text{Horsepower required} = \frac{182\,000}{33\,000}$$

$$\text{Horsepower required} = 5.5$$

HOW TO SELECT A STATIONARY AIR MOTOR (Continued)

Now that we know the horsepower required, we can go back to our **Product Description** sheet or Air Motor catalog and select a motor of that horsepower range. In the vane-type motors we have the 551SO and 92RB078 motors with 5.6 and 7.9 horsepower, respectively. In the piston motors we have the EE59G with 6.5 horsepower. For clarification, let's catalog these motors as follows:

Motor	Maximum Horsepower	Speed at Maximum Horsepower, RPM
551SO51-W/RC	5.6	59
EE59G	6.5	100
92RB078	7.9	59

The proper selection based on speed depends upon the drive pulley arrangement at the conveyor which determines the rpm-to-fpm ratio. If we assume that we want a 1 to 1 rpm-to-fmp ratio, then we need a conveyor drive speed of 14 rpm. Knowing this, let's determine the gear reduction needed to run the conveyor at 14 feet per minute. To determine the reduction needed, we divide the motor speed by the conveyor drive speed. For the 551S0 and the 92RB078, divide 59 by 14 which tells us that a gear reduction of 4.2 is required. The same formula applied to the EE59G shows us that a 7.14 reduction is needed. At this point, it should be mentioned that gearing slightly reduces the power of a motor, so the less gearing we use to get our desired speed, the more efficient will be our motor and the less will be our power loss.

Since both the EE59G and the 92RB078 have more power than necessary, refer to the tables **How to Determine Performances at Air Pressure Other Than 90 psi.** We find that the EE59G should be operated at 80 psi in order to deliver 5.6 (6.5 hp x 86%) horsepower, while the 92RB078 should be operated at 70 psi in order to deliver 5.7 (7.9 hp x 72%) horsepower.

Now the question arises, should we select one of the vane motors or should we select the piston motor? Our choice for this example is the 92RB078 because:

a) A good rule to follow is to size an air motor based on approximately 70% of the lowest available air pressure. This will allow additional power for starting, possible overloads, and variations in supply line air pressure.
b) The 92RB078 is significantly less expensive than the other two choices making it more economical for the customers.

In most cases there will be more involved in the selection of a motor than speed and horsepower. In the foregoing example, there could have been space limitations, starting or stall torque requirements, available air pressure, or special mounting adapters or shafts.

HOW TO SELECT A STATIONARY AIR MOTOR (Continued)

Example No. 2

Select an air motor to replace a non-reversible, 1/2 horsepower, 1750 rpm electric motor driving a 4 to 1 speed reducer.

As a rule, an air motor should not be selected solely on the basis of matching the horsepower of the electric motor. In many cases, either speed or torque, but not both, is the primary requirement and a lower horsepower air motor can be used. When the lower horsepower motor is selected and speed is the primary requirement, a lower torque will result. Conversely, if torque is the critical requirement, a lower speed will result.

The first step is to determine the speed of the air motor which will replace both the electric motor and the speed reducer:

$$\frac{\text{Electric Motor Speed}}{\text{Gear Reduction}} = \frac{1750}{4} = 437 \text{ RPM}$$

The second step is to determine the running torque of the motor at 437 RPM:

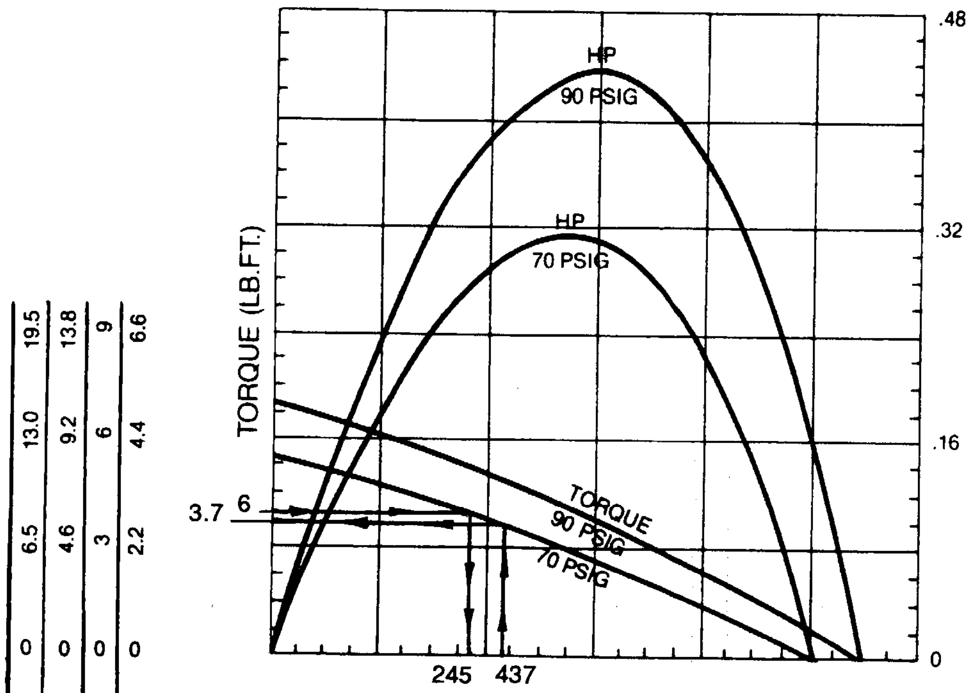
$$T = \frac{\text{HP x 5250}}{\text{RPM}} = \frac{.50 \text{ x } 5250}{437} = 6.0 \text{ ft-lbs}$$

Remember, running torque is not the stall or starting torques listed in catalog specifications.

Based upon this information, if speed is the primary requirement and a lower torque output is allowable, a M004RHR015AR3 is a good selection. If the torque is the primary requirement and a lower speed is allowable, then a M004RHR023AR3 is a good selection.

These selections were determined as follows using the performance curve shown on page 30 and a minimum plant air pressure of 70 psi.

HOW TO SELECT A STATIONARY AIR MOTOR (Continued)



MODEL	SPEED (RPM)		
M004RHR011AR3	542	1084	1626
M004RHR015AR3	400	800	1200
M004RHR023AR3	262	524	786
M004RHR033AR3	184	368	552

For the selection based on speed as the primary requirement, start with the horizontal (speed) axis. For the M004RHR015AR3 note that the first eight divisions on the axis represent speeds from 0 to 400 RPM. This equates to 50 RPM per division (400 ÷ 8), therefore 8 3/4 divisions (437 ÷ 50) represent the 437 RPM mark. Draw a vertical line from the 437 RPM mark until it intersects the 70 psi torque curve. Now draw a horizontal line from the intersection to the vertical (torque) axis. It meets the torque axis at the fifth division mark. Since 4 divisions represent 3.0 ft-lbs, 5 divisions represent 3.75 ft-lb (3.5 ÷ 4 x 5). In other words, a M004RHR015AR3 running at 437 RPM delivers 3.75 ft-lb torque.

For the selection based on torque as the primary requirement, start with the vertical (torque) axis. For model M004RHR023AR3 note that the first 4 divisions on the axis represent torques from 0 to 4.6 ft-lb. This equates to 1.15 ft-lb per division (4.6 ÷ 4), therefore, 5 1/4 divisions (6 ÷ 1.15) represent the 6 ft-lb mark. Draw a horizontal line from the 6 ft-lb mark until it intersects the 70 psi torque curve. Now draw a vertical line from the intersection to the horizontal (speed) axis. It meets the speed axis at the 7 1/2 division mark. Since 8 divisions represent 262 RPM, 7 1/2 divisions represent 245 RPM (262 ÷ 7 1/2). In other words, a M004RHR023AR3 delivering 6.0 ft-lbs of torque runs at 245 RPM.

Realizing that different model numbers operating at different air pressures can yield similar performance characteristics, the above two models are not the only possible selections.

MODEL NUMBER CODE FOR STATIONARY AIR MOTOR

Basic Model	Nominal Horsepower	Rotation	Air Inlet Exhaust	Gear Ratio	Flange	Shaft
M	**002** (.11 to .25)	**RV** (Reversible)	**R** = Rear	**000**= Direct Drive	**A**= 2 Hole Flange	**R3** = 3/8" Round Keyed
	004 (.31 to .50)	**RH** (NR, CCW facing shaft)	**S** = Side	**086** = 86:1	**B**= 4 Hole Face Mount	**R4** = 1/2" Round Keyed
	007 (.61 to .85)	**LH** (NR, CW facing shaft)		**374** = 374:1 etc. (consult current Air Motor catalog for complete list of ratios by model)	**B**=6 Hole Face Mount (on M007 motors with 063, 086, 119, 151, 188, 275 and 374 gear ratios)	**R6** = 3/4" Round Keyed
						S3 = 3/8" Square Drive
						S4 = 1/2" Square Drive
						S5 = 5/8" Square Drive
						T3 = 3/8"-24 Threaded

M004RVR023AR3

Basic Model	Gear Ratio	Drive Shaft
1801, **3800**, **4800** (nonreversible)	**M**	**No designation in this column means round, keyed shaft**
1841, **3840**, **4840** (reversible)	**N**	**2** (square drive)
	P	
	Q	
	S	
	U	
	W	

3840Q2

MODEL NUMBER CODE FOR STATIONARY AIR MOTORS (Continued)

Basic Model
22
551

Gear Ratio
N
SM
SO

Mounting
51 (base)

Control
W/RC (set up for Remote Control Operation)

551SO51-W/RC

Basic Model
17R (reversible)
34R (reversible)
48R (reversible)
92R (reversible)

Gear Box / **Gear Ratio**

A (single stage) —
005 (5 to 1)
008 (8 to 1)
011 (11 to 1)
014 (14 to 1)
017 (17 to 1)
022 (22 to 1)

B (two stage) —
029 (29 to 1)
036 (36 to 1)
045 (45 to 1)
078 (78 to 1)

92RB078

MODEL NUMBER CODE FOR STATIONARY AIR MOTORS (Continued)

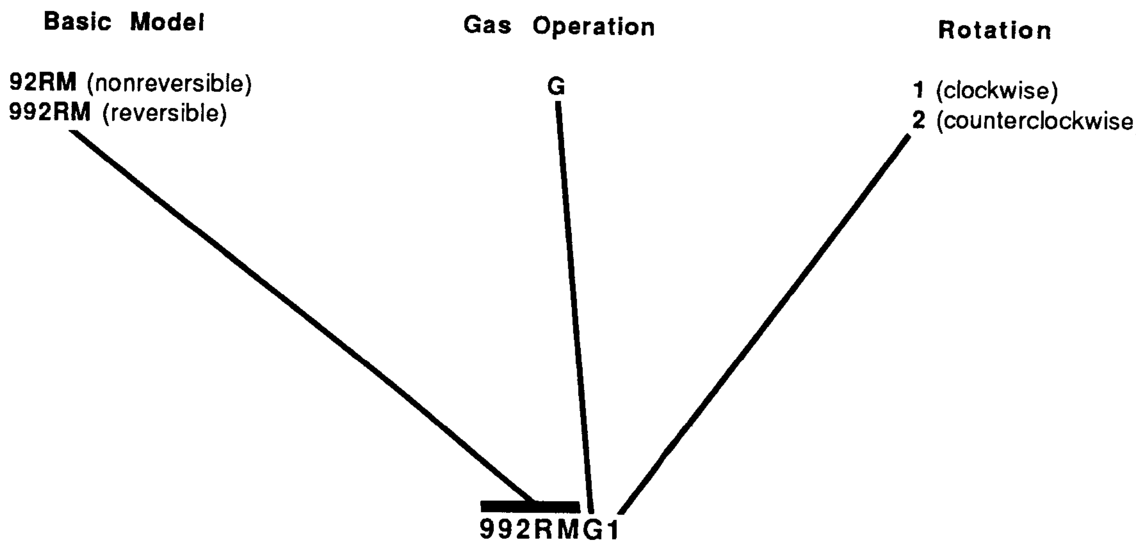
Basic Model	Nominal Horsepower	Mounting
MOV	**005** (3/4)	**A** (foot)
MVA	**008** (1)	**AA** (foot/face)
	017 (2)	**B** (NEMA C face)
	034 (4)	
	075 (10)	

MVA017B

Basic Model	Nominal Horsepower
MRV	**003** (1/3)
	015 (1-1/2)
	040 (4)
	050 (5)

MRV050

MODEL NUMBER CODE FOR STATIONARY AIR MOTORS (Continued)



EVOLUTION OF INGERSOLL-RAND VANE-TYPE STATIONARY AIR MOTORS

Model or Series	Introduced	Discontinued	Replaced By
JA3	(?)	February, 1954	JA31
JA31	February, 1954	July, 1972	
JC55	(?)	February, 1954	JC551
JC551	February, 1954	November, 1966	
9RM1, 2, 3, 4, 5, 6, 7, 8	September, 1953	June, 1954	
9RM11, 9RM12	June, 1954	March, 1962	91RM1, 91RM2
91RM1, 9RM2	March, 1962	September, 1973	92RM1, 92RM2
99RM1	June, 1954	March, 1962	991RM1
991RM1	March, 1962	September, 1973	992RM1
992RM1, 92RM2	September, 1973		
992RM1	September, 1973		
92RMG1, 92RMG2	September, 1973		
992RMG1	September, 1973		
20RM1, 2, 3, 4	September, 1953	April, 1957	201RM1, 2, 3, 4, 5, 6
220RM2, 220RM3	June, 1954	April, 1957	2201RM1, 2, 3
201RM1, 2, 3, 4, 5, 6	April, 1957	October, 1973	
2201RM1, 2, 3	April, 1957		
2201RM1		October, 1973	
2201RM2		?	
2201RM3		September, 1985	
JC33501	April, 1957	July, 1972	
180 Series	(?)	April, 1955	1800P, 1800Q
1800P, 1800Q	March, 1956	February, 1961	1801P, 1801Q
1801P, 1801Q, 1801U	February, 1961		
1801P		October, 1973	
1801P (Reintroduced)	August, 1980		
1841P, 1841Q, 1841U	February, 1961		
1841P		October, 1973	
1841P (Reintroduced)	August, 1980		
1801W, 1841W	August, 1964	October, 1973	
1801W, 1841W (Reintroduced)	September, 1985		
380 Series	(?)	November, 1956	3800M, P, Q, S
3800M, P, Q, S	November, 1955		
3840M, P, Q, S	November, 1955		
4800M, P, Q, S	February, 1957		
4840M, P, Q, S	February, 1957		
00B2L56, 00B2M56, 00B2P56, 00B2Q56, 00BR2L56, 00BR2M56, 00BR2P56 and 00BR2Q56	February, 1959	January, 1964	1400, 1440
1400J, K, L, M, P, Q	January, 1964		
1400J, K, L, P		October, 1973	M004 Series
1400M, Q		February, 1973	M004 Series
1440J, K, L, M, P, Q	January, 1964		M004 Series
1440J, K, L, P		October, 1973	M004 Series
1440M, Q		February, 1989	M004 Series

EVOLUTION OF INGERSOLL-RAND VANE-TYPE STATIONARY AIR MOTORS (Continued)

Model or Series	Introduced	Discontinued	Replaced By
0B1L56, 0B1M56, 0B1N56, 0BR1L56, 0BR1M56 and 0BR1N56	February, 1959	January, 1964	1600, 1640
1600D, H, J, K, L, M, N, P, Q, U, V, W and X.	January, 1964		
1600D, H, J, K and M		October, 1973	
1600L, N, P, Q, U, V, W and X		April, 1978	R1602L, N, Q, U, V, W, X
1600 Series (sold as specials)		February, 1989	
1640D, H,J,K,L,M,N,P,Q,U,V,W and X	January, 1964		
1640D,H,J,K and M		October,1973	
1640L,N,P,Q,U,V,W and X		April,1978	1642L, N, Q, U, V, W, X
1640 Series (Sold as specials)		February,1989	
R1620L, N, Q, U, V, W and X	April, 1978	February,1989	M007
1642L, N, Q, U, V, W and X	April, 1978	February, 1989	
1200J, K, L, M and N	January, 1964	October, 1973	
1200J, L, N (Reintroduced)	August, 1980	September, 1985	
1240J, K, L, M and N	January, 1964	October, 1973	
1240J, L, N (Reintroduced)	August, 1980	September, 1985	
22N51, 33SM51, 44SM51	These three models were listed on a price sheet dated March 8, 1956. They were not formally introduced until January, 1958.		
2XH51, 2XJ51, 2XK51, 2XL51, 2XM51 2XN51, 2XP51	January, 1958	October, 1973	
22H51, 22J51, 22K51, 22L51, 22M51 22N51, 22P51	January, 1958	October, 1973	
22N51-W/RC (Reintoduced)	August, 1989		
3H51, 3J51, 3SK51, 3SM51 and 3P551	January, 1958	October, 1973	
33H51, 33J51, 33SK51, 33SM51 and 33P551	January, 1958	October, 1973	
4J51, 4K51, 4L51, 4SM51	January, 1958	October, 1973	
44J51, 44K51, 44L51, 44SM51	January, 1958	October, 1973	
5H51, 5J51, 5K51, 5L51, 5SM51, 5SN51 and 5S051	January, 1958	October, 1973	
55H51, 55J51, 55K51, 55L51, 55SM51, 55SN51 and 55S051	January, 1958	April, 1964	Series 551
551H51,551J51, 551K51, 551L51,551SM51, 551SN51, 551S051 and 551SP51	April, 1964		
551H51, 551J51, 551N51 and 551SP51		October, 1973	
551K51 and 551L51		November, 1979	
551SM51 and 551S051		August, 1980	551SM51-W/RC and 551S051-W/RC
551SM51-W/RC and 551S051-W/RC	August, 1980		

EVOLUTION OF INGERSOLL-RAND VANE-TYPE STATIONARY AIR MOTORS (Continued)

Model or Series	Introduced	Discontinued	Replaced By
5AMM56, 5AMN56, 5AM056, and 5AMP56...	April, 1964	October, 1973	
551AMM56, 551AMN56, 551AM056 and 551AMP56..	April, 1965	October, 1973	
MOV010AA, MOV010AB and MOV020AA....	May, 1964	July, 1971	MVA008, MVA017, MVA034
MOV003AA, MOV003AB.........................	April, 1967		
MOV003AA...		September, 1976	
MOV005AA, MOV005AB.........................	April, 1967		
MOV005AB...		(?)	
MOV050AA, MOV050AB and MOV050AC....	April, 1967		
MOV050AB and MOV050AC.................		(?)	
MOV075AA..	April, 1967		
MVA008, MVA017, MVA034.....................	July, 1971		
8R, 17R, 34R, 48N, 48R, 92N and 92R.........	May, 1972		
48N, 92N..		September, 1985	
MRV003, MRV015, MRV040, MRV050.........	June, 1982		
M800, M850..	September, 1985	February, 1989	
M880, M8850..	September, 1985	February, 1989	
M002 Series	December, 1986		
M004 Series..	April, 1987		
M007 Series..	December, 1988		

Note: It may be possible to supply some discontinued motors on special order. Contact your I-R representative for availability.

EVOLUTION OF INGERSOLL-RAND PISTON-TYPE STATIONARY AIR MOTORS

Model or Series	Introduced	Discontinued	Replaced By
4 and 10	(?)	May, 1926	CM, CCM, DM, DDM, D6M, DD6M, EM, EEM
CM	May, 1926	October, 1973	
CCM	May, 1926		
DM	May, 1926	October, 1973	
DDM	May, 1926		
D6M	May, 1926	October, 1973 (?)	
DD6M	May, 1926		
EM	May, 1926	October, 1973	
EEM	May, 1926		
CM56, CCM56 (originally A276)	May, 1926	October, 1973	
DM56, DDM56 (originally A276)	May, 1926	October, 1973	
D6M56, DD6M56 (originally A276)	May, 1926	October, 1973	
EM56, EEM56 (originally A276)	May, 1926	October, 1973	
E3G, EE3G	May, 1928	October, 1973	
EE3G (Reintroduced)	September, 1985		
E9G, EE9G	July, 1932	October, 1973	
EE9G (Reintroduced)	September, 1985		
HM	June, 1935	October, 1973	
HHM	June, 1935		
KM	June, 1935	October, 1973	
KKM	June, 1935	April, 1990	HH5M
HM56, HHM56	June, 1935	October, 1973	
KM56, KKM56	June, 1935	October, 1973	
E5M	January, 1951	October, 1973	
EE5M	January, 1951		
E5M56, EE5M56 (originally A276)	January, 1951	October, 1973	
E53G, EE53G	January, 1951	October, 1973	
EE53G (Reintroduced)	September, 1985		
E59G, EE59G	January, 1951	October, 1973	
EE59G (Reintroduced)	September, 1985		
H5M	January, 1951	October, 1973	
HH5M	January, 1951		
H5M56, HH5M56	January, 1951	October, 1973	
K5M, KK5M	January, 1951	October, 1960	K6M, KK6M
K5M-A276, KK5M-A276	January, 1951	October, 1960	K6M56, KK6M56
AM	January, 1953	October, 1973	
AAM	January, 1953		
AM56, AAM56 (originally A276)	January, 1953	October, 1973	
K6M	October, 1960	October, 1973	
KK6M	October, 1960		
K6M56, KK6M56	October, 1960	October, 1973	
25HHWMC1	April, 1978	February, 1989	HH5M
35KKWMC1	April, 1978	February, 1989	KK6M

SERVICE LITERATURE FOR STATIONARY AIR MOTORS

Motor	Form No.	Edition
AM, AAM	P5767	4
CM,DM,D6M,EM,HM,KM,H5M,K5M	5620	12
ET1604	P6342	3
ET1803	P6277	4
ET1804	P6445	3
E3G	5619	7
ET3802	P6308	4
ET3803	P6446	3
JA31	5987	Discontinued
JC33501	5813	Discontinued
K6M	P5876	4
M002R	P6839	2
M002R	S6839	1
M004	P6855	2
M007	P6877	2
MOV003	P6039	4
MOV010	P5993	Discontinued
MOV050	P6047	4
MRV003, 015, 040 and 050	P6626	2
MRV003, 015, 040 and 050	S6626	1
MVA008, 017, and 034	P6154	6
M800	P6654	1
M8800FG744BA	P6939	1
R1602, 1642	P6436	2
R1602, 1642	S6436	1
1200	5933	Discontinued
1200-2	5990	5
1400,1440	P5983	6
1400-2	P5995	7
150RMG14	P6442	1
1600	P5938	7
1600-2 L, M, N and P	5954	Superseded by P6948
1600-2 Q, V, W and X	6084	Superseded by P6948
1601 L, M, N, P, Q, U, V, W and X	P6948	1
1801	P5901	7
1801-2	P5929	6
1802-2, 1812-2	6173	2
2X, 22	P6412	Discontinued
201RM	5821	Discontinued
201RM16	P6207	Discontinued
25HH	P6437	1
25HH	S6437	1
3H51, 3J51, 3SK51, 3SM51	P6410	1
3800	P5798	10
3800-2	P5797	11
3801-2, 3811-2	P6167	4
48R	6203	1
4800	P5815	11
4800-2	P5816	6
4801-2, 4811-2	P6188	4
5HMN56	5980	Discontinued
8R, 17R, 34R	P6208	2
9RM, 99RM	5822	Discontinued
91RM, 991RM	5920	Discontinued
92N, 92R	6204	Superseded by P6401
92N, 92R	P6401	2
92RMG10	6148	3

LINK LETTERS

The following Link Letters cover changes made on Stationary Air Motors.

Link No.	Subject
L16	New Cylinder for 55 Motors.
L-17	New Exhaust Deflector Seal for 00 Motors.
L-18	Gear Case Bolts for 33, 5, 55 and 551 Motors.
L-23	New O-ring for EE3G, EE9G and EE53G Motors.
L-25	Nylon Caps for Wrist Pins in Piston Motors.
L-26	Throttle Valve Spring Change for Manual-Closing Roll Throttle on 551 Motors.
L-77	New Oil Seal for AM56, AAM56 and AAUM56.
L-82	New Small End Plate Dowel for MOV003 and MOV005.
L-86	Heat-Treated and Non-Heat-Treated Cylinders for 20RM, 201RM and 201RM14.
L-114	R33H-138A Housing Stud Discontinued.
L-116	End Plate Material Change on 201RM, 2201RM, 20QDM, 20RM and 220RM.
L-117	Spare Reverse Valve Bushings and Rotary Valve Bushings for Piston-Type Motors.
L-152	Tapped Exhaust Deflector for 1801, 3800 and 4800.
L-158	New Piston for DM, DDM, DDUM, DGQ and DMQ Motors.
L-174	Improved Front Head for MVA Motors.
L-204	HU-513 Cast Iron Piston replaced by HU-513A Aluminum Piston on all H and HH Series Motors.
L-219	D6H60A-A513A Piston.
L-220	D02-513C Piston.
L-241	Improved Gear Box Assemblies for Series 48 and 92 Geared Motors.
L-248	Poppet Throttle Valves.
L-268	New Planet Gear Assemblies for all 00, 1400, 1401 and 14015 Motors.
L-282	Change in Check Balls on MOV003 and MOV005.
L-294	Die Cast Aluminum Pistons for H Series.
L-327	New D6H60A-A513D Piston Assemblies for D Motors.
L-330	New D10-A513B for E Motors.
L-331	New HU-A513B for H and 25HH.
L-332	New K5W-A513A for K, KK and 35KKWM.
L-373	Rotory Valve Seals for K5W-526, K5W-H526, H5W-526, 25HHWMC1-526 and 35KKWMC1-526 Rotary Valves.

BRIEF HISTORY OF INGERSOLL-RAND STATIONARY AIR MOTORS

Our earliest record of stationary piston air motors is an Engineering Information Sheet dated May, 1926, introducing the CM, CCM, DM, DDM, DD6M, EM and EEM motors, and discontinuing the 4 and 10 motors. Although we have no positive history of the 4 and 10 motors, information compiled many years ago for sales trainees states: "Originally, piston motors had only 3 cylinders, but they were not very smooth and they operated with a definite jerky motion so we standardized on a 4-cylinder motor."

Actually, there was a bit more to it than that. In July, 1923, we had come out with an entirely new line of hoists that replaced the worm geared hoists of that time, but retained the old style 3-cylinder revolving motor. In 1925 we redesigned the hoist motors so that instead of having rotating cylinders, we now had a conventional radial piston motor with reciprocating pistons and a rotating crank. The next logical step was to take these same hoist motors, install them on a properly designed base and offer them as stationary motors. This we did in May, 1926, offering them in both reversible and nonreversible models. Today, 64 years later, we are still marketing the reversible models CCM, DDM, DD6M and EEM.

At the time of introduction of these motors, there were many applications where the motor had to be face mounted instead of base mounted. For these applications we offered what was termed as an "A276 Special Mounted Motor" on which the base was replaced with a special motor mounting cover, and the outboard end of the motor shaft was left unfinished so that the customer could machine it to his own specifications. These flange mounted motors were known by the "A276" designation until 1960 when the digits "56" were added to the basic model number to indicate a flange mounted motor.

A quick check of the **Evolution** sheet for the piston motors will show that all of the flange mounted motors and the nonreversible motors in existence before 1973 were discontinued in October, 1973. While this may appear on paper as a major portion of our line, such is not the case.

The only difference between a reversible and nonreversible piston motor is in the rotary valve, and since rotary valves are physically interchangeable for a given motor size, any reversible piston motor can be converted to nonreversible by installation of the proper rotary valve. Further, the configuration of the air ports in the rotary valve is such that by installing the proper rotary valve, the motor can be converted to deliver maximum power in a specific direction of rotation or, in reversible motors, equal power in either direction of rotation. This applies to all piston motors except the 25HH and 35KK motors introduced in April, 1978. These are reversible motors for which only one rotary valve is available. These motors deliver equal power in either direction of rotation.

In addition to the various rotary valves, we still offer the special motor mounting covers for converting a piston motor from base mounting to flange mounting.

In May, 1928, to meet the demand for slower speed stationary piston motors, we offered the E3G and EE3G. These were actually EM and EEM motors with a 3 to 1 gear reduction. In July, 1932, we introduced the same motors with a two-stage 9 to 1 gear reduction and designated them as E9G and EE9G.

Now, before somebody gets the idea that an E59G motor is the same motor with a 59 to 1 gear reduction, let's get our facts straight! In January, 1951, we introduced the E5M and EE5M motors which were 5-cylinder motors as opposed to the 4-cylinder EM and EEM motors. Thus, the first digit in the E59G model designation indicates a 5 cylinder motor, while the second digit indicates the 9 to 1 gear ratio.

Simultaneous with the introduction of the 5-cylinder E5M and EE5M motors in January, 1951, we also introduced the "H" and "K" series 5-cylinder motors. It is interesting to note that these 5-cylinder motors did not replace any of the 4-cylinder motors, but when we introduced the 6-cylinder "K" motor in 1960, we discontinued the 5-cylinder "K" motor. This is the **only** replacement we have had since 1926!

The last addition to the piston motor line was the powerful 25HHWMC1 and 35KKWMC1 motors in 1978. These were basically motors from our Popeye® Winch with base mounting dimensions the same as the HH5M and KK6M respectively, and essentially the same physical size and weight also. Due to an extremely large rotary valve, air inlet and exhaust, they developed far greater Horsepower and speed than the HH5M and KK6M but not any appreciably greater torque. They were discontinued in 1989, a few years after the Popeye® Winch.

BRIEF HISTORY OF INGERSOLL-RAND STATIONARY AIR MOTORS (Continued)

Over the years there have been minor improvements in our piston motors, the most significant of which is the change from cast iron pistons to aluminum pistons.

Our history of the vane type stationary motors begins sometime in the late 1940's or early 1950's. During this time frame—prior to the actual cataloging and price listing of vane-type stationary motors—we were producing motors for three specific markets.

1. We sold some motors as special products to OEM accounts.
2. We were just beginning to market air starting motors—not a complete air starter, but an air motor to replace the electric motor on an existing starter. These were the 9BM and 19BM motors. (The "BM" stood for "Bendix Motor").
3. We were in the process of building a multiple nut runner where we used as high as 24 gang-mounted motors to simultaneously run a series of hexagon nuts or cap screws.

Each of these three markets contributed significantly to our line of vane-type stationary air motors. Just as most of our piston-type stationary motors were offsprings of other products, so it was with our vane-type stationary motors. The JA3 was a derivative from a jackbit grinder, and the JC55 was a near twin to a special motor marketed to Joyce-Cridland Jacks. Similarly, the 9RM's and 99RM's were from the 9BM air starting motor, and many of our other motors were offsprings of comparable size drills. The 1200, 1400, 1600, 1800, 3800 and 4800 motors were round, keyed shaft versions of our square-drive multiple nut runner motors, and the 2X, 22, 3, 33, 4, 44, 5 and 55 motors were base mounted offsprings of our comparable line of drills.

It wasn't until May, 1964, that we introduced a vane-type stationary motor that was designed specifically for that purpose. This was the MOV010 and the MOV020. In 1967 we added four more motors to this line, and in July, 1971, we introduced a new series designated as the MVA008, MVA017 and MVA034. These new motors superseded the MOV010 and MOV020 and offered several new features not found in their predecessors—primarily mounting dimensions and shaft dimensions that conformed to NEMA C standards. The MVA008 and MVA017 could be used to replace electric motors of equivalent horsepower and having a 56C frame size, while the MVA034 served as a replacement for electric motors having a 182C frame size.

In May, 1972, we introduced a complete new line of vane-type geared motors having seven basic power units and ten different gear ratios to provide seventy individual models. These motors are the series 8R, 17R, 34R, 48N, 48R, 92N and 92R. They are especially adapted to overhung load applications, since bearings, bearing seats and shafts are of ample size and strength to prevent damage due to shaft deflection forces within certain limitations. In conjunction with these motors, we also offered special shafts and mounting flanges to accommodate a number of NEMA frame sizes. It should be pointed out here that the special shafts and flanges are for those motors with the small gear box only (refer to the **Product Description** sheets and the **Model Number Code** sheets).

Our line of vane-type, non-geared motors was increased in June, 1982, with the introduction of the MRV003, MRV015, MRV040 and MRV050. These motors did not replace any of our existing line, but were offered primarily as power units which could be economically replaced instead of spending time and money for major overhauls. This is not to say that a customer could not replace major parts if he so desired—because he could. However, the design of these motors was such that if they required a major part replacement, it was often more economical to scrap the motor and install a new one than to spend time aligning and installing a new cylinder, rotor or end plate. The MRV's are good, heavy duty motors totally sealed against dust and dirt, and have rugged cast iron housing members. Further, they have spring-loaded vanes to assure positive starting under load.

In order to further increase our OEM motor business, our line expanded again in 1986 with the introduction of a newly designed line of geared, vane air motors. Designated as the M002 Series, they were followed by the M004 Series in 1987 and the M007 Series in 1988.

The new motors were specifically designed to fill the large variety of individual needs required by many different original equipment manufacturers. Modular design, reversible or non-reversible styles, rear or side air inlet, rear or side exhaust, keyed, square, or threaded arbors, dozens of gear ratios, etc.