Application Engineering Bulletin
AE-1240-R6

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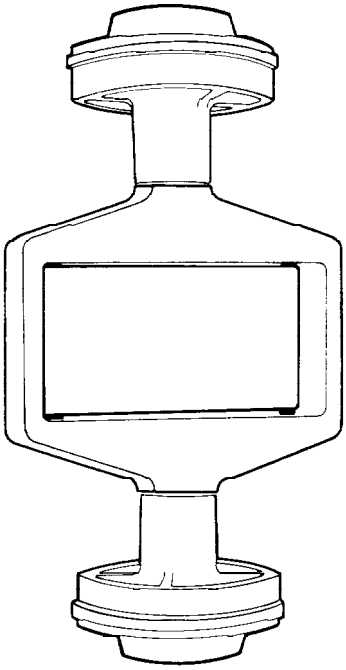
APPLICATION OF MODEL BR COMPRESSOR

Since the introduction of the Copelaweld "BR" motor-compressor family, major improvements in design and construction have been incorporated which greatly expand the application range of these models. The double Scotch yoke design has proven its rugged durability under severe operating conditions.

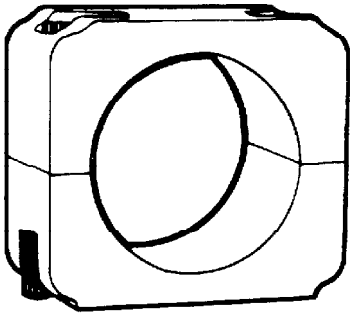


YOKE AND PISTON ASSEMBLY
Figure 1

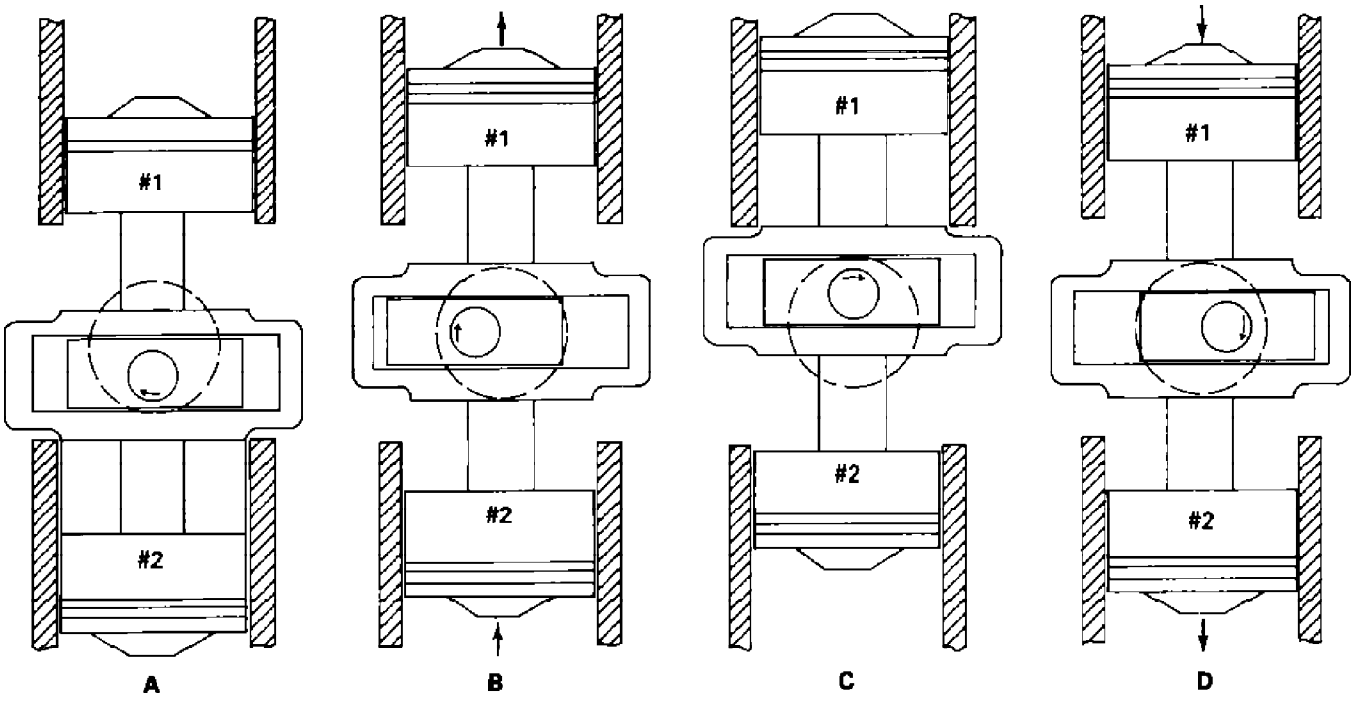
Figure 1, 2, and 3 help visualize the internal working parts of the compressor and their interrelated movement when the motor is energized. Power is transmitted from an electric motor by a revolving crankshaft of conventional design, with offset throws to create a circular driving force.

Figure 1 illustrates the yoke and piston assembly. Two opposing pistons are mounted rigidly on a yoke. The yoke is constructed of high strength aluminum with steel plates on the inner surfaces for a durable bearing surface.

The slide block shown in Figure 2 fits inside the yoke and is designed to slide smoothly back and forth, providing the means of converting the rotating movement of the crankshaft to the reciprocating movement of the pistons. The offset throws of the crankshaft fits through the hole in the slide block.



SLIDE BLOCK
Figure 2



SCOTCH YOKE COMPRESSION CYCLE
Figure 3

Figure 3 illustrates a complete compression cycle with the double Scotch yoke mechanism.

In position A, #1 piston is at the bottom of its suction stroke, while #2 piston is on top dead center at the end of its compression stroke.

In position B, the crankshaft has rotated 90°. The #1 piston is now midway in its compression stroke, while #2 piston is midway in a suction stroke. Note that the slide block has moved to the left to compensate for the rotary movement of the crankshaft, while the yoke and piston assembly moves rigidly as shown.

In position C, the crankshaft has now rotated 180° from its original position. The slide block has returned to the center of the yoke. The #1 piston has completed its compression stroke while #2 piston has completed its suction stroke.

In position D, the crankshaft has rotated 270° from its original position or 3/4 of one revolution. The slide block has moved to the right, #1 piston is now on its suction stroke, while #2 piston is midway in its discharge stroke.

When the crankshaft has completed one revolution, it will again return to position A, and the cycle will be repeated. During the cycle, the slide block moves in four directions in one plane, while the movement of the yoke and piston assembly is two directional only.

The BR family is a four-cylinder compressor with two double-ended Scotch yoke assemblies mounted one above the other. In the compressor, the crankshaft is vertical and each Scotch yoke assembly is offset 180°, so the cylinders are located 90° apart. As a result, the compressor is inherently well balanced and smooth running.

Motor Protection

BR*2 models all have internal inherent motor protection. BR*1 models had pilot circuit solid state protection, manufactured by either Robertshaw or Texas Instruments, which are not interchangeable. The wiring diagrams for BRK1 compressors with Texas Instruments protection modules are shown in Figure 4. The wiring diagram for compressors with internal inherent protection is shown in Figure 5.

Lubrication

BR compressors are furnished with either white or 3GS oil, depending upon OEM requirements. White oil and 3GS are fully compatible and may be mixed in the field.

On applications where a service replacement compressor has been installed, it is quite possible that there may be residual oil in the system, with the result that, after a short period of operation, the replacement compressor can be operating with an excessively high oil level. This can result in oil slugging and valve plate damage.

In order to provide a means of checking the oil level and removing excess oil from the system, a Schrader type valve at the normal oil level is provided on "BR" compressors. The Schrader valve should discharge refrigerant vapor with a proper oil charge in the compressor. If the Schrader valve discharges oil (liquid or foam), this indicates an excessive oil charge, and oil should be removed through the valve until it discharges vapor.

Application

All "BR" compressors include as standard equipment a bellyband type crankcase heater installed at oil level on the compressor shell. This heater should be located 1-1/4 to 2-1/2 inches from the top of the mounting foot. Field experience indicates that as the refrigerant charge in the system increases, the potential mechanical stress level from liquid flooding or liquid migration also increases rapidly. Furthermore, if the evaporator can drain liquid by gravity to the compressor, the crankcase heater may be overpowered by refrigerant recondensing and running back into the compressor as fast as the crankcase heater vaporizes it.

While a compressor can digest small amounts of liquid refrigerant on an occasional basis, frequent liquid induced stress can cause mechanical damage. Since the BR line is in the higher horsepower range for welded compressors, by the mere fact of its size and capacity, system induced problems tend to more severe. Therefore, in the best interest of both Copeland and our customers, more stringent application requirements have been established for "BR" compressors compared to smaller hermetic compressors.

Since there is no direct factory control of condensing unit applications, a suction accumulator is mandatory on any remote condensing units utilizing the BRH and BRK models. A suction accumulator is mandatory for all BR models in all systems if the system refrigerant charge exceeds 16 pounds. Packaged computer room air-conditioners require an accumulator under all conditions due to potential rapid cycling operation and close coupled components. If the system refrigerant charge on any type of system exceeds 30 pounds, a pumpdown system type of control should be used in addition to the accumulator. Failure to follow Copeland specifications in this regard may adversely affect compressor replacement at no charge should a failure occur during the warranty period.

There is no internal pressure relief valve in BR compressors and a high pressure control is required for all applications. On compressors with Rotalock spud connections, a port is provided on the spud for a high pressure control connection. On compressors with stub tubes for brazed connections, no port is provided on the compressor and the connection must be made externally to the hot gas discharge line. Abnormally high discharge pressure usually indicates a system problem which needs to be corrected. Automatic reset high pressure controls provide marginal protection at best, and a manual reset high pressure control is strongly recommended for proper compressor protection.

For loss of charge protection, a low pressure control is required for all applications. For air conditioning applications a minimum setting of 30 psig is recommended while 10 psig is recommended for heat pumps. For heat pump applications a high discharge temperature cut-off on the discharge line is required to prevent overheating under loss of charge conditions. The cut-out temperature should be 275°F.

The "BR" compressor requires air flow over the compressor shell for proper cooling. Ventilation of the compartment in which the compressor is located by air flowing to the condenser fan will be adequate provided vents are located so that air flows freely around the base of the compressor. Tightly insulated compressor compartments can cause excessively high oil temperatures.

"BR" models are suitable for both air conditioning and heat pump applications with refrigerant R-22. The published operating curves indicate the limits for specified evaporating and condensing temperatures.

The compressor cut-off points on the operating curves are established at conditions when discharge valve temperatures reach a level where oil coking can occur. Prolonged operation at or near cut-off points can have a detrimental effect on compressor life and for compressors which must operate continuously with low evaporating temperatures R-502 may be a preferable refrigerant because of its lower discharge temperatures.

For heat pump applications the general recommendations as set forth in Application Engineering Bulletin AE 17-1243 apply, including a liquid flooding refrigerant control device, a suction accumulator, and continuous compressor operation at low ambients. In order to avoid compressor overheating on air-to-air heat pump applications, the expansion device must flood sufficient liquid to cool the compressor, and to avoid liquid refrigerant damage, the accumulator must limit the amount of liquid refrigerant that reaches the crankcase. The most critical operating conditions are operation at low outdoor ambients in the heating mode, or operation with the outdoor coil iced up, which results in high compression ratio.

Recommended Test Procedure for Air-to-Air Heat Pumps

In order to determine if the "BR" compressor can be maintained within safe temperature limits on an air-to-air heat pump, the following test procedure should be followed.

Mount the unit in a suitable test room and disconnect the defrost control. Maintain the indoor room at 70°F and lower the temperature of the outdoor room to as low a temperature as possible. Spray the outdoor coil with water to frost it completely, and recirculate the airflow on the outdoor coil to drive the evaporator temperature to -20°F or below. Operate the unit several hours at this condition.

If the compressor sump temperature falls below 35°F, too much liquid refrigerant is reaching the compressor crankcase, and an accumulator with a smaller orifice should be used.

If the discharge temperature exceeds 250°F, the compressor is not being adequately cooled, and either the liquid expansion device or the orifice in the accumulator must be enlarged to allow additional liquid refrigerant flooding to cool the compressor.

The use of refrigerant R-502 is another alternative which will result in a significant reduction in discharge temperatures.

Replacement of BR*1 Compressors with BR*2 Models

Aside from the electrical terminal box, BR*2 models with inherent protection are physically identical to BR*1 models with solid state module protection. Therefore, the only installation problem when changing models is a minor wiring modification described below:

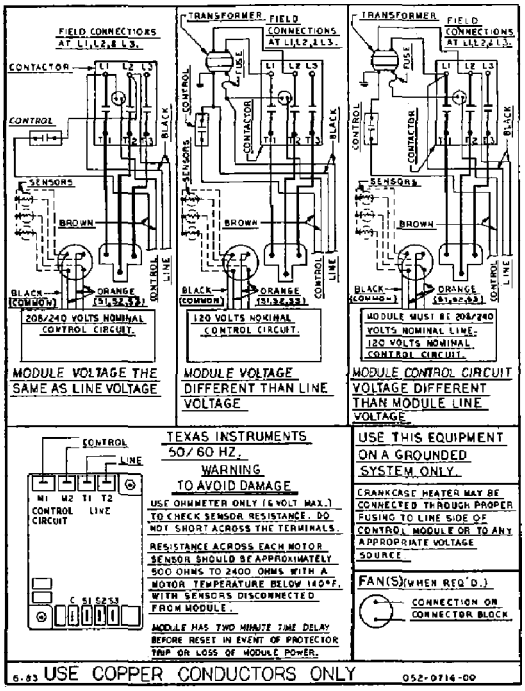
When installing BR*2 models in a system originally containing BR*1 models:

1. Remove the wiring leads originally run from the line or transformer to the “line” terminals (T1-T2) on the solid state module.
2. Either jumper the leads originally run to the “control” terminals (M1-M2) on the solid state module, or remove the leads to M1-M2 and rerun the control wiring directly from the control to the contactor coil.
3. The only wiring connections to the BR*2 models are the three power leads.

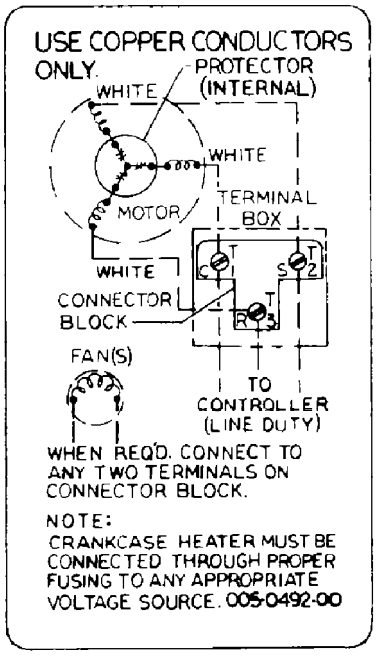
See Figures 4 and 5.

BR Mounting Assembly

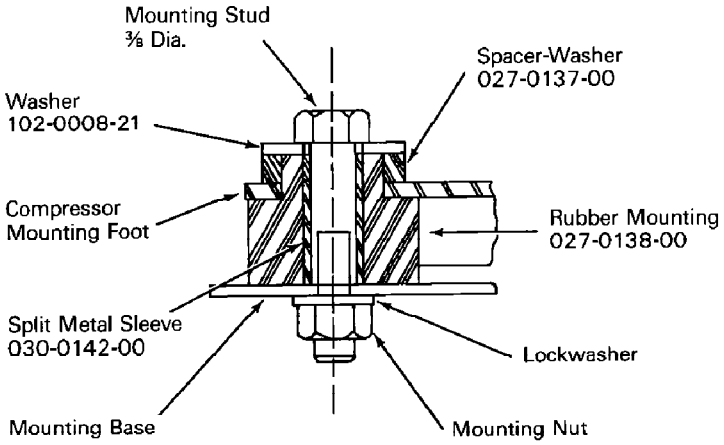
The mounting assembly for the BR compressor is shown in Figure 6, along with part numbers for the mounting components which Copeland supplies.



SOLID STATE PROTECTION, TSC, TSD, TSE
BRK1 MODEL
Figure 4



INTERNAL INHERENT MOTOR PROTECTION
BRE2, BRG2, BRH2, BRK2 MODELS
Figure 5



BR MOUNTING ASSEMBLY
Figure 6