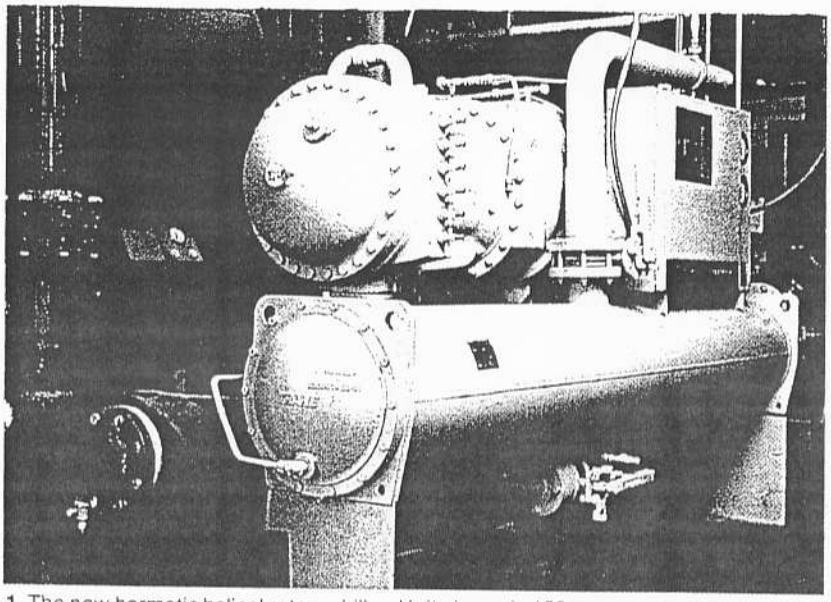
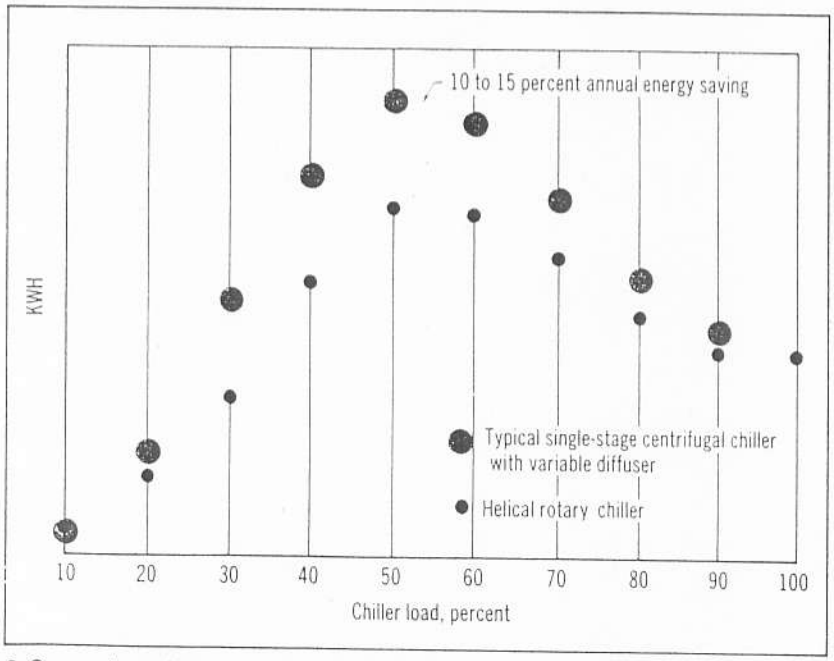
TRANE SCREWS

New technology and the helical rotary compressor

New helical rotary compressor optimized for air conditioning applications meets needs of both new construction and renovation projects



1 The new hermetic helical rotary chiller. Unit shown is 150 ton capacity with sizes ranging from 100 to 300 tons.



2 Comparison of helical rotary chiller and single-stage centrifugal chiller at part load.

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Beautiful to behold, but what makes the sculptured steel rotors of the newest helical rotary compressor a technological breakthrough? And what does the compressor offer owners?

We believe the compressor and its new chiller series (Fig. 1) meet definite market needs for both new construction and renovation projects. Recent progress in computerized design, manufacturing, and coordinate measuring technology make it possible to bring to the market a simple, compact, highly reliable and efficient helical rotary compressor optimized for air conditioning applications.

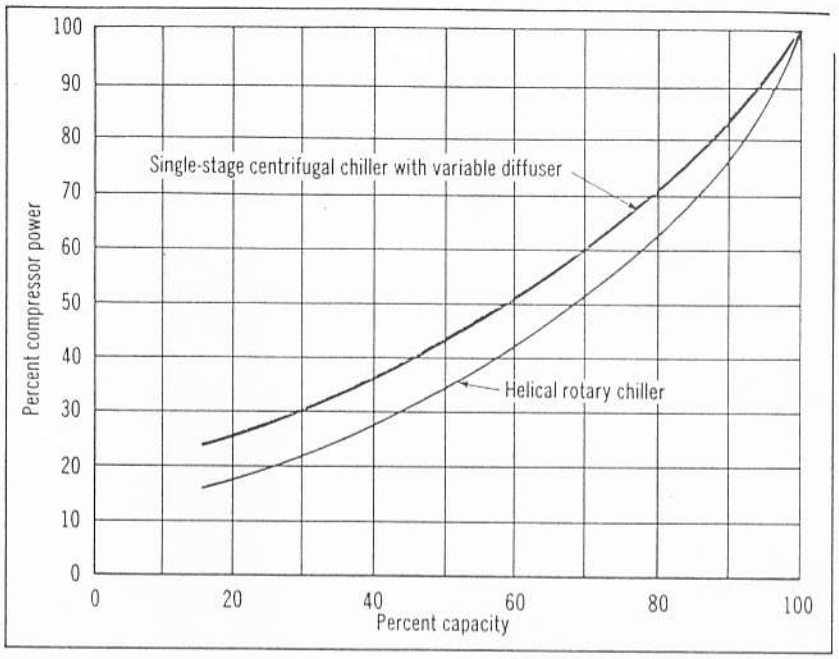
Efficiency of the latest generation of compressors is 10 to 20 percent greater than that of helical rotary designs that have been in use since the 1960s. Full load efficiency of these helical rotary compressors is equal to that of today's single stage centrifugals while part load efficiency has proven to be clearly superior (Fig. 2). Since chillers operate a majority of the time at part load, helical rotary chiller owners can realize substantial energy savings (Fig. 3).

The helical rotary compressor is not new, having been invented in 1878. The compressor developed slowly over the last 100 years, mainly because of its manufacturing complexity. Svenska Rotor Maskiner (SRM), a Swedish com-

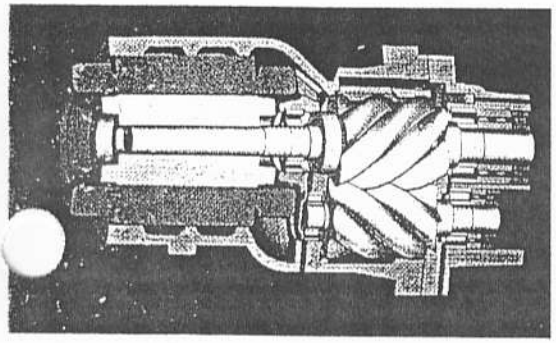
pany, has done a great deal of research and development with helical rotary compressors, particularly in air compressor applications, and owns many patents associated with the compressor. Its work began in the early 1900s.

Development work

We first considered the helical rotary compressor in 1946 when we commissioned an independent laboratory to do development work on the concept. The thinking at the time was that, theoretically, the machine could work well as a refrigerant compressor. To provide proper rotor sealing for acceptable efficiency, however, a very high precision machine tool would be required. Final machining of rotors and housings with the machine tools that did exist at that time was very difficult and labor intensive. Acceptable final fit, for reliability of rotor pairs, could only be achieved by hand lapping the parts. And efficiency of the compressor was not at all acceptable relative to centrifugal chillers. It should be noted, however, that some manufacturers were building helical rotary compressors primarily as replacements for reciprocating compressors.



3 Energy saving possible with helical rotary chiller vs. single-stage centrifugal chiller.



4 Powerful computer modeling allows optimized compressor design.

5 Accurately machined compressor rotors and drive motor.

As a result, we concluded that the helical rotary compressor was not yet efficient enough for air conditioning use nor economically manufacturable with the technology available in the late 1940s.

Enter the computer, CAD/CAM, and the coordinate measuring machine (CMM) technology of the 1980s.

Within the last five years, SRM developed computer software for generating what is known as the "D" profile for rotor lobes. Using this profile as a basis, we developed and refined software to optimize the compressor for air conditioning applications by increasing efficiency and enhancing reliability (Fig 4).

With powerful computer simulation, engineers can optimize rotor designs for virtually any specific air conditioning application and job site condition, with the knowledge that the design can be machined accurately and economically (Fig. 5).

The computer makes thorough, scientific analysis of rotor design possible. Granted, thousands of helical rotary compressors have been built since 1878. But only recently have designers been able to manipulate the many compressor design variables to optimize the compressor for air conditioning applications. These variables include:

- Rotor length to diameter ratio.
- Ratio of male to female lobes.
- Wrap angle of the lobes.
- Lobe profile.
- Intake and discharge port geometry.
- Unloading mechanisms.
- Oil injection for sealing and lubrication.
- Tip speed.
- Clearances.
- "Blow hole" area.
- Operating pressures and

temperatures.

Most previous designs were successful and did the job reasonably well, but now helical rotary compressor design is a precise operation giving the owner a much more efficient and reliable compressor.

The optimized rotor designs and compressor assemblies are buildable too. Only recently have ultra-high precision machine tools become available that can accurately and economically machine the rotors being designed for high efficiency.

The design and construction of the rotor housing is equally important for best efficiency and reliability. Very accurate machining is necessary to locate the rotors precisely relative to each other and the housing surfaces. Accurate machining provides 3 to 4 percent more efficiency compared to compressors that are only hand inspected for fit and clearance.

We use a Swiss built horizontal machining center considered the most accurate in the world. This machine can bore holes in a housing within a 0.0005 in. diameter target area. In comparison, the diameter of a human hair is about 0.003 in.

To assure that rotors and housings are machined according to specifications, the world's most accurate coordinate measuring machine (CMM), also Swiss built, is used. This machine is capable of linear measuring accuracies of under 0.00005 in. and volumetric measuring accuracies of under 0.0001 in. This capability confirms machine tool accuracy during production.

Both the machine tool and the CMM are located in a temperature and humidity controlled room. This room is equal to or better than such facilities found at aerospace manufacturers.

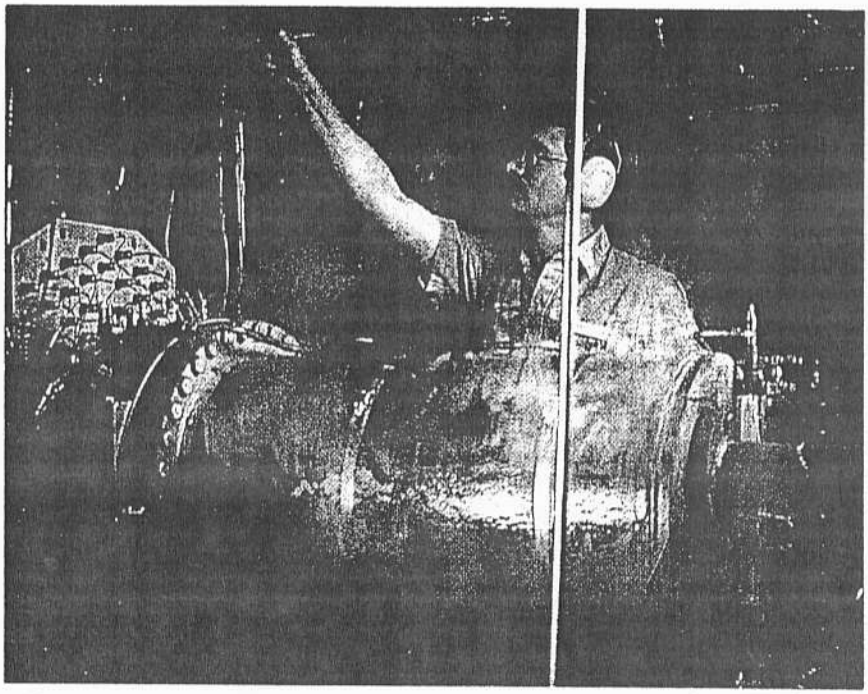
Computerized design, manufacturing, and measuring means helical rotary compressors can be built with the precise clearances necessary for high efficiency while maintaining reliability. Computers have solved the efficiency vs. reliability paradox. To achieve the efficiency levels necessary to meet market demands, rotor clearance must be close to minimize gas leakage in the compressor. Previously, these small clearances were unmanageable and could not be used since reliability would suffer, a result of undeveloped manufacturing and measuring capability. Thus, until now, efficiency was not optimized.

True mass production of helical rotary compressors is achieved by using such accurate machine tools. Until now, helical rotary compressors, especially the rotors, required careful hand fit and assembly. Now rotors can be machined exactly to drawing specifications with the assurance that the parts will fit correctly.

Owner benefits

Efficiency has been improved to meet market needs and has been proven to be superior to that of reciprocating and single stage centrifugal compressors.

Reliability is improved over earlier designs through precise machine work and manufacturing techniques. The new design has been tested for more than 22,000 hr in the laboratory and in actual job site conditions, proving to be very rugged and reliable (Fig. 6). Because it is a positive displacement compressor, the helical rotary compressor cannot encounter surge problems. The inherently smooth operation of the new design compressor generates very little noise. This makes equipment room placement and insulation less critical.



6 Rigorous testing has shown the new helical rotary compressor to be very rugged under extreme operating conditions. In this accelerated life test, ice forms on the suction line while paint on the compressor discharge begins to smoke.

The compact size of the helical rotary compressor has always been an advantage. Chillers up to 150 tons will fit through a standard 36 in. wide door. Larger chillers will easily fit through double width doors. Compact size makes these chillers especially attractive for replacement and renovation work.

Delivery of the new helical rotary compressors with the chillers will begin early this year. Ω

TRANE

General Service Bulletin

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B.U	Europe Chiller Manufacturing
Page	1 OF 4
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Supersedes	NOTHING

SUBJECT : HELICAL ROTARY COMPRESSORS INSULATION RESISTANCE TESTING

INTRODUCTION :

The purpose of this Service Bulletin is to discuss the use and interpretation of motor insulation resistance testing of semi-hermetic helical rotary compressors.

DISCUSSION :

Megger testing of helical rotary compressor motors can provide results which are subjective and may be misleading. Any one of the factors listed below can make a perfectly good compressor motor appear to have marginal insulation.

There are many factors that contribute to low megger readings which include :

- Type and amount of system contaminates (moisture, acid, dirt, etc).
- Condition of oil in the system.
- Cleanliness of the compressor terminal board, both inside and out.
- The amount of oil or refrigerant liquid in the compressor (high levels may cause the leads to be saturated and lower the reading).
- Condition of the terminal studs and insulators.
- Windings temperature (insulation resistance of most materials varies inversely with temperature).

(This bulletin is informational only and does not authorize any parts or labor)