CHILLERS

Timothy C Wray P.E. July 1999

A. TYPES OF ELECTRIC DRIVEN CHILLERS

1.

20 to 60 tons	Hermetic reciprocating or scroll
40 to 150 tons	Reciprocating
100 to 1,200+ tons	Screw open and hermetic
100 to 1,500 tons	Centrifugal
1500 to 3,000+ tons	Customs Centrifugal
½ to 250 tons	Air Cooled - Scroll, Recip, Screw

2. Screw Compressors
   a. Oil seal
   b. Good turn down
   c. + 0.60 KW/Ton
   d. Noisy, both motor and compressor

3. 2 & 3 stage centrifugal - (Trane low pressure chillers)
   a. High efficiency
   b. Good turn down
   c. + 0.50 KW/Ton
   d. Quite

4. Gear Drive Centrifugal
   a. Good efficiency
   b. 25% turn down
   c. + 0.600 KW/Ton
   d. Noisy
   e. Requires some additional maintenance

5. Air Cooled
   a. Reciprocating / Scrolls - 20 to 150 tons
   b. Screws - 60 to 250 tons
   c. Centrifugal - 150 to 300 tons
   d. 1.2 to 2.0 KW/TON
   e. Easy maintenance
      (1) No cooling towers or water chemical maintenance
      (2) No condenser water pumps

B. ALTERNATE DRIVE SOURCES FOR CENTRIFUGAL MACHINES

1. Engine driven - open drive.
    a. Great efficient, +Absorption chiller for waste heat
    b. Large footprint
    c. Requires extra maintenance, Run time tear down
    d. Expensive
    e. Noisy and should be in separated room.

2. Steam Turbine - open drive.
    a. Need high pressure steam for economics
    b. Need to be above 800 tons for economics
    c. Better turn down, faster start up colder water than Absorber.
    d. Large foot print.
    e. Cooling towers should be sized to handle the additional load of condensing the steam.

C. ABSORPTION

1. Steam
    a. Two stage, high pressure @ 10#/ton
    b. Single stage, low pressure @ 17#/ton

2. Hot water
    a. 250° and up hot water
    b. + 18,000 btu/ton

3. Gas fired
    a. Efficient, Low KW/Ton
    b. Can heat or cool, but not at same time
    c. Requires extra maintenance
    d. Expensive

D. WATER

1. Condenser Water (Cooling tower)
    a. 10°Δ to 12° Δ temperatures for electric chillers.
    b. 15°Δ to 17°Δ temperatures for Absorption chillers.
    c. Typical temperatures 95°-85° or 105° 0-85°
    d. Start up - 75° min temperature on most machines.
    e. Absorption should never fall below 70 degrees even under full load on most machines.

2. Chilled Water -

   a. 10°Δ, Typically 45° to 55°

   b. 12°Δ & 15°Δ chiller will operate more efficiently
      (1) Saves pump HP / Chilled water coils are larger.
   c. Lower water temperatures ,
   d. Absorption - 42° min. water temp.

3. Pressure Drops
   a. Number of passes - single pass or multiple passes
   b. Enhanced Tube - turbulence
   c. Condenser (Cooling Tower) - 15' (Try for less)
   d. Evaporator (Chilled Water) - 20' (Try for less)
   e. Tube velocity, typically 7 FPS

4. Connection type
   a. Victaulic
   b. Flanged
   c. Marine box

E. REFRIGERANTS
   1. Phased out
      a. R-11 - Old low pressure Typically all old Trane Centrifugal
      b. R-12 - Old medium pressure

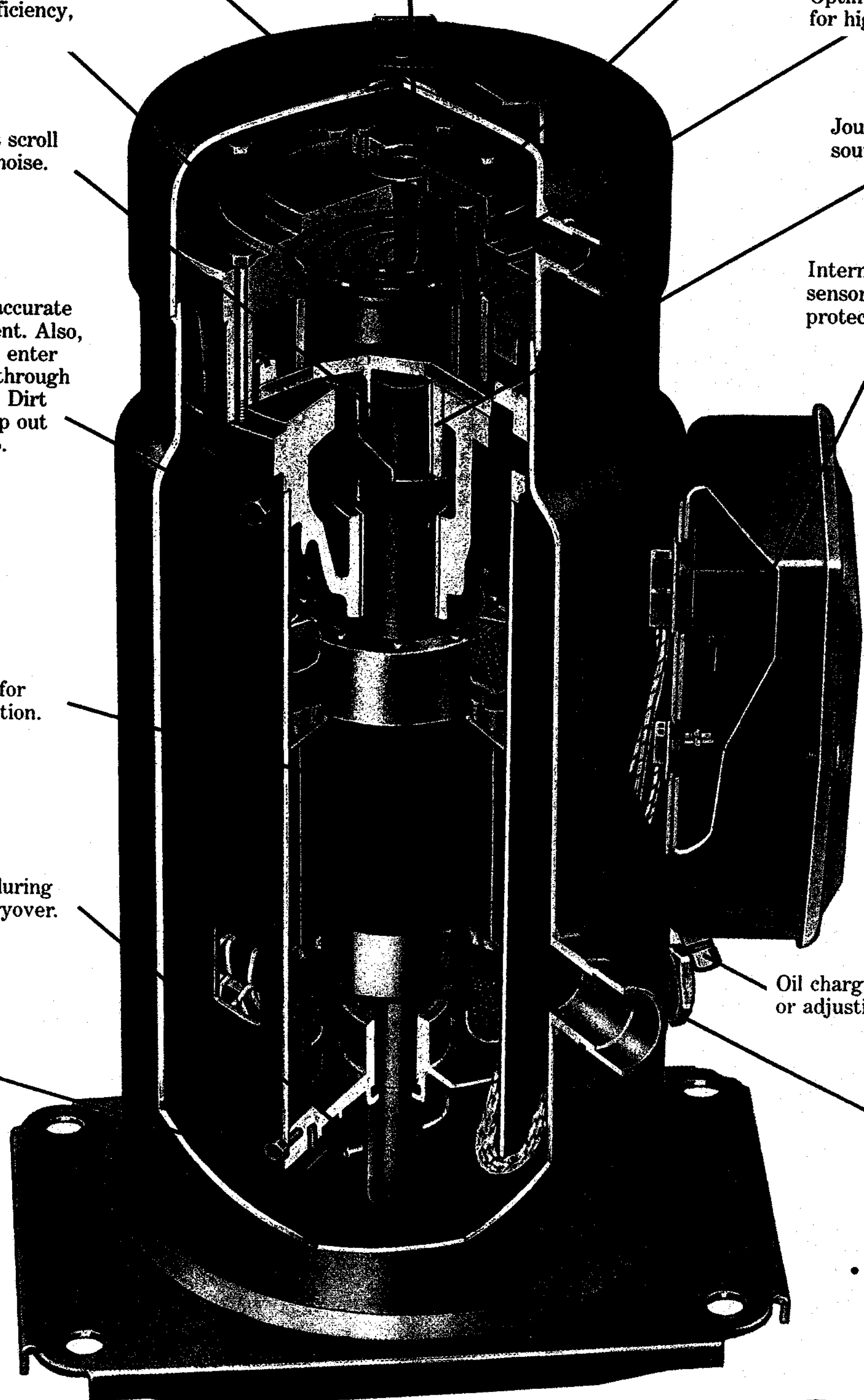
   2. New replacement Refrigerants
      a. R123 replaces R-11
      b. R134A replaces R-12

   3. R-22 on the way out (2015? stop production)

F. SAFETY REQUIREMENT
   1. Rupture disk - Typically low pressure machines
   2. Safety Relief Valving
   3. Refrigerant Monitor
   4. Exhaust fans

G. START-UP AND JOBSITE OBSERVATION.
   1. Verify refrigerant monitor is operational.
   2. Verify Safety relief piped outside.
   3. Verify pumps rotation and pressures.
   4. Verify flow switch or differential pressure switch installation.
   5. Verify water temperatures at thermometers and Pete's plugs Vs Chiller control panel.
   6. Stand back and let the Manufactures Start-up person do there job.

HERMETIC SCROLL



- EER's range to 11.5
- Proven design

UL c UL

Features and Benefits

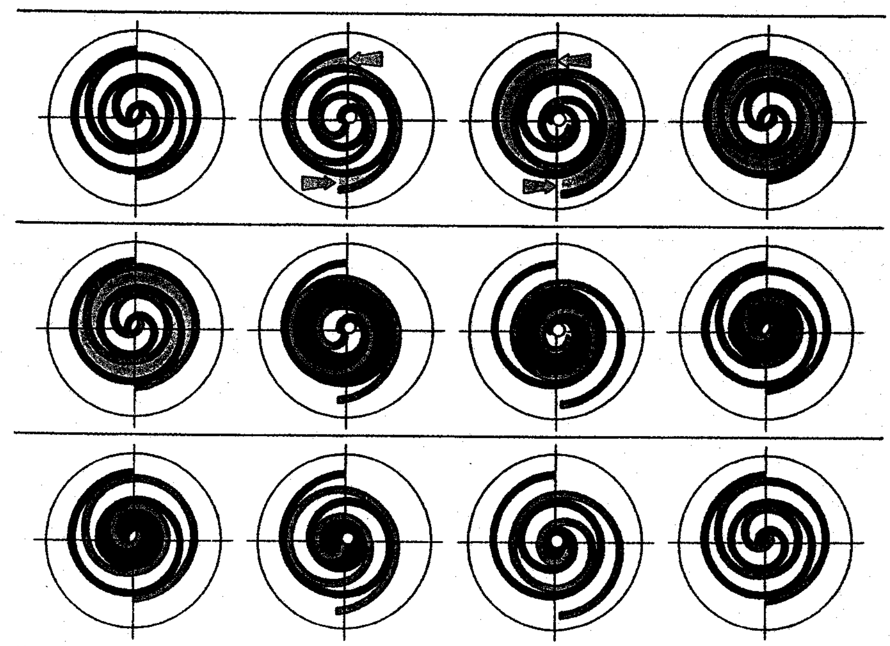
Trane Scroll Compressor
— Maximum Efficiency with Enhanced Reliability

General
The scroll compressor has two scrolls. The top scroll is fixed and the bottom scroll orbits. Each scroll has walls in a spiral shape that intermesh.

Inlet-First Orbit
As the bottom scroll orbits, two refrigerant gas pockets are formed and enclosed.

Compression-Second Orbit
The refrigerant gas is compressed as the volume is reduced closer to the center of the scroll.

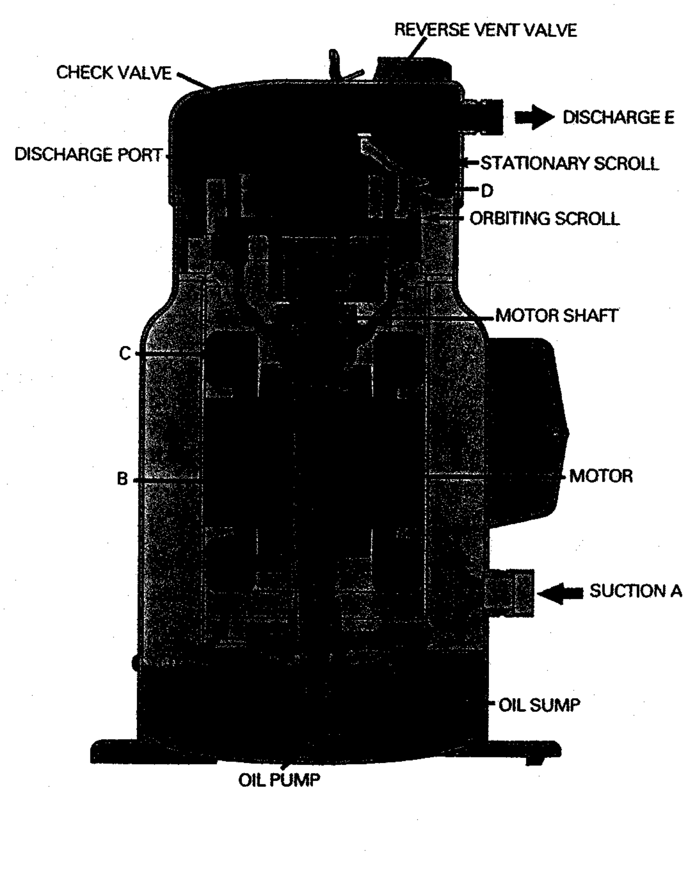
Discharge-Third Orbit
The gas is compressed further and discharged through a small port in the center of the fixed scroll.



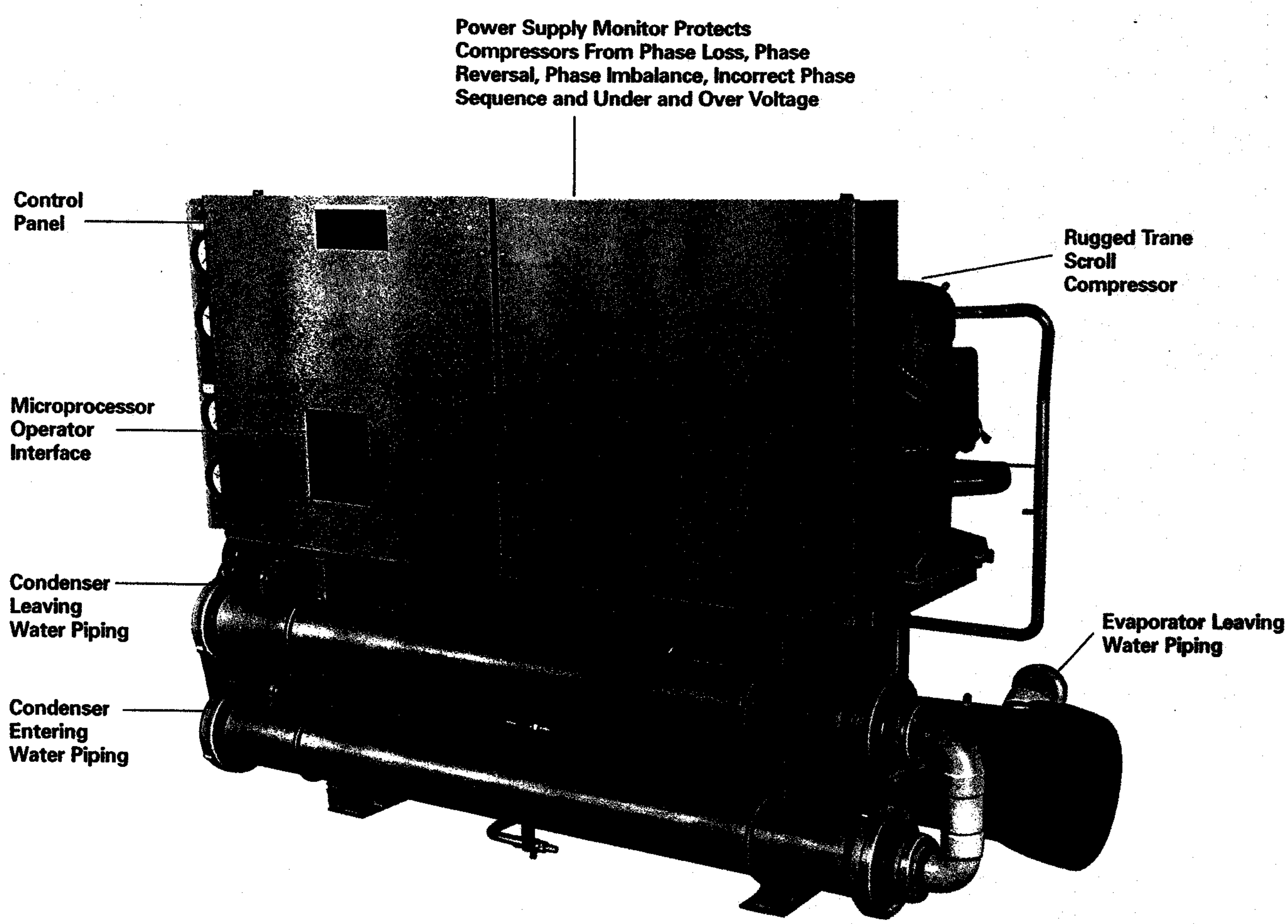
Scroll Principal Components
This is a cutaway view of a hermetic, scroll compressor, showing the relative positions of the principal components. Shown is a Trane 10-ton, 3600 rpm, scroll compressor as an example.

The principle of operation of this example compressor is as follows: The suction gas is drawn into the compressor at A. The gas then passes through the gap between the rotor and stator, B, cooling the motor, before it enters the compressor housing, C. Here, the velocity of the gas is reduced, causing a separation of the entrained oil from the gas stream. The gas then enters the intake chamber, D, that encircles the scrolls.

Finally, the suction gas is drawn into the scroll assembly where it is compressed and discharged into the dome of the compressor. The dome of this example compressor acts as a hot gas muffler which dampens the pulsations before the gas enters the discharge line, E.



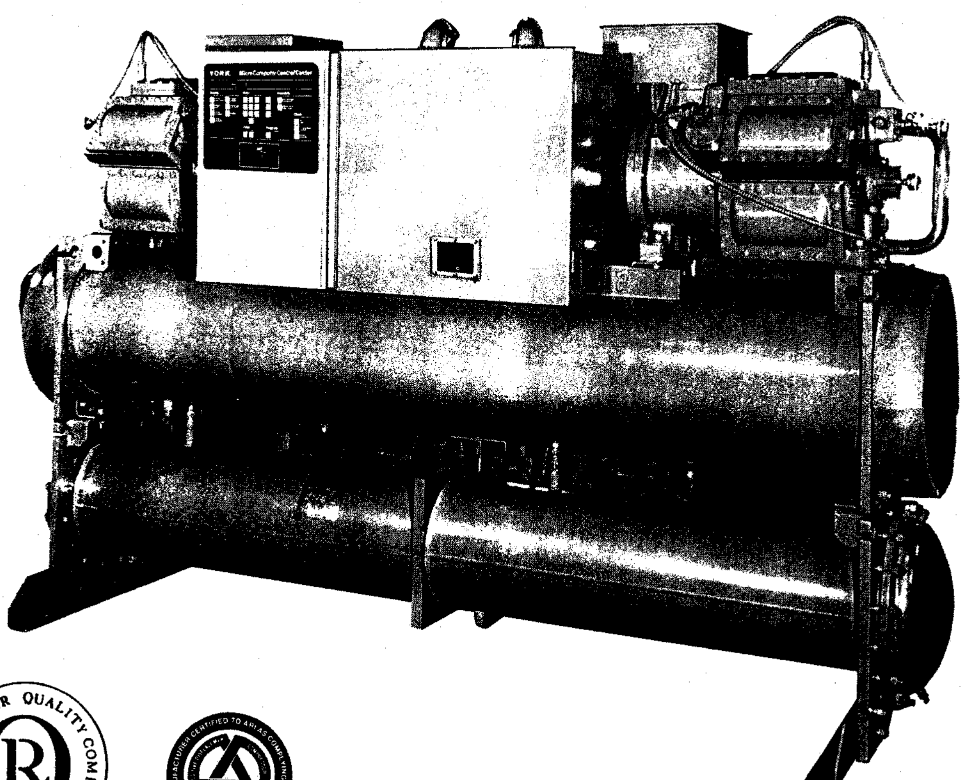
HERMETIC SCROLL CHILLER



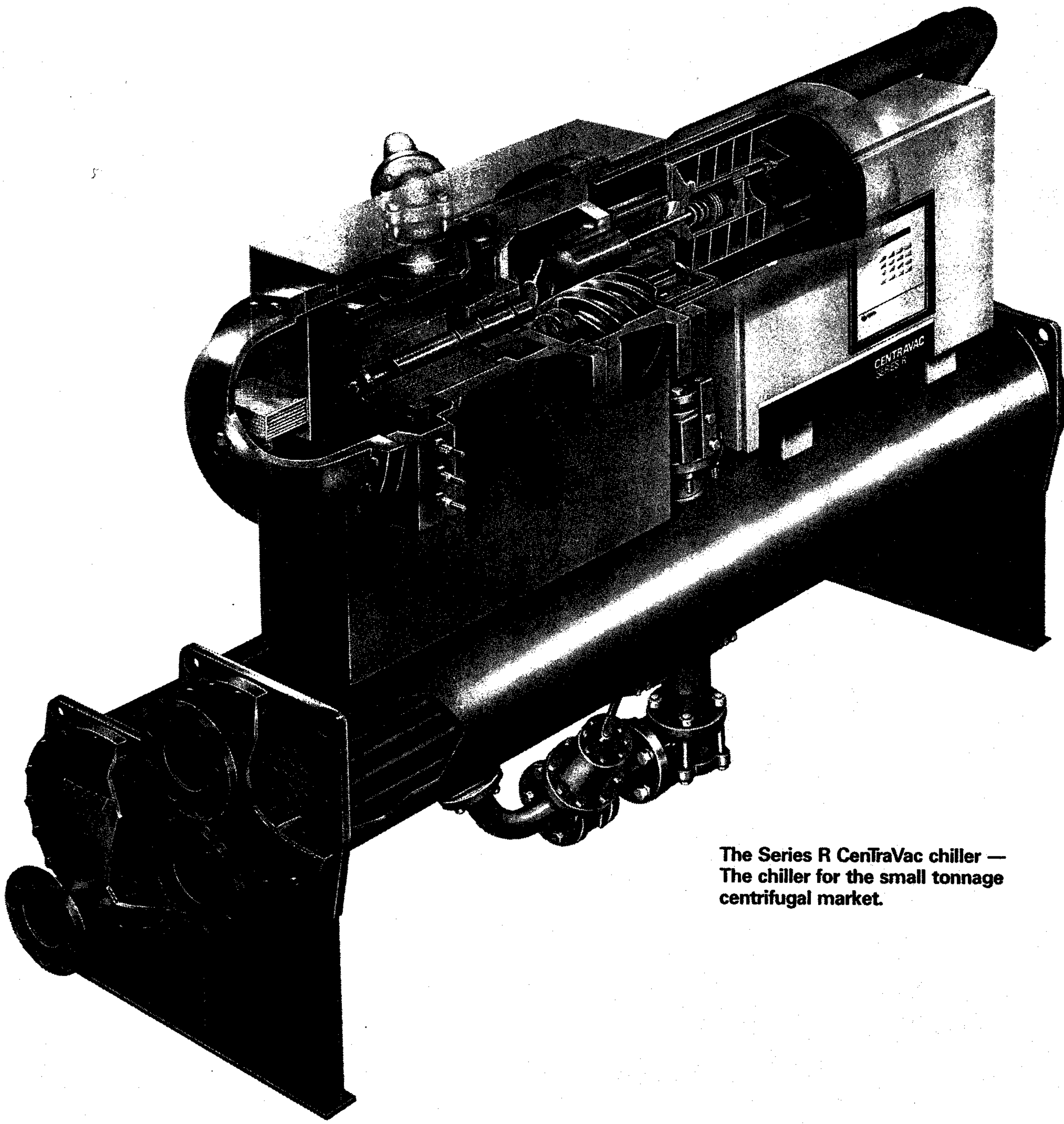
RecipPak™
LIQUID CHILLERS
WATER COOLED & REMOTE CONDENSER MODELS

R-22

60 TO 250 TONS
(50 & 60 HZ.)



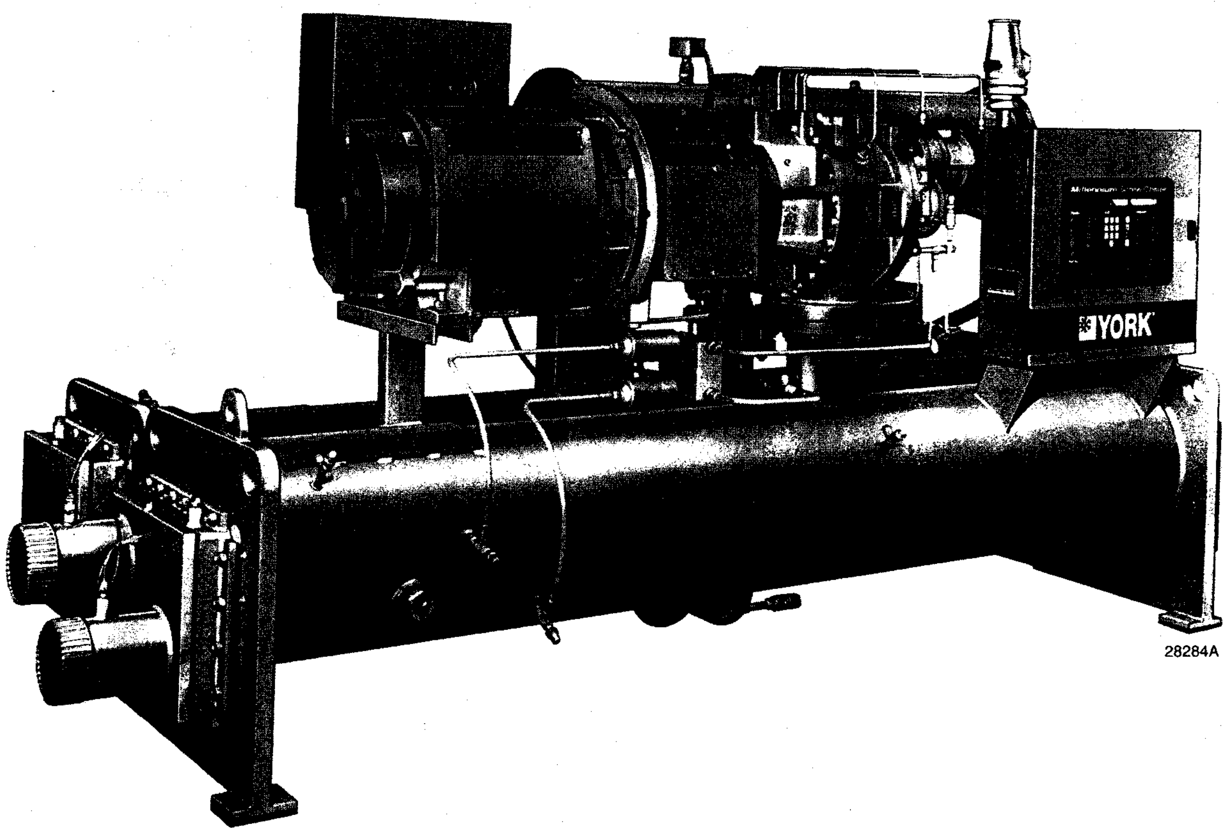
HERMETIC ROTORY SCREW CHILLER



The Series R CenTraVac chiller — The chiller for the small tonnage centrifugal market.

Rotary Screw Liquid Chillers

OPEN DRIVE

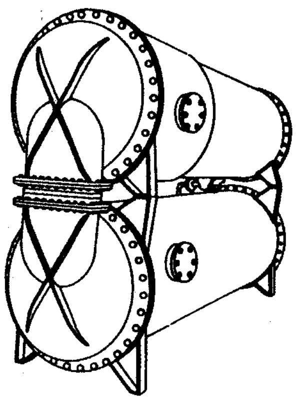


28284A

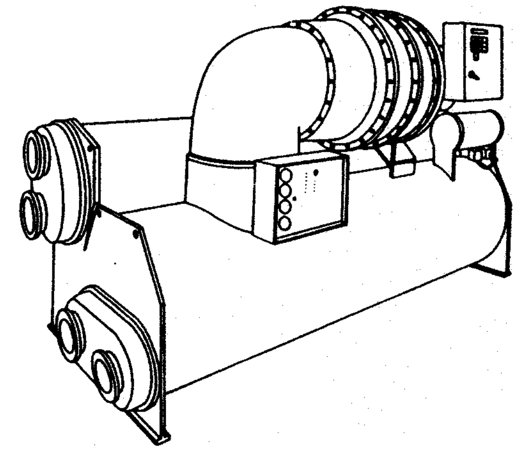
100 through 675 tons

R-22 and R-134a

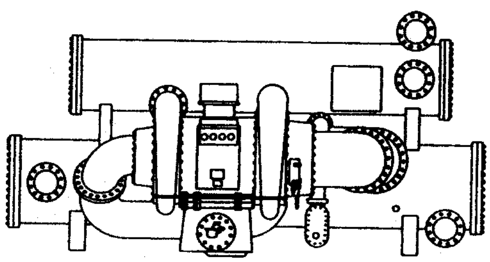
ELECTRIC DRIVE CENTRIFUGALS - HERMETIC



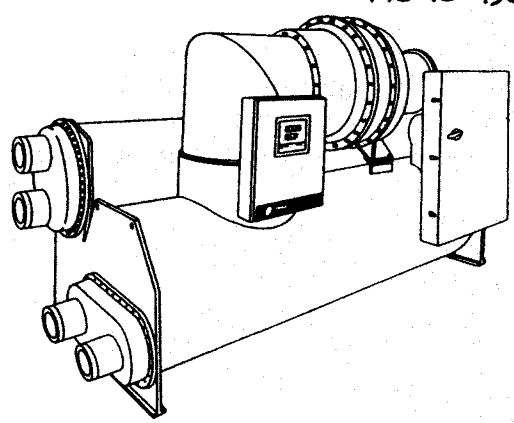
1939 — The Trane Turbovac



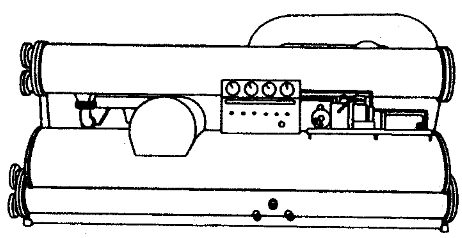
1982 — The three-stage CVHE CenTraVac Chiller 170 TO 1300 TONS



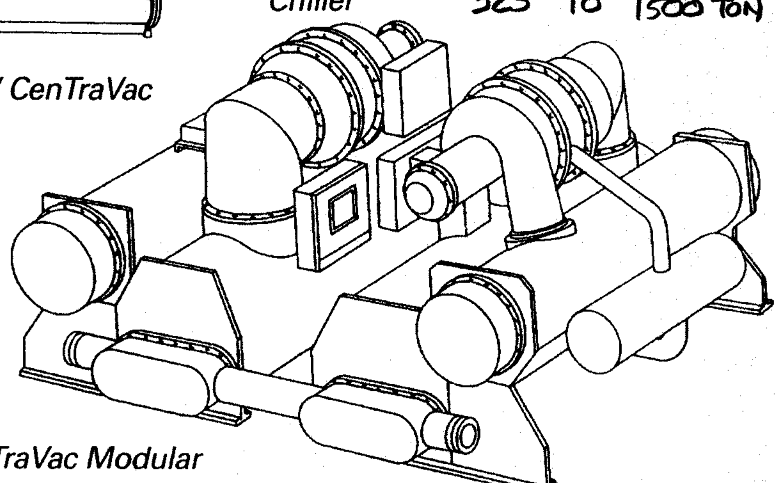
1951 — The original Trane CenTraVac chiller



1992 — The two-stage CVHF CenTraVac Chiller 325 TO 1500 TON



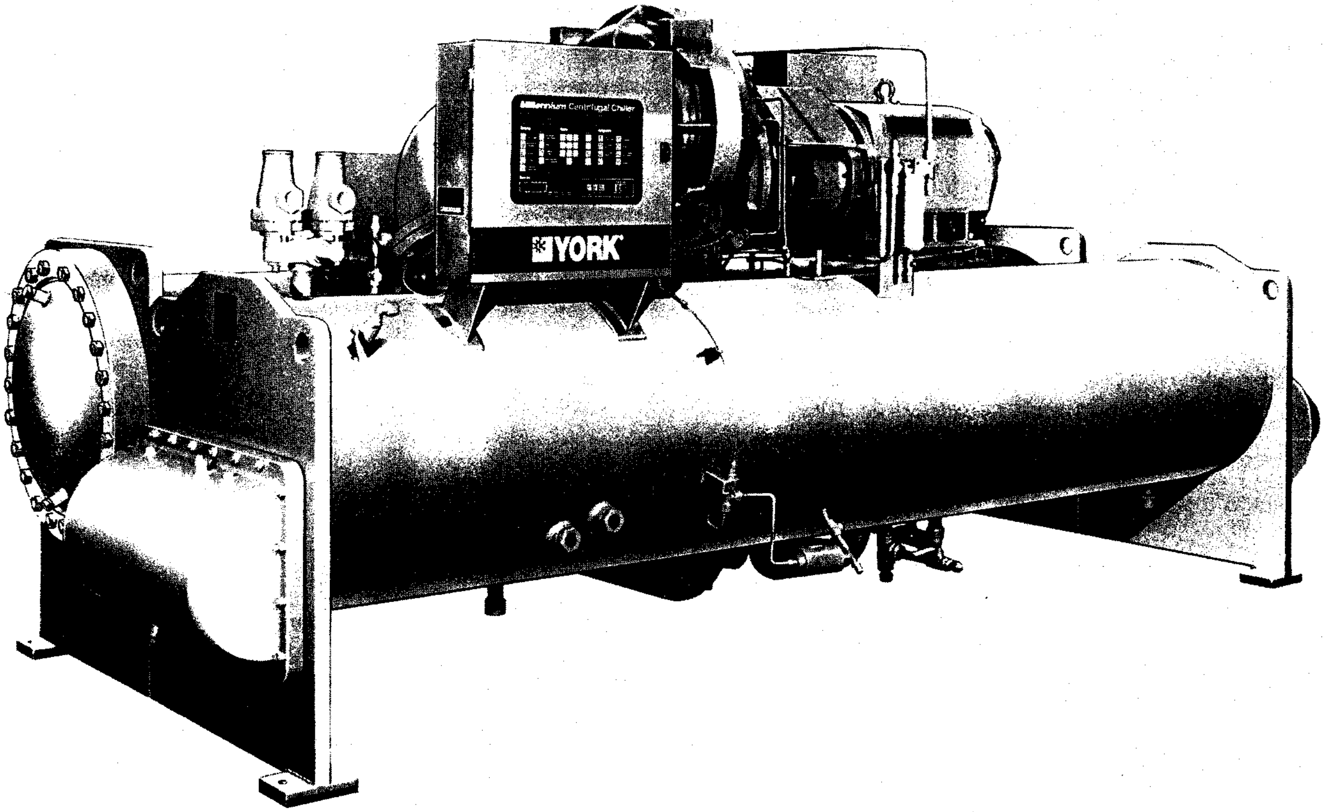
1965 — The Model PCV CenTraVac chiller



1992 — The LHCV CenTraVac Modular Chiller system 1300 TO 3000 TON

Centrifugal Liquid Chillers

OPEN DRIVE

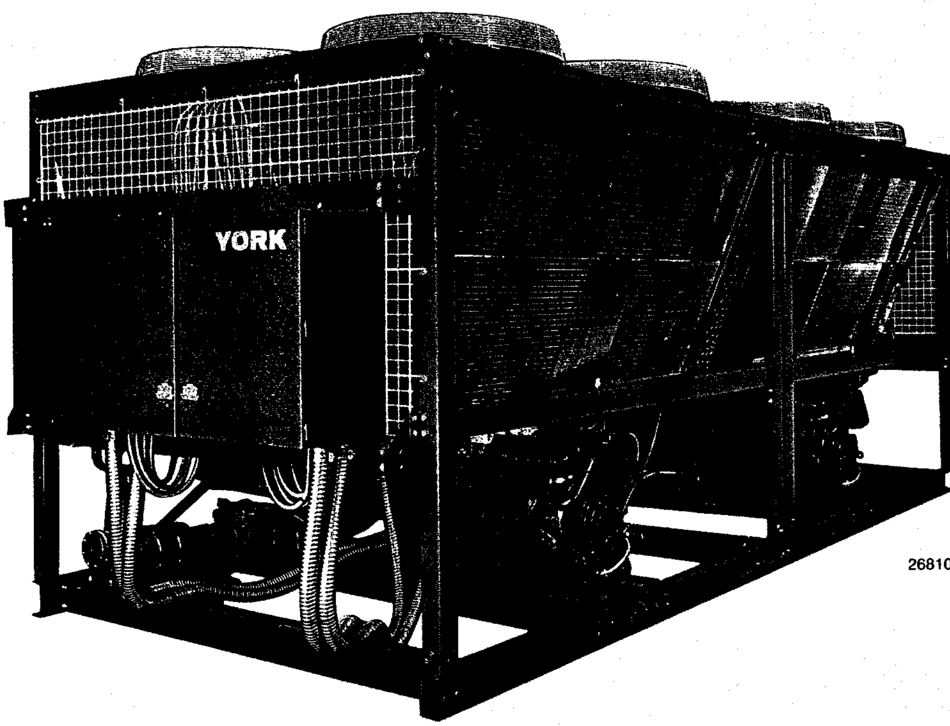


350* THROUGH 2100 TONS
Utilizing HFC-134a and HCFC-22

* HFC-134A 900 — 2100 TONS
350 — 900 DESIGN LEVEL D.

Rated in Accordance with the latest edition of ARI STANDARD 550

Air Cooled Reciprocating Liquid Chillers



26810A

50 - 200 TONS

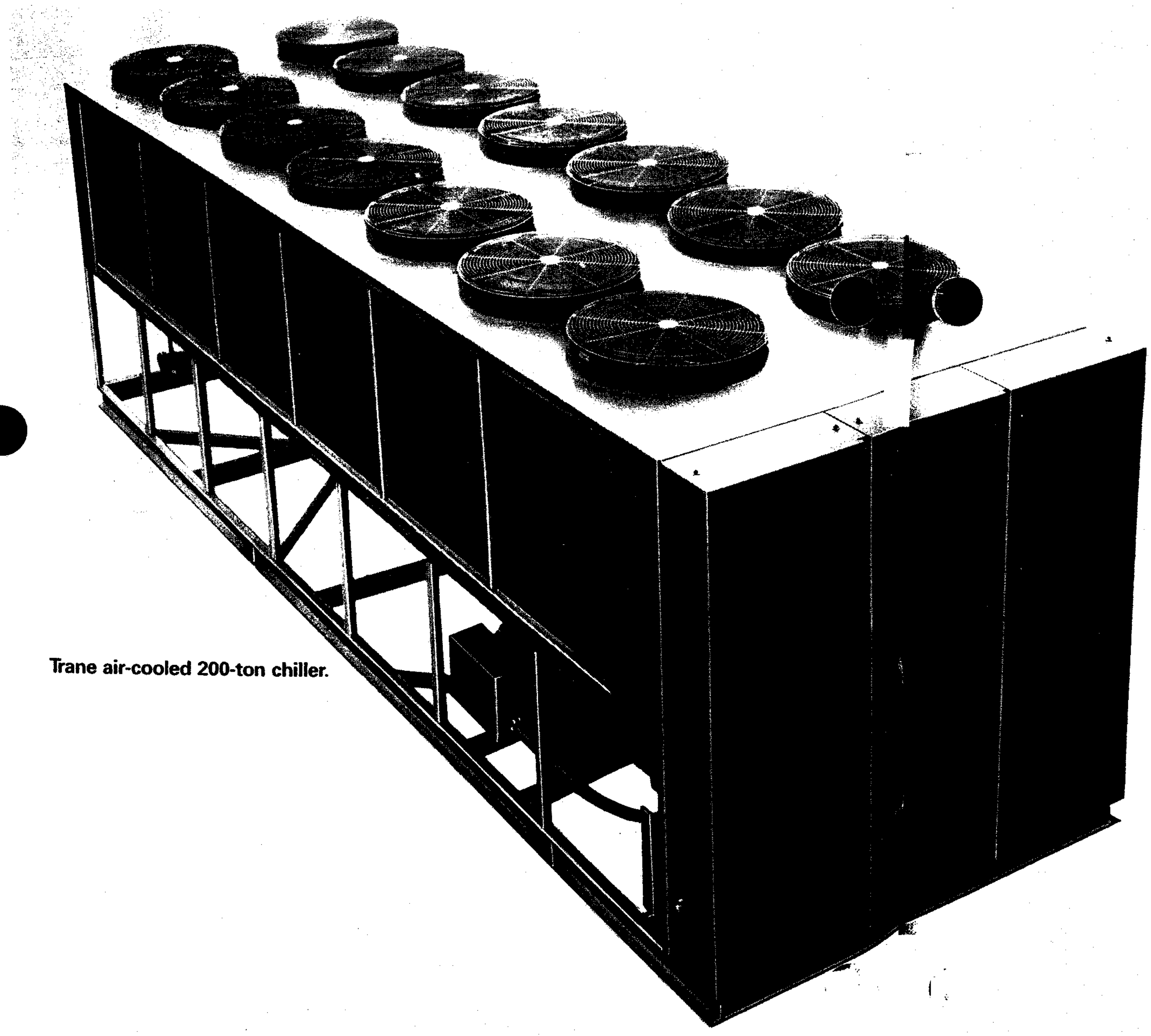
50 TO 230 TONS

60 HZ

Metric Conversions

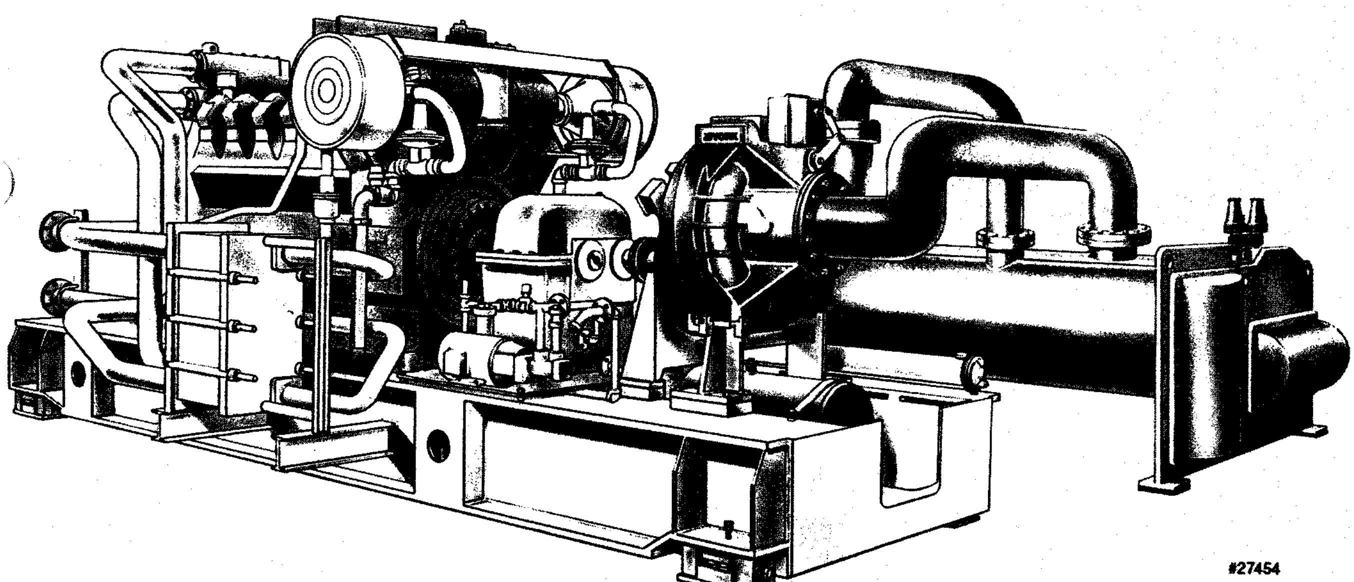
See page 4 for U.L. and C.U.L approved models.

ROTORY SCREW - AIR COOLED



Trane air-cooled 200-ton chiller.

GAS-ENGINE-DRIVE CHILLERS



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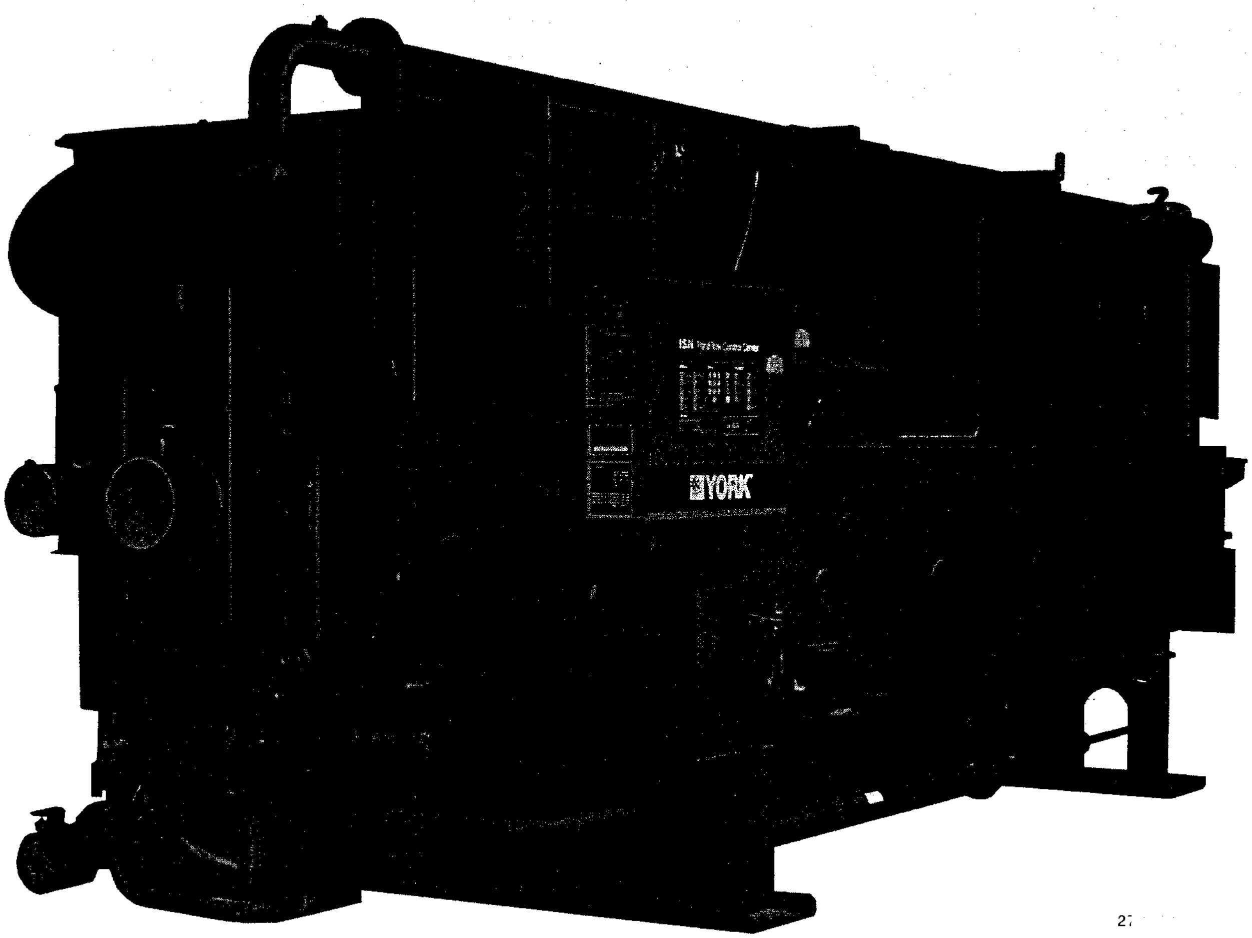
400 Through 2100 Tons
Utilizing HFC-134a

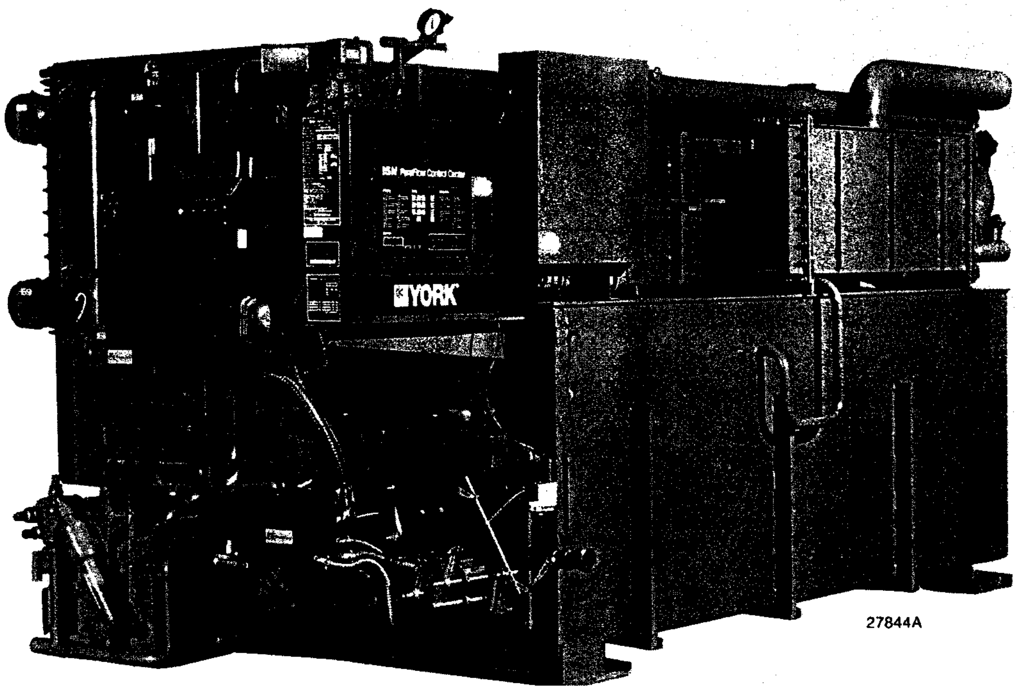
Two-Stage Steam-Fired Absorption Chiller



300 through 675 Tons

Two-Stage Direct-Fired Absorption Chiller-Heaters

NATURAL GAS



27844A

200 through 675 Tons

MECHANICAL DESIGN MANUAL SUMMARY SHEET

SUBJECT:	Chilled Water Plant Design
DESCRIPTION:	Applications/Considerations
SPEC SECTION:	15510 – Hydronic Piping; 15682 – Air Cooled Chillers; 15684 - Electric Water Chillers
APPLICABLE REFERENCES:	ASHRAE Systems and Equipment Handbook 2000 & 2004 Chapters – 4,11,12,13 ITT Fluid Handling Seminar – Large Chilled Water Systems May 2002 McQuay Chiller Plant Design Application Guide – February 2001 Trane Refrigeration System Equipment Room Design - January 1995 Trane Multiple Chiller System Design and Control Applications Engineering Manual SYS-APM001-EN – March 2001 Trane Applications Waterside Heat Recovery in HVAC Systems Engineering Manual SYS-APM005-EN – August 2003 ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-rise Residential Buildings
DATE:	August 2004
PREPARED BY:	Cooling Piping Committee (Brian Winterle)

Introduction

Large business, hospital, and school campuses utilize chilled water systems to:

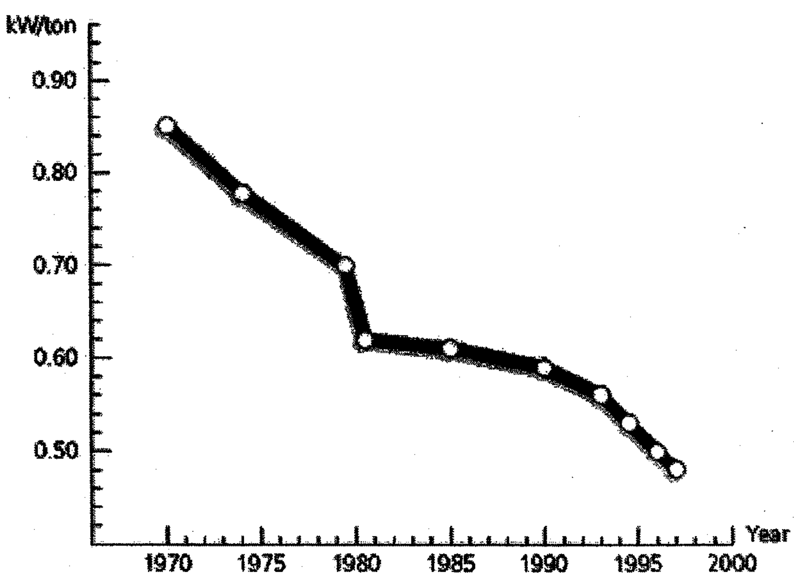
- Centralize major equipment for maintenance, sound, and aesthetic reasons.
- Reduce energy costs by taking advantage of diversity within the campus.
- Operate larger more efficient equipment.
- Add flexibility in campuses where growth is unknown and/or large and added cooling can be provided with less cost per ton.
- Allow variable frequency drives to be applied to pumps and chillers greatly reducing energy during part load hours.

Chilled water-based cooling systems can provide significantly better energy efficiency than de-centralized equipment cooling systems for large buildings or campuses. However, they also represent a significant investment in terms of first cost, physical space consumed, maintenance costs, etc.

The focus of this handout is primarily centrifugal water chillers with cooling towers but it will touch on other configurations and chiller types.

Figure 1 shows how centrifugal chiller energy efficiencies have evolved in recent years and shows why it is important to keep informed on energy efficiency and plant operation technologies since they change very quickly.

Figure 1 – Centrifugal Chiller Performance History



Source: Trane website, www.trane.com