THE WATER VAPOUR CENTRIFUGAL

Centrifugal Compressors for Water Vapor

In the preceding discussion on the cooling of water with a steam jet, it was shown that the temperature of the water can be reduced to any desired point by maintaining a sufficiently low pressure above the water surface. Such a low pressure can be maintained only if the flash vapor, formed in cooling the relatively warm return water, can be removed as quickly as it is produced. Because of the very large volume of low pressure water vapor, only steam ejectors and centrifugal compressors can be used. The steam ejector is described in the preceding sections.

In the centrifugal compressor, water vapor is compressed by the centrifugal action of a series of impellers rotating at high speed. The vapor flows through one impeller after another; each increasing its pressure. A complete centrifugal compressor and evaporator for cooling water is illustrated in Figure 7-Q. This type of unit is essentially a large capacity machine, being built in capacities of 50 tons and up.

"Trane Air Conditioning Manual," USA, 1938

When the unit is operating, a chilled water pump withdraws the water from the flash tank and delivers it to the air cooling unit in the same manner as in the steam ejector cooling unit. A small part of the water returning to the flash tank from the air cooling unit is vaporized. This vapor is withdrawn by the centrifugal compressor, and is compressed to such a pressure that it can be condensed by the available condenser water. The condensate is returned from the condenser to the flash tank through a water seal formed by a small pipe line.

The condenser used with these compressors is of the shell-and-tube type with the water flowing inside the tubes. These condensers are relatively small compared to those used for steam jet compressor units. The reason is that only the flash vapor is condensed here, whereas in the steam jet unit both the flash vapor and the entire steam supply must be condensed. The quantity of water needed for the condenser of a

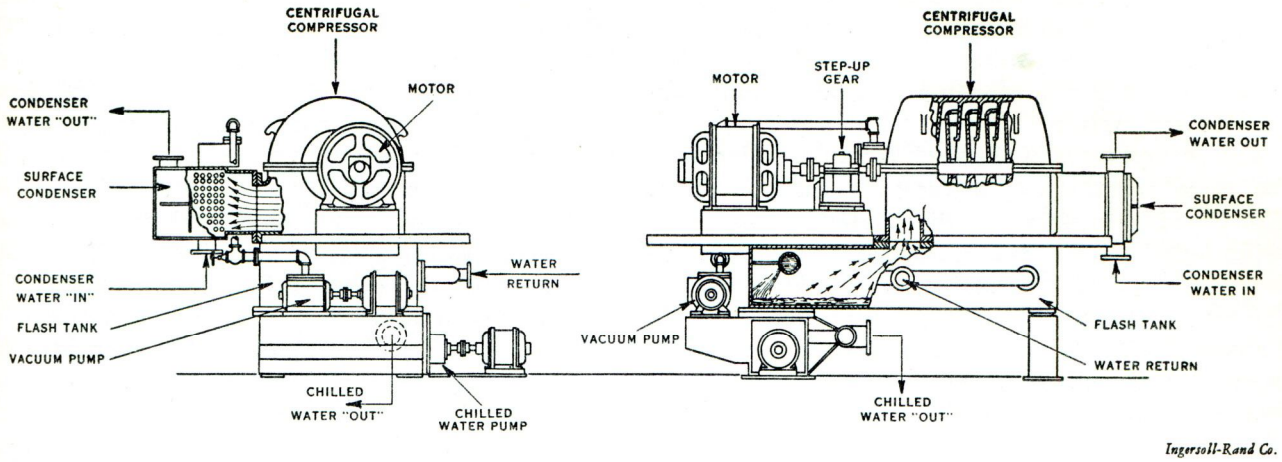


FIGURE 7-Q

CENTRIFUGAL WATER VAPOR COMPRESSOR

motor-driven centrifugal unit is approximately the same as the amount needed for a conventional refrigerating system using fluorinated hydrocarbon or ammonia, because the amount of heat to be removed in the condenser amounts to approximately 240 Btu per minute per ton of refrigerating capacity.

Steam turbines can be used instead of electric motors to drive the centrifugal compressor. Inasmuch as the operating speeds of turbines and compressors are approximately the same, the turbine makes an ideal drive for the centrifugal compressor where economic considerations make its use desirable. Usually the turbines are operated condensing, which means that an additional condenser is needed for condensing the steam exhausted from the turbine. However, the same condenser water can be used both in the condenser for the exhaust steam from the turbine and in the condenser for the vapor discharged from the compressor. The condenser water flows first

through the condenser for the vapor discharged from the compressor, and then through the condenser for the turbine. The coldest water is used for the compressor condenser because it is important to keep the head pressure on the compressor as low as possible.

A motor-driven vacuum pump is commonly supplied as a part of the apparatus. Before starting the centrifugal unit, the vacuum pump is run for a period long enough to withdraw the air from all parts of the unit. While the centrifugal compressor is operating, the vacuum pump must be kept running to withdraw the air that leaks into the system or is released from the return water.

The speeds of centrifugal compressors for water vapor range from about 7000 to 10,000 rpm depending upon the size and duty. If an electric motor is used to drive a centrifugal compressor, a set of speed increasing gears is needed between the motor and compressor shafts. With steam turbines direct drives are possible, eliminating the need for speed increasing gears. As was the case with the steam ejector, either an open or closed system can be used for circulating the chilled water to the air cooling equipment.

PICTURES OF THE MONTH.

ODEON THEATRE, LEICESTER SQUARE.

SINCE the installation of correct air conditioning plant is now being regarded as an essential in this country, it is interesting, but not surprising, to note that the New Theatre built on the site of the old Alhambra in Leicester Square by Odeon Theatres Ltd., is equipped with the most comprehensive air conditioning plant at present available for this service. The design of the building was entrusted to the well-known theatre architects, Mr. Andrew Mather, F.R.I.B.A., F.I.A.A., and Mr. Harry Weedon, A.R.I.B.A., who acted in a joint capacity, while the Construction and Engineering Department of Odeon Theatres Ltd., under Mr. S. B. Swingler, Engineer-in-Chief, has been responsible for many exclusive features.

Unfortunately, the term "air conditioned" has hitherto been very freely applied, and installations which fulfil only the barest ventilating service have been included in this category. In the case of the new Alhambra, however, the Engineers of Odeon Theatres, Ltd., decided that the conditions inside the theatre should be maintained within a prescribed temperature and humidity range, and that equipment of the most modern type should be installed.

The plant is, therefore, designed to give a constant dry bulb temperature inside the building of 68° F., with 57 per cent. Relative Humidity, when the outside shade temperatures vary between 80° F. and 30° F. Should the outside summer shade temperature at any time exceed 80° F., a corresponding increase will be provided in the theatre, so that the difference between the inside and outside dry bulb temperatures will not be more than 12° F., otherwise patrons would experience discomfort owing to the wide divergence. The percentage of humidity will, however, remain unaltered.

The new theatre will accommodate some 2,300 persons, and in designing the equipment is has been necessary to take into consideration the vast amount of heat and humidity liberated by so many people.

Each occupant will be supplied with 1,200 cubic feet of fresh air per hour, and as in the summer months the outside air may be of high temperature and comparatively heavily charged with moisture, it must be properly conditioned before entry into the auditorium.

The heat gains described in the foregoing make it essential for refrigeration to be incorporated in the service in order that excess moisture may be condensed out of the air.

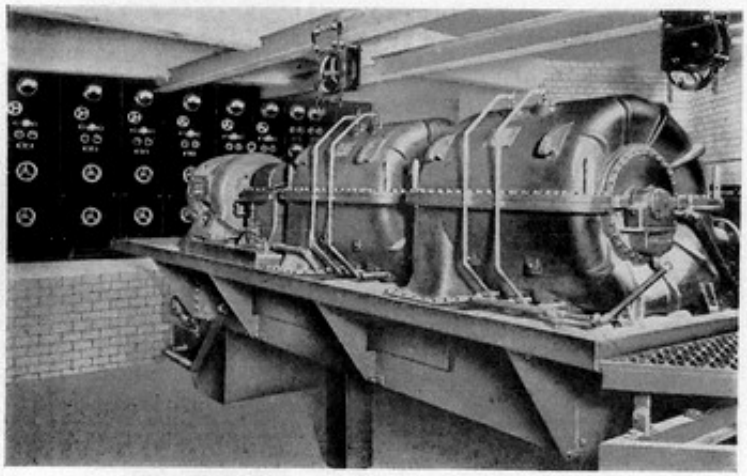
The advent of vacuum refrigeration offered the air conditioning engineer an entirely new and 100 per cent. safe system of refrigeration, by means of which the chilled water required for use in the spray washing plant can be obtained by circulating it through a vessel maintained under high vacuum. Under this treatment the water "boils," the heat required for the partial evaporation being extracted from the remainder of the liquid.

In this system water is the only refrigerant used, and as the plant operates under high vacuum, the risk of explosion is entirely eliminated.

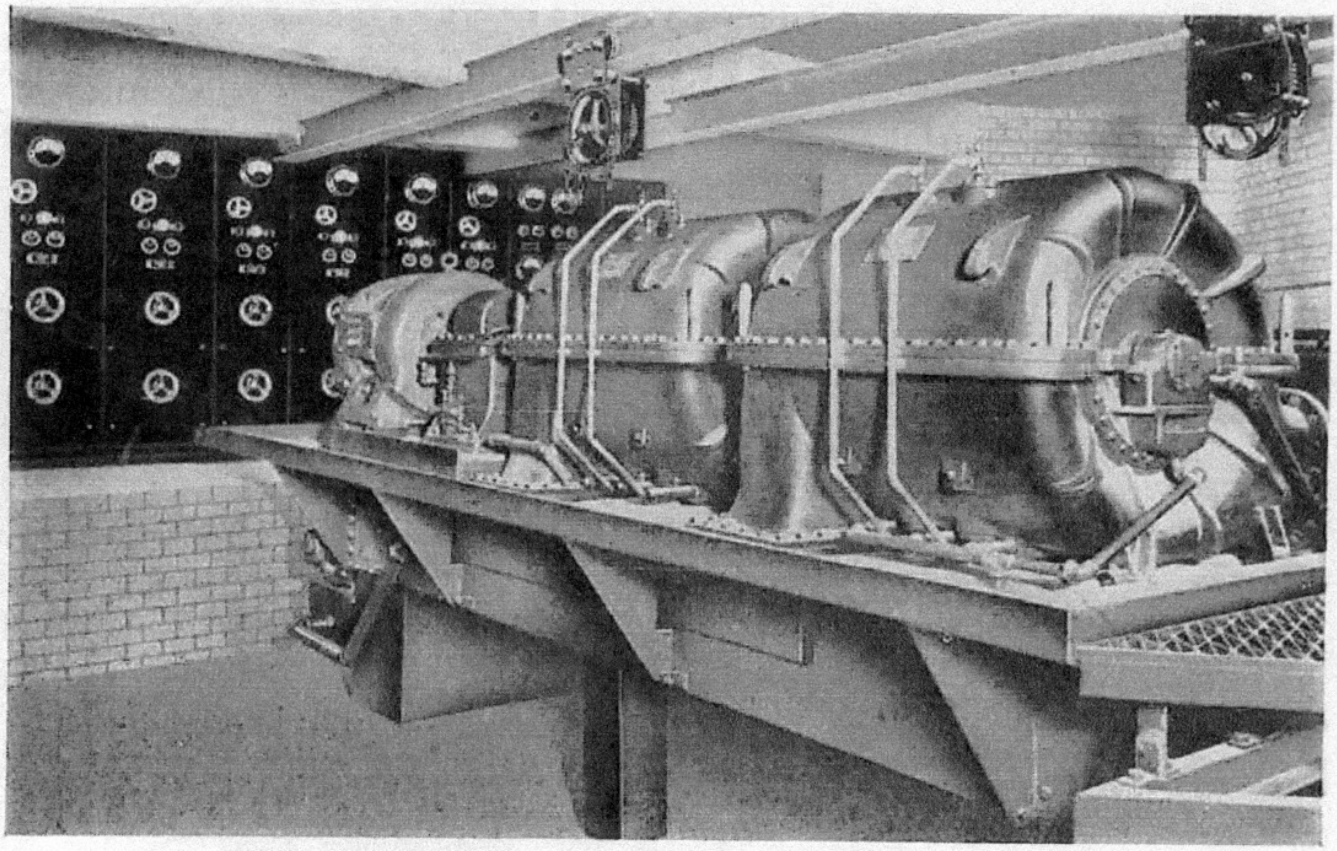
The Alhambra plant under review is designed to eliminate 2,400,000 B.Th.U. per hour, which is equivalent to the melting of 200 tons of ice per 24 hours at 32° F., the compressor being operated at full load by a 185 h.p. electric motor. This is equivalent to 0·925 h.p. per ton of refrigerating duty, which figure shows an advantage when compared with other methods of refrigeration.

The chilled water leaves the evaporator at a temperature of 45° F., and is circulated to the spray washing plant at the rate of 800 gallons per minute.

Regarding the air conditioning section of the installation, the whole of the air admitted



Odeon Theatre.—200 ton capacity Centrifugal Water Vapour Refrigerating Unit and Control Panel.



Odeon Theatre.—200 ton capacity Centrifugal Water Vapour Refrigerating Unit and Control Panel.

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