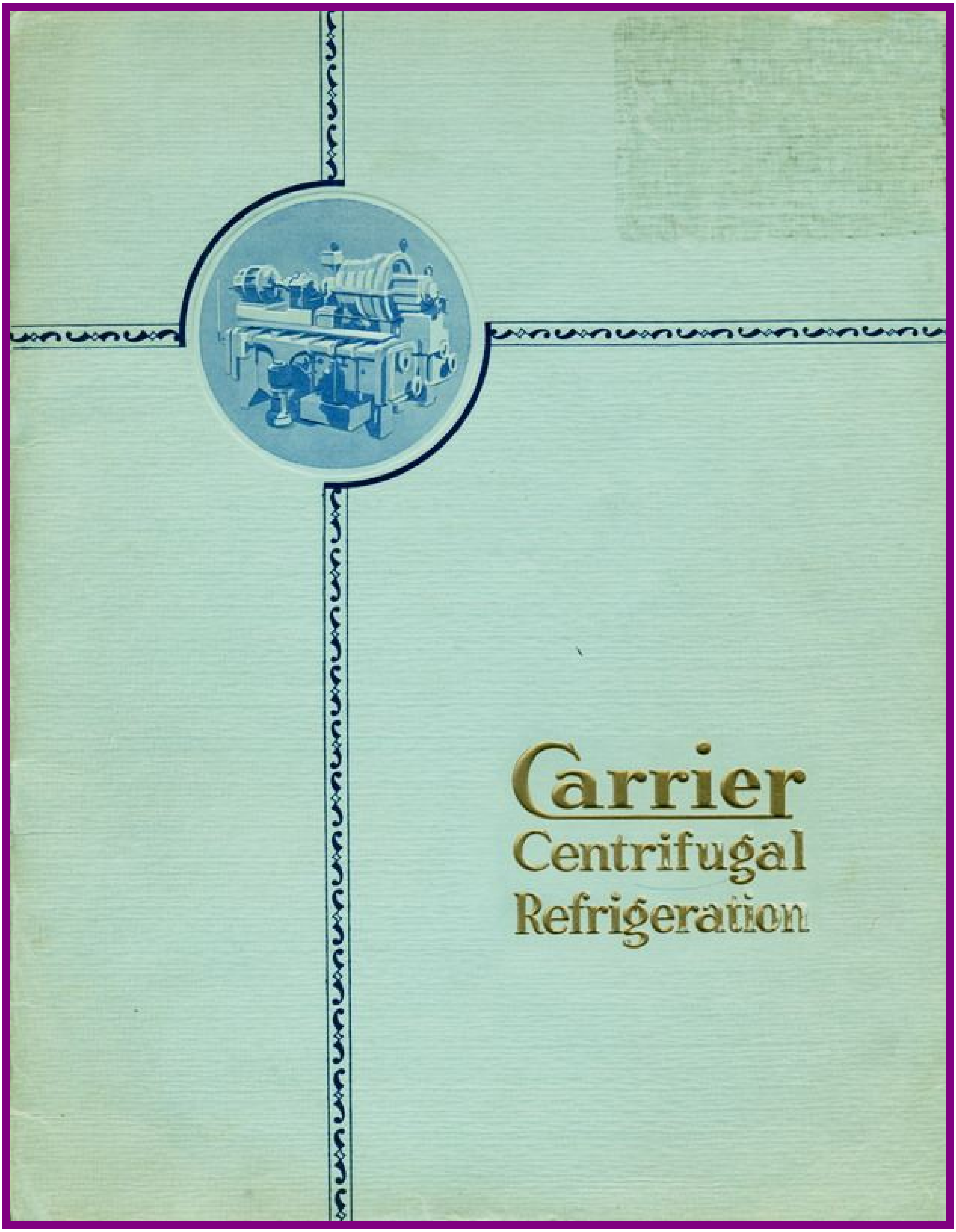


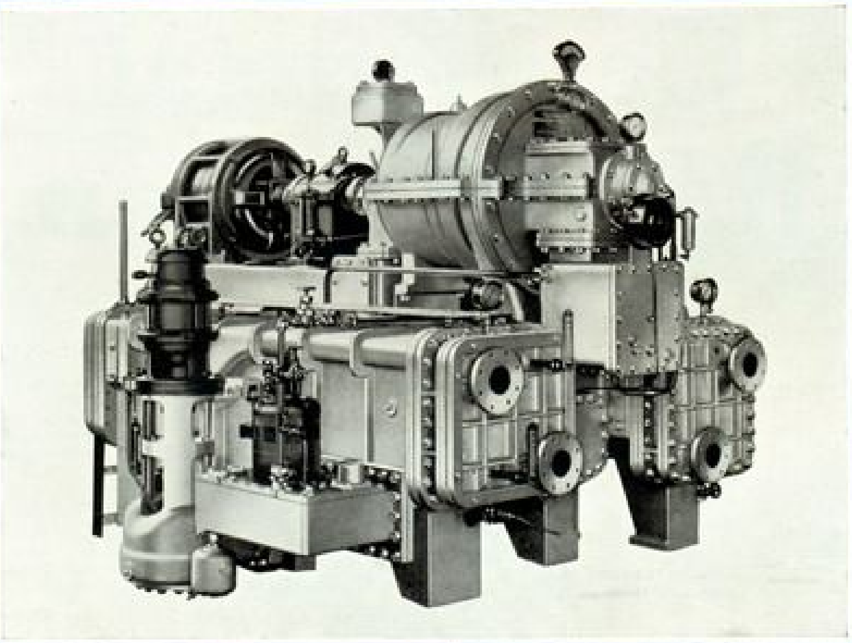
UK Catalogue c.1930

Printed by
Messrs. Ben Johnson & Co. Ltd.
in a Carrier Air-Conditioned
Factory.

Carrier Centrifugal Refrigeration

Carrier Engineering Company Ltd

24 Buckingham Gate, London.



Showing a complete Carrier Centrifugal Refrigerating Machine including compressor, motor, condenser, evaporator, liquor circulating pump, and evacuator unit.
This machine has a capacity of 150 ice melting tons and can be accommodated in a small space.

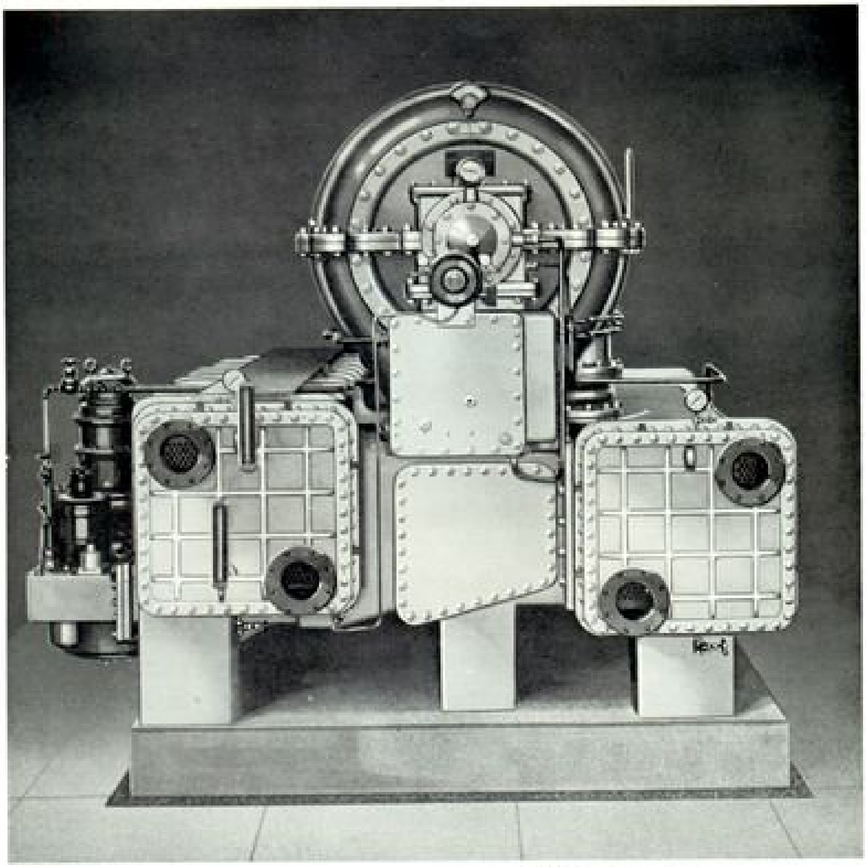
The Carrier Centrifugal Refrigerating Machine

BEFORE the development of the Carrier Centrifugal Refrigerating Machine the only refrigerants employed in commercial machines were ammonia, carbonic acid, and sulphur dioxide. All these involve comparatively high operating pressures and small vapour volumes, so that positive piston type compressors and heavy pipe evaporators and condensers must be used.

The mechanical and other advantages of a centrifugal refrigerating compressor are obvious by the contrast between the old-fashioned positive piston type pump and the modern centrifugal pump, or the reciprocating steam engine and the steam turbine. The Carrier Centrifugal Refrigerating Machine is, in fact, as great an advance in its sphere as they were in theirs. Before the Carrier Centrifugal Machine could be perfected, however, it was necessary to find an entirely new refrigerant, because the usual types cannot be economically employed with centrifugal compression.

Research yielded a hydro-carbon which not only possessed the required characteristics, but was thermo-dynamically more efficient than ammonia, the best previously known refrigerant. Further, over the whole range of operating temperatures, the pressure exerted by this substance is less than that of the atmosphere. Hence, there is no danger of bursts or explosions, and no outwards leakage can occur. Neither has the machine to be designed to withstand any considerable pressure, consequently compact tubular evaporator and condenser surfaces similar to steam condenser construction can be employed, resulting in great savings in space and weight.

In addition, this new refrigerant is entirely innocuous, being non-poisonous, non-explosive, non-inflammable, and non-corrosive. It is also a perfect solvent for oil, so that the internal surfaces remain clean, and, unlike the older systems, the efficiency does not fall off



A view of a complete Carrier Centrifugal Refrigerating Machine, showing the compressor mounted above the condenser and evaporator.

owing to the accumulation of an oil film in the evaporator and condenser.

We therefore have an ideal refrigerant, and the machine employing it is equally ideal and simple.

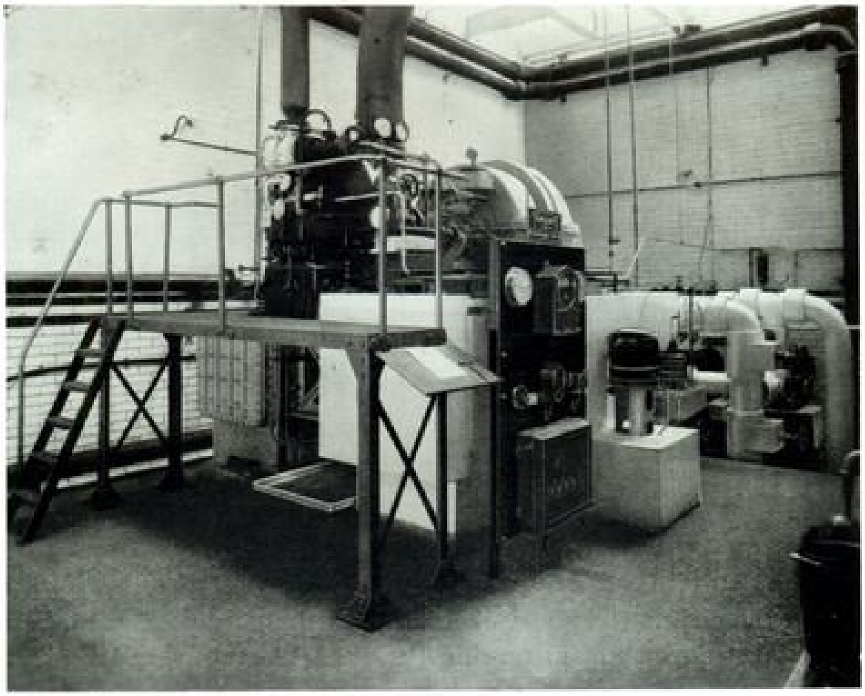
The centrifugal compressor is similar in design and construction to the centrifugal air or gas compressor which has long been known and used in general engineering practice. It is a purely rotary machine, there being no reciprocating parts whatever. The impellers do not run in contact with the housing, and the two main bearings, to which oil is circulated by a pump, merely have to support the weight of the impeller shaft and are not subjected to reciprocating loads. One of these bearings is totally enclosed, and the impeller shaft penetrates the compressor housing at one end only. The sealing device consists of two broad faced rings, one of which is fixed to the compressor housing and the other to the impeller shaft. When the compressor is in operation, these two rings move apart and the space between them is kept full of oil by the lubricating pump, which is driven directly from the impeller shaft. In this way perfect sealing is effected without the use of any stuffing box or packing. It should be noted that the rings do not run in contact, and therefore are not subjected to any wear.

In order to keep the machine tight against air-leakage when shut down, the two seal rings close automatically immediately the machine stops.

They are moved and held apart as soon as the compressor starts by means of an oil pressure operated equilibrium disc on the enclosed end of the shaft. It will be observed that the only parts subjected to wear are the two main bearings, and these have a very long life. They are, however, both accessible without removing the top half of the compressor housing, and can easily be replaced should it be necessary.

The lubricating system consists of a simple gear pump driven directly from the compressor shaft which supplies oil to the two main bearings, the seal rings and the equilibrium disc.

The evaporator consists of a cast iron rectangular shell with brass tube plates at either end into which straight brass tubes are expanded. These are nested close together and arranged in passes, the water or brine to be cooled passing through the tubes. The liquid refrigerant lies in the bottom of the evaporator shell and is lifted by means of a centrifugal pump to the spray deck from which it is distributed over the whole outer surface of the tubes. The compressor suction is connected to the space surrounding the



Turbo-driven Carrier Centrifugal Refrigerating Machine installed at the York factory of Messrs. Joseph Terry & Sons, Ltd. This machine has a capacity of 200 ice melting tons and operates in conjunction with a Carrier Air Conditioning Equipment.

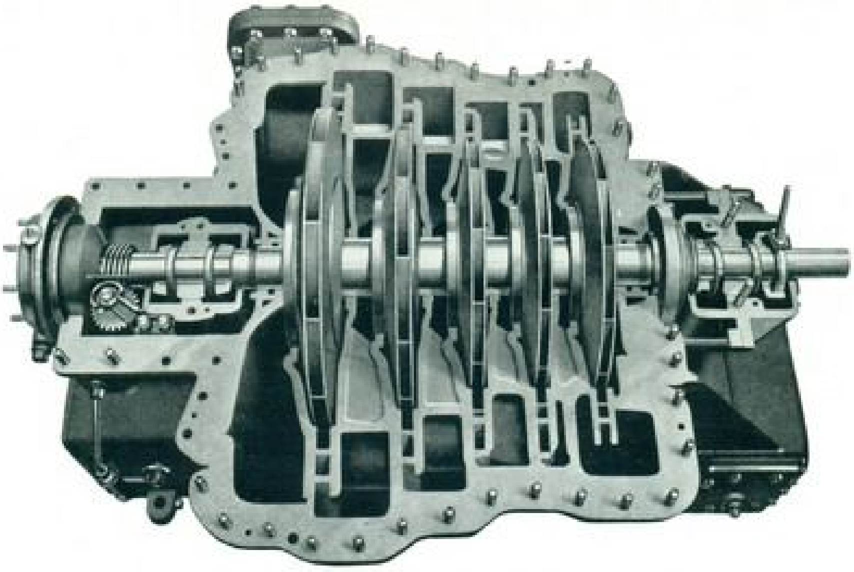
outside of the tubes and the vapour formed on their surface is withdrawn through eliminator plates (see illustration on pages 8 and 9). The object of the eliminator is to prevent free unevaporated liquid in the form of drops entering the compressor. Attached to the evaporator is a small air pump known as an evacuator, which withdraws the small amount of air that leaks into the machine, and, after eliminating refrigerant from it, rejects it to atmosphere. The evacuator is also used for creating the initial vacuum in the machine.

The condenser is of the same construction as the evaporator, and attached to it is the liquid trap. This is a float-operated valve which prevents uncondensed vapour passing directly back to the evaporator. The ordinary type of refrigerator requires an expansion valve somewhere in its circuit, but no such valve is necessary in the Carrier Centrifugal Machine.

From the design and construction of the machine it is evident that it can be made very compact. Since no great pressure, accumulation of oil or corrosion have to be contended with, the tubular surfaces of the evaporator and condenser can be closely nested. The insides of the tubes through which the brine and water pass are immediately accessible by the removal of the bolted-on heads covering the tube plates. The compressor itself occupies the minimum of space, and since it runs at a comparatively high speed, can be direct or gear connected to a high-speed turbine or electric motor.

All these features of design and construction result in a Refrigerating Machine which, for a given duty, occupies very much less space and has considerably less weight than the most compact form of positive compression machines. Having no reciprocating parts, it requires no heavy foundations, sets up no vibration, and is comparatively noiseless in operation. There are no valves or pipes carrying refrigerant, the three main components being rigidly bolted together.

It should be noted that whereas a failure of the condenser cooling water in a positive compression machine will cause dangerous pressure, bursts and explosions, such failure on a Carrier Centrifugal Machine merely causes the gas flow to cease and the refrigerating effect to be suspended. As a precaution against sudden falling off of the load or the flow of water (or brine) through the evaporator ceasing, two safety devices—a thermostat and a flow control—are arranged to automatically shut down the liquid pump and thereby immediately arrest the refrigerating effect. The machine therefore is perfectly fool-proof. Among its many peculiar advantages is its quick response to varying load demands. Since the evaporator is light compared with its surface, there is none of the delay associated with positive compression systems before the refrigerating effect is transmitted to the brine or water to be cooled. Furthermore, the compressor is capable of large overloads and takes full advantage



The Compressor of a Carrier Centrifugal Refrigerating Machine with top half casing removed.

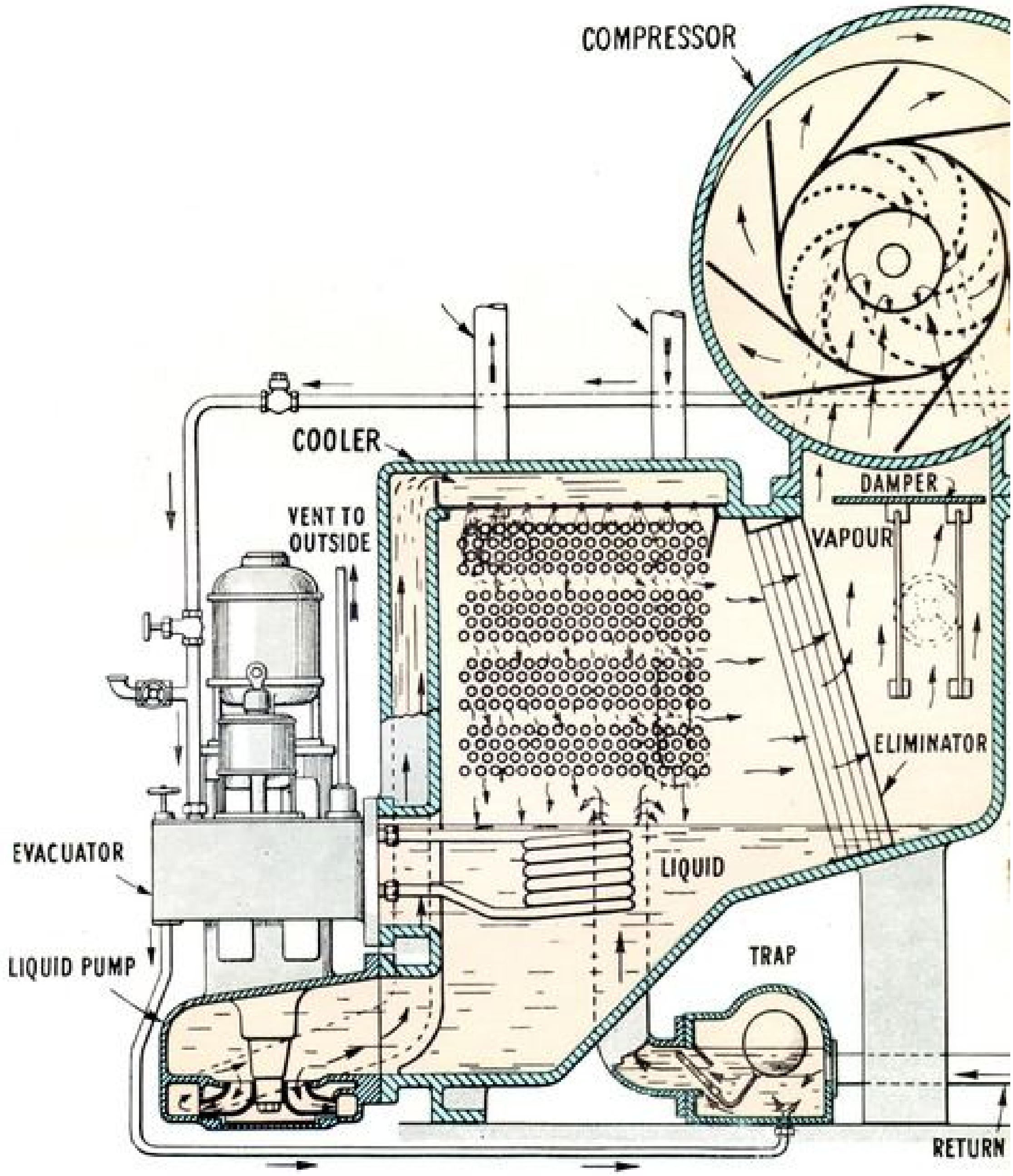
of the high evaporator temperatures which prevail when first starting up. The natural flexibility can be increased by providing speed regulation which, where varying loads and condenser cooling water temperatures have to be met, reduces the average power consumption.

As has already been noted, the compressor runs at a comparatively high speed and can be direct coupled to a steam turbine. In many industrial plants exhaust steam can be used for processing, and the compressor can be driven by means of a back pressure turbine so that the power cost is nil.

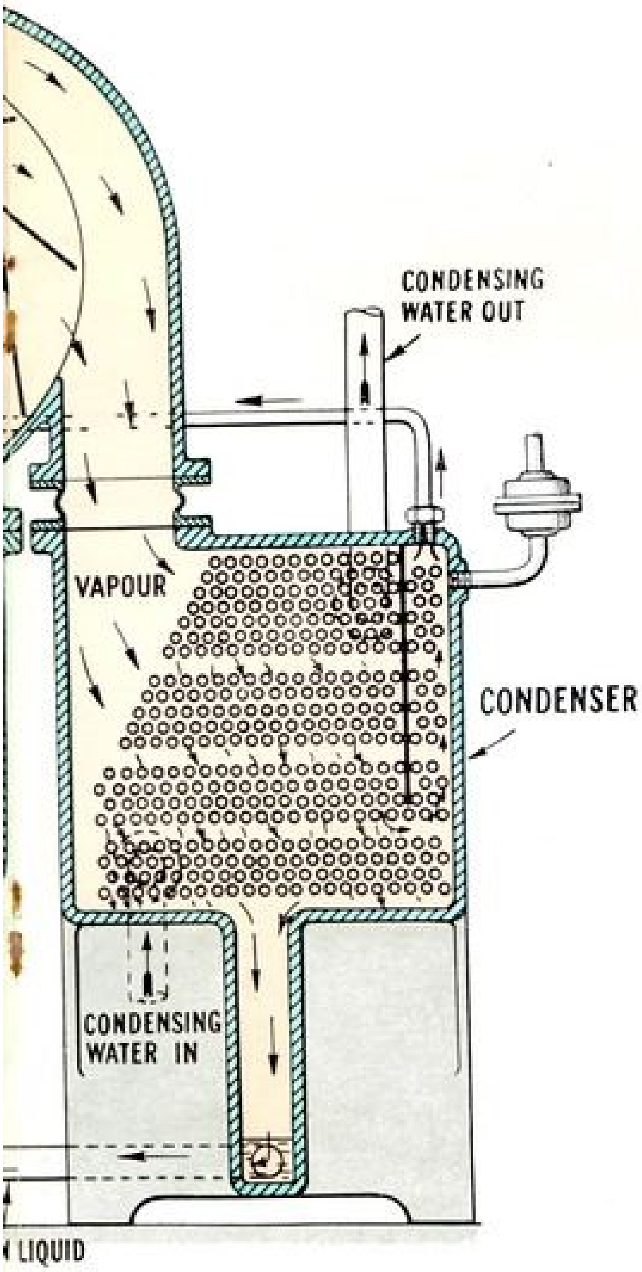
The variety of prime movers which can be employed to drive the Carrier Refrigerator constitutes a very valuable and unique feature of the machine.

Where the fluid being cooled has to be maintained at a definite temperature under varying conditions of load, automatic control is provided to regulate the flow of condenser cooling water according to the demand for refrigeration. For example, if the load falls off, the temperature of the brine or water cooled will tend to decrease, with the result that a thermostat placed in the outlet of the evaporator actuates an automatic valve in the condenser water pipe line and reduces the flow. The condenser temperature and pressure therefore rises, less gas flows and the refrigerating effect is reduced.

Having so many advantages over all positive compression systems, the Carrier Centrifugal Refrigerating Machine is ideal for installations where space, safety, silence and reliability are considerations.



The Carrier Centrifuga



This cross-sectional elevation illustrates the operation of the Carrier Centrifugal Refrigerator.

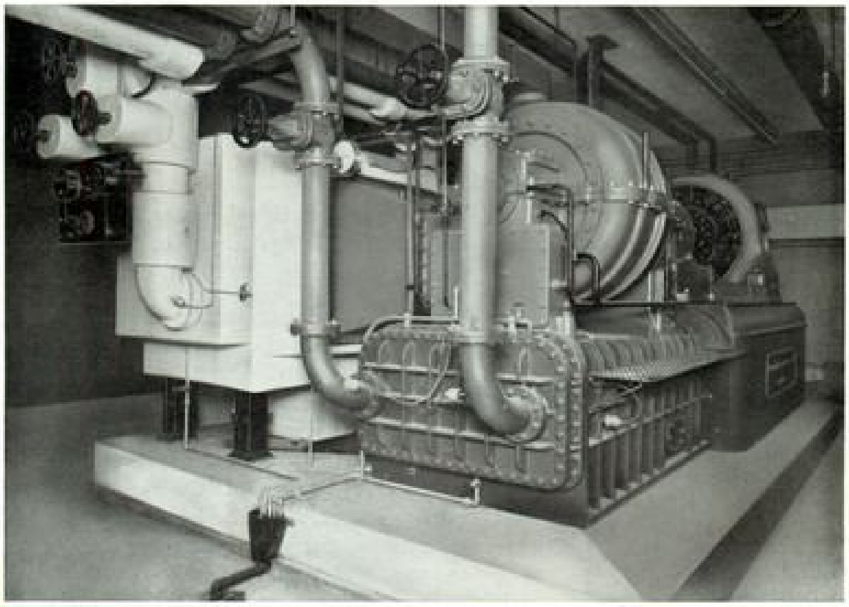
The centrifugal compressor shown in the centre creates a vacuum in the evaporative cooler, thus drawing off the vapour from the boiling refrigerant through the eliminator blades, which prevent the passage of any liquid drops into the blades of the compressor. The latter then compresses the vaporised refrigerant to a higher pressure when it is discharged into the condenser. Here the cooling effect of the condenser water passing through nests of tubes liquefies the refrigerant, which falls to the bottom of the condenser.

The liquid refrigerant then passes through the liquor trap back to the cooler, where it is showered over the tubular surface by means of the circulating pump.

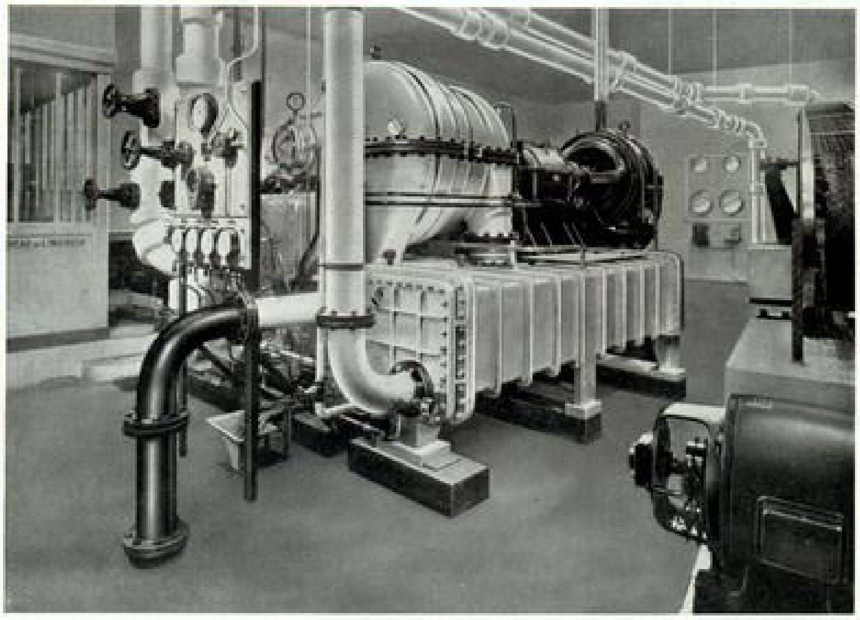
On the left-hand side is shown the evacuator unit which maintains the vacuum on the machine by withdrawing from the system, when necessary, the small amount of air and permanent gases which leak into the machine and accumulate at the top of the condenser by virtue of their difference in density compared with that of the refrigerant vapour.

The whole machine operates at a vacuum, so that no explosions or bursts are possible.

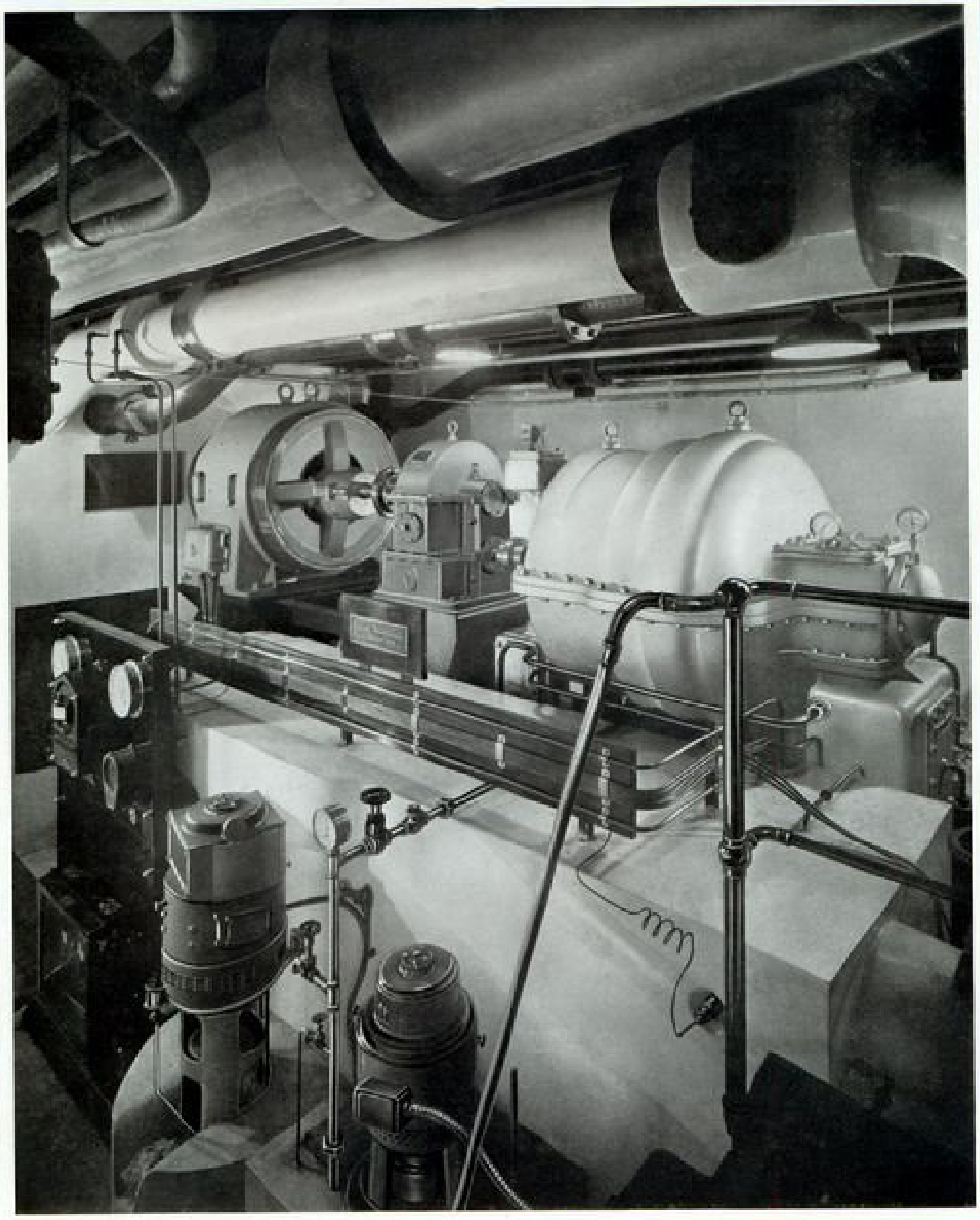
al Refrigerating Machine



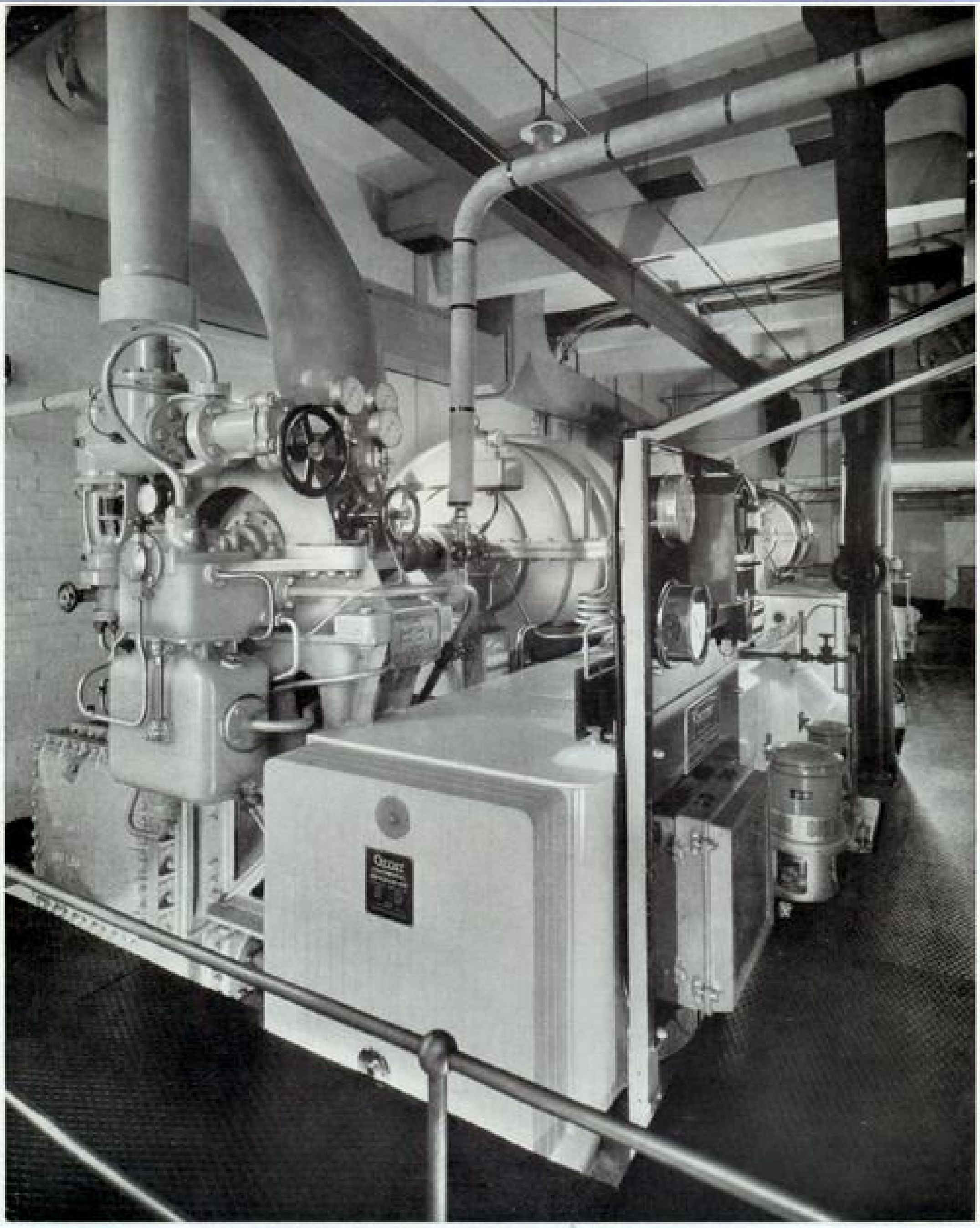
Showing a Carrier Centrifugal Refrigerating Machine, having a capacity of 250 ice melting tons, installed in the Empire Theatre, Leicester Square, London, in conjunction with the Carrier Air Conditioning System for the cooling of the Auditorium.



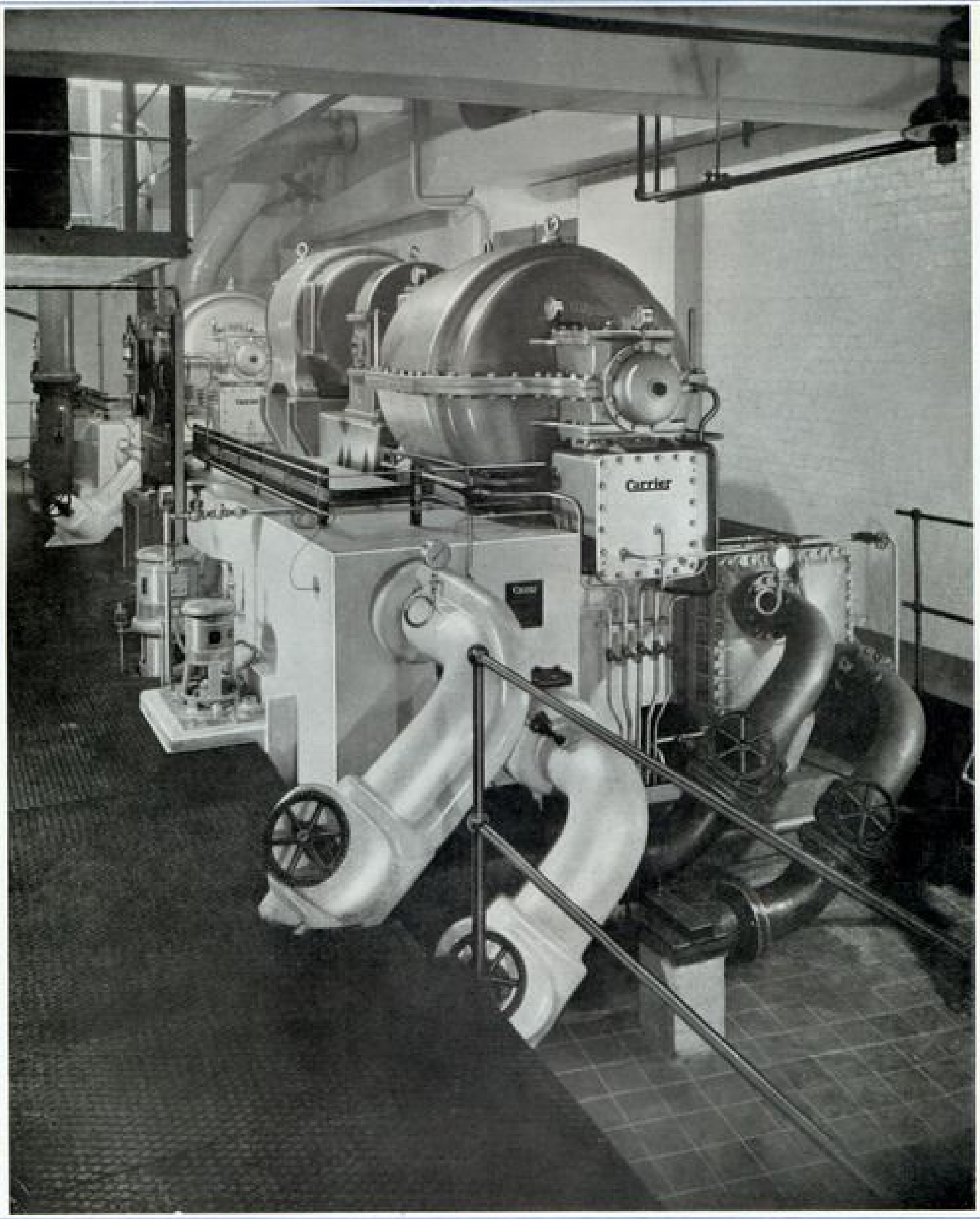
Showing the Carrier Centrifugal Refrigerating Machine, having a capacity of 150 ice melting tons, installed at the Paramount Theatre, Paris, in conjunction with the Carrier Air Conditioning System for the cooling of the Auditorium.



A Carrier Centrifugal Refrigerating Machine installed in Princes House, 95 Gresham Street, London, E.C.2.
Photograph by courtesy of Princes House Estate, Ltd.

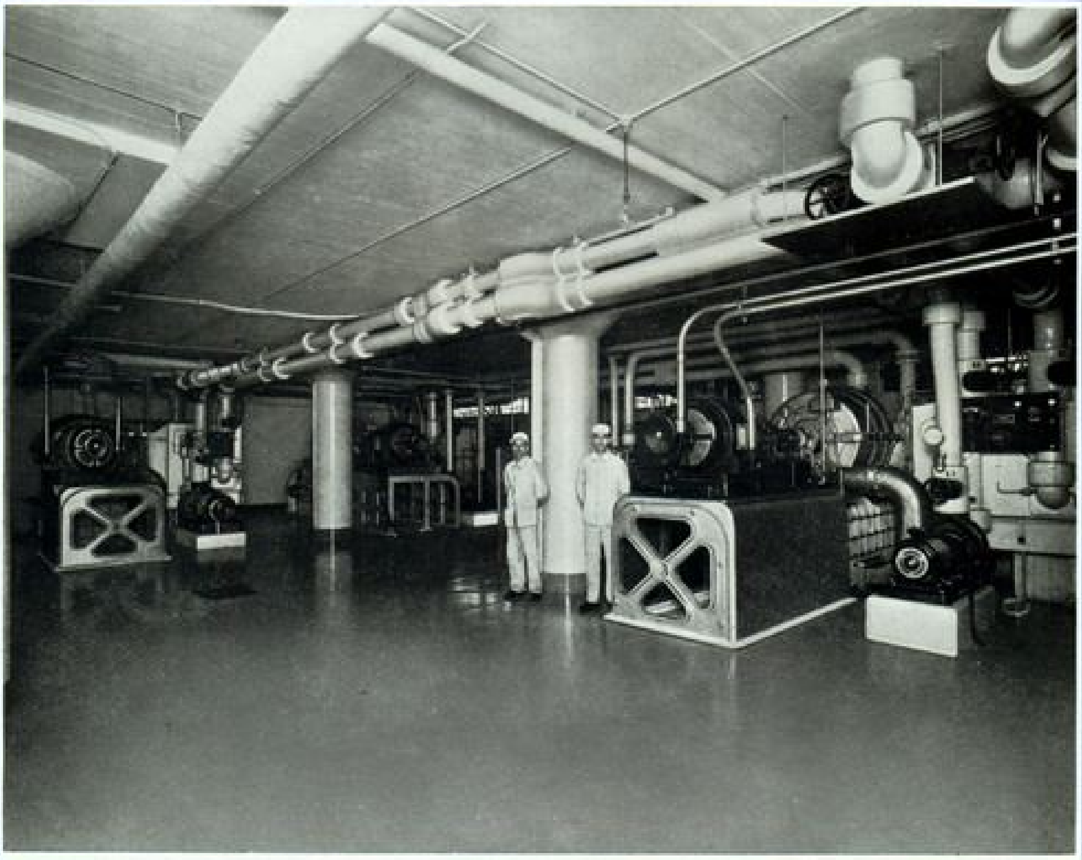


The illustrations above and on the page facing show two Carrier Centrifugal Refrigerating Machines installed at the Cumberland Hotel, Marble Arch, London, W. One of these machines is driven by a steam turbine while the other is driven by means of an electric motor. The above photograph shows the steam turbine driving the first machine, with the second machine in the background.



This photograph shows the compressor of the electrically driven machine at the Cumberland Hotel, with the steam-driven machine in the background. The total refrigerating capacity of the two refrigerating machines is approximately 500 ice melting tons.

These photographs are reproduced by the courtesy of Messrs. The Cumberland Hotels, Ltd.



Showing the three Carrier Centrifugal Refrigerating Machines, having a capacity of 350 ice melting tons, and operating in conjunction with the Carrier Air Conditioning Equipment installed at the Wembley factory of Messrs. Wrigley's Products, Ltd.

The advantages of the Carrier Centrifugal Refrigerator may be summed up as follows :

(1) The refrigerants employed have a very high thermo-dynamic efficiency, so that the power consumed for a given amount of refrigeration is reduced to a minimum.

(2) The Carrier Centrifugal Refrigerating Machine occupies very much less space and has considerably less weight than the most compact form of positive compression machines.

(3) As all the moving parts of the Carrier Centrifugal Refrigerating Machine are rotary, there is no vibration, and consequently heavy foundations are avoided.

(4) The characteristics of the refrigerant employed enable the machine to be operated under vacuum, so that no bursts or explosions can take place.

(5) The refrigerant is innocuous, non-poisonous, non-asphyxiating, non-inflammable and non-explosive.

(6) The compressor can be driven direct by a steam turbine or by an electric motor through suitable gearing, so that the drive is always positive and efficient.

(7) Full refrigerating effect is immediately available when the Carrier Machine is started up. With all other systems the compressor must be run for some considerable time before equilibrium is reached and full load conditions are realised.

(8) The immediate response of the Carrier Refrigerating Machine makes it peculiarly suitable to varying load conditions.

(9) The tubular surfaces of the condenser and evaporator can easily be cleaned on the water side, and owing to the materials employed in their construction are not subject to corrosion. On the refrigerant side the surfaces are kept permanently clean owing to the solvent action of the refrigerant, therefore there can be no diminution in the efficiency of the heat transmission surfaces.

For those interested in the first principles of refrigeration

AN important axiom in thermo-dynamics—the science that deals with the movement of heat and mechanical energy—is that heat cannot pass from a cold body to a hot body without the expenditure of energy, or, conversely, that heat will always flow from a hot body to a cold body.

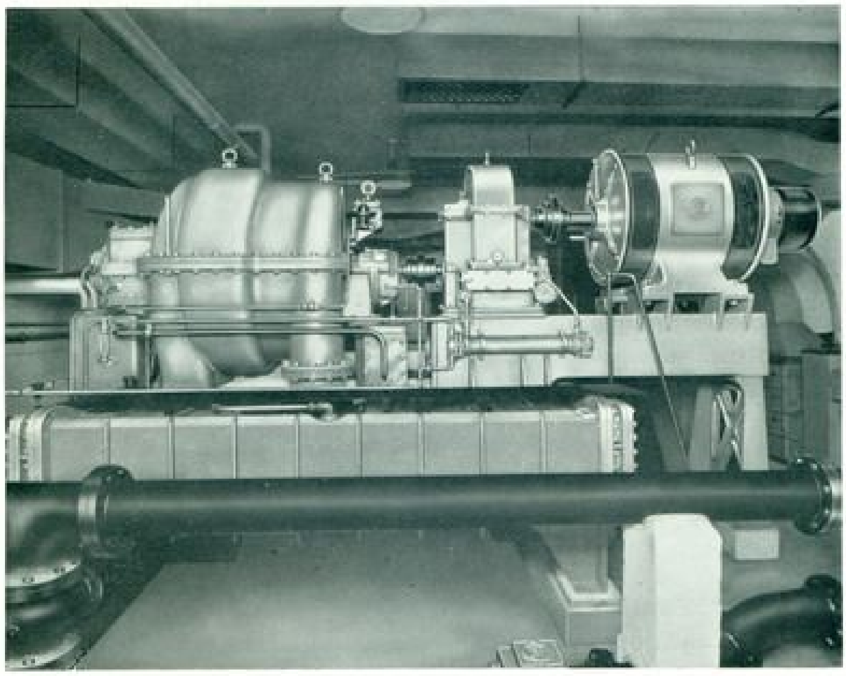
The latter phenomenon is a matter of common experience, as it is well known that if two bodies of different temperatures be placed in contact with each other, heat will flow from the warmer to the cooler. This natural heat flow can be reversed by interposing between the two bodies certain apparatus which will take heat from the cooler body and, by the expenditure of energy, transfer it to the hot body. The apparatus which performs this function is known as a Refrigerating Machine.

The Refrigerating Machine may well be compared with a pump which takes heat from the low level of the cold body and lifts it by the expenditure of energy to the higher level of temperature in the hot body, just as an ordinary pump lifts water from a low level to a high level.

In the course of the development of this branch of science, many types of refrigerating apparatus have been devised involving mechanical, chemical and physical processes. As the result of this accumulated experience, it has now been demonstrated beyond question that the process most suitable for commercial purposes is that of the mechanical type employing a continuous cycle of evaporation, compression and liquefaction. The essentials of such a Refrigerating Machine are a compressor, evaporator, condenser and a charge of suitable fluid known as refrigerant.

It is the function of the refrigerant to transfer the heat from the cold brine to the warmer condenser water, from which it can be dissipated into the atmosphere. This transfer is performed by making use of the latent heat of the refrigerant.

All liquids at any given pressure boil at a definite temperature, and in the process of boiling are transformed from liquid to vapour. The transformation involves an absorption of energy in the form of



A Carrier Centrifugal Refrigerating Machine installed in Broadcasting House, Portland Place, London, W.1. Photograph by courtesy of The British Broadcasting Corporation.

heat, and for every pound of liquid boiled away at a constant temperature a definite quantity of heat is absorbed. This quantity is known as the latent heat of evaporation at the particular temperature and pressure.

The photo is Lyon's Corner House, Oxford Street not the BBC (BR)

Conversely, when a vapour condenses to a liquid at a given temperature and pressure, the heat of evaporation is given up once more. Under reduced pressures the temperature at which boiling takes place is also reduced, consequently liquids can be made to boil at very low temperatures, absorbing at that temperature the latent heat of evaporation. Upon this natural phenomenon is based the process whereby the refrigerant transfers heat in the course of its cycle through the refrigerating machine.

In the evaporator a suitable liquid is made to boil at a low temperature under the reduced pressure created by the suction of the compressor. In boiling the refrigerant absorbs heat from the brine or other media which would be in contact with the outside of the tubes of which the evaporator is composed. The brine is thus cooled down to a temperature approaching that at which the refrigerant is evaporating, and this temperature may be many degrees below freezing point if required.

The vapour rising from the boiling refrigerant is drawn away by the compressor, which raises it to a higher pressure and temperature. In this condition it is discharged to the condenser, which is also built up of a group of tubes or coils of piping over one side of which the cooling water circulates.

The refrigerant at the higher pressure condenses, giving up its heat to the circulating water. The refrigerant, now in a liquid form, is returned to the evaporator, where it passes through the same cycle again.

Thus, the Refrigerating Machine, acting as a heat pump, withdraws heat from the fluid being cooled and transfers it to the cooling water circulating in the condenser. This transfer of heat is maintained by the movement and change in state of the refrigerant which passes through a continuous cycle, boiling at a low temperature in the evaporator and condensing back to a liquid at a higher temperature in the condenser under the control of the pressures created by the compressor. All vapour compression systems operate in this way.

Carrier