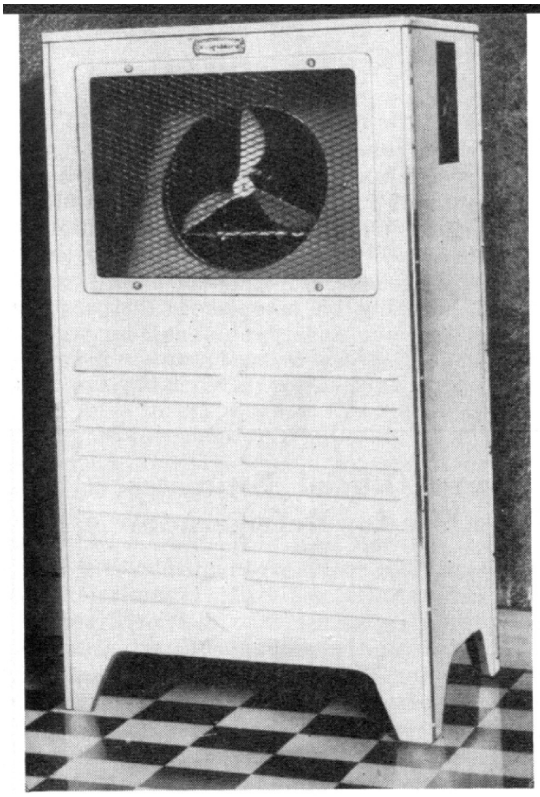

Fig. 1. One of the first room coolers to be sold commercially was made by Frigidaire in 1928.

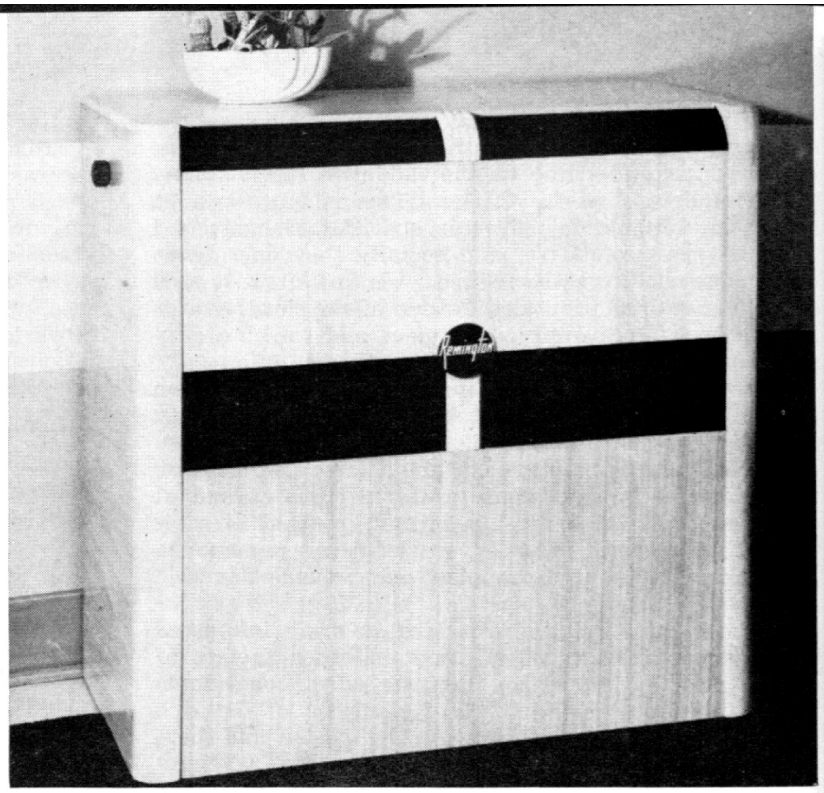


Fig. 2. A modern console room cooler as made by Remington. It is rated at 10,500 Btu per hr and has cabinet that blends with modern furniture.

# ROOM AIR CONDITIONERS—PAST AND PRESENT

## *A Survey of the Design History of This Equipment Since 1928 with a Discussion of Engineering Problems Still to be Solved*

**R. W. Morgan**
*Chief Engineer*
*Fedders-Quigan Corporation*

*One of the outstanding events of the 45th Annual Meeting of ASRE held last month in Chicago was the Room Air Conditioner Conference. Organized under the direction of Conference Chairman H. L. Laube, The Remington Corp., with the assistance of M. C. Terry, Philco Corp., J. H. Jennings, Mitchell Mfg. Co., C. O. Wood, Carrier Corp., R. W. Morgan, Fedders-Quigan Corp., H. J. Prebenson, Air Comfort Corp., and P. B. Moore, York Corp., the meeting attracted many engineers interested in the design of these units and future trends of this "embryonic industry." The Conference was opened by a paper and series of slides showing console and window air conditioners since their inception around 1928. The latter part of the Conference was given over to discussion of various design problems. This issue of REFRIGERATING ENGINEERING publishes the paper by Mr. Morgan and a portion of the illustrations of early and modern units; next month's issue will carry a specification comparison of current room air conditioners and the discussion of pertinent problems presented at the Chicago Conference.*

TO appreciate and understand thoroughly the engineering problems that confront the designers of room air conditioners today, it is considered advisable to trace the history of this type of unit, bringing out the early design thinking and showing the evolution of design through the years on both console and window type units.

The illustrations in this article will make up for a lot of words in regard to design details. Interesting differences in design are highlighted by comments to supplement the figures. The latter part of the paper will cover the engineering problems brought about by application of room air conditioners. As can be readily appreciated, there are many unsolved engineering problems, particularly in the fields where it is felt the greatest potential market exists—i.e., bedrooms in homes, hotels, and apartment buildings.

### Design Problems Past and Present

It would be well to call attention to the many problems brought up in the design of room type air conditioners. These design factors fall into three classifications:

(a) Physical and operational characteristics
(b) Restrictions imposed upon the designer by codes and ordinances
(c) Application problems

These problems will not be covered in detail since the discussion of this subject, to be published in the February issue of REFRIGERATING ENGINEERING, will expand upon them.

In the category of physical design problems it would appear that a successful air conditioner must have the best treatment of the following factors:

(1) It must have ample capacity to take care of average sized rooms under normal summer conditions.
(2) It must be small in size so as to be unobtrusive in offices, living rooms, and bedrooms. Its width should be such as to allow installation in a standard 27-in. window. It

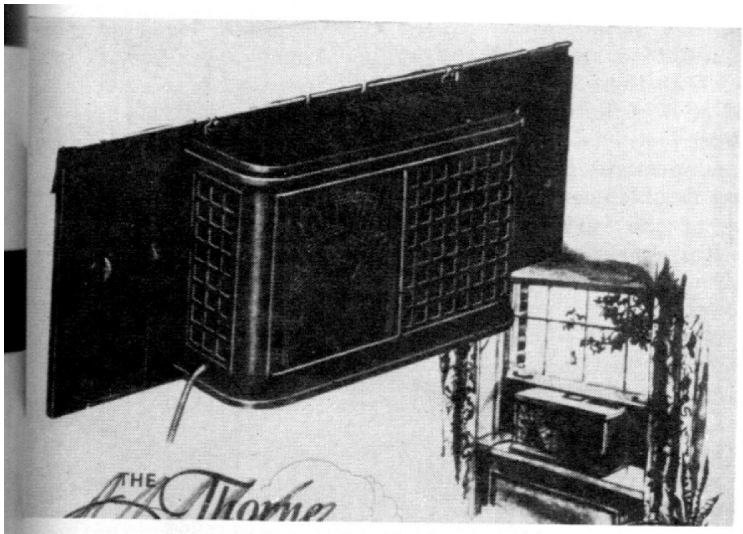


Fig. 3. The Thorne room cooler was one of the first window units but it is doubtful if this model ever was actually in production.

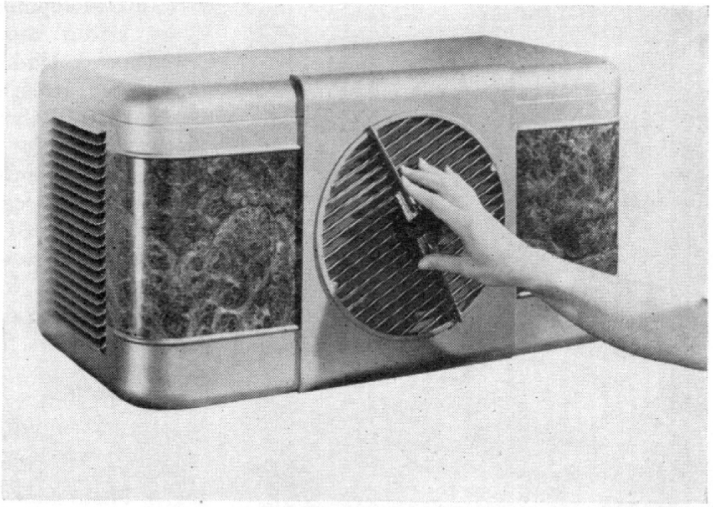

Fig. 4. A 1949 Fedders 1/2-hp window type room air conditioner combining high cooling capacity and attractive styling.

must also be light in weight to allow installation with minimum effort.

(3) It must be quiet in operation so as not to interfere with normal conversation in an office, or with sleep if used in a bedroom. It must also be quiet in operation from outside of the building so as to cause no disturbance to neighbors.


The author addressing Room Air Conditioning Conference

(4) It must be reasonable in cost.

(5) In the smaller capacities, unit must be a factory engineered, self-contained unit ready to be plugged into a 15-amp wall socket without special wiring.

(6) Air cooled units must not have water connections or drain connections to interfere with easy removal to another location.

(7) It must be styled for eye appeal and blend harmoniously with any type of office or home surroundings.

(8) It must be as reliable as a household refrigerator, which more or less demands the inclusion of a hermetic refrigerating system.

Some of the operational characteristics of a good unit are as follows:

(1) Materials selected for components of the unit must be such that they will last the life of the compressor and fan motor under normal weather conditions.

(2) The unit should be designed to allow the use of the unit not only for cooling, but for ventilating and for exhausting odors.

(3) It must dispose of condensate without dripping either inside or outside the building at reasonably low outside temperatures (80 F db) with high relative humidities (90%).

(4) It must not sweat to the point where it will drip on the floor causing damage.

(5) It must run with outside air temperatures up to 115 F with voltages at 90% of rated power without interruption.

(6) It must operate without freezing or cutting out on the overload at all conditions of operation covered by the summer zone of the ASHVE comfort chart.

Some of the more prevalent restrictions brought about by certain codes and ordinances are:

(1) Restrictions brought about by Underwriters' Laboratories—wiring codes, refrigeration system codes, and industrial control codes.

(2) Restrictions brought about by electric power companies limiting unit locked rotor current because of lamp flicker.

(3) Building restrictions calling for nonprojection of conditioners beyond window line.

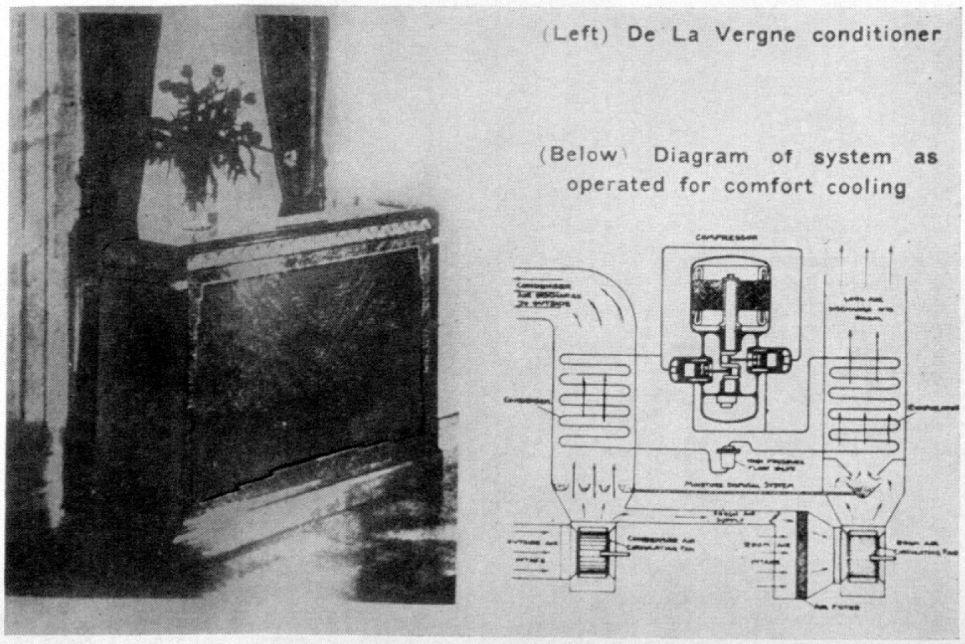


Fig. 5. Photo and diagrammatic view of a 1931 console air conditioner brought out by De La Vergne. This model incorporates many ideas used in current models today.

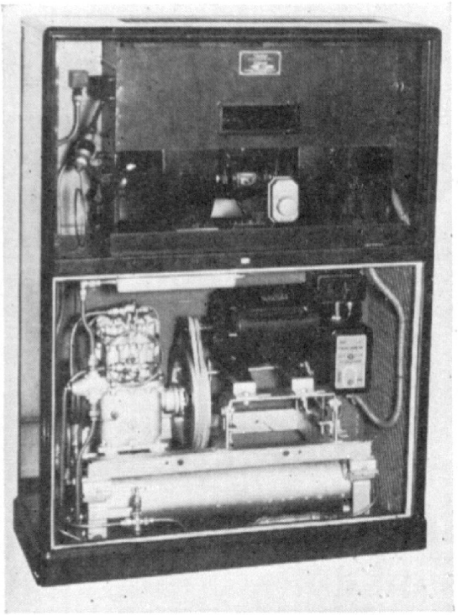

Fig. 6. One of Carrier's first console models introduced about 1932. Open type 2-cylinder compressor was used.

(4) Restrictions brought about by window washers in certain metropolitan areas.
(5) Restrictions brought about by neighborhood noise complaints.
(6) Restrictions brought about by excise tax on units under 10,000 Btu per hr ASRE capacity.

Another series of problems comes about in the application of air conditioners. Some of the more important ones are as follows:

(1) Application in the casement or metal type window.
(2) Development of a method of sizing the unit to a given room load so that there is a guarantee of having the unit handle the load.
(3) Design of an adequate window mounting flexible enough to take care of the various types of metal hung sash windows. This mounting should be such that the unit cannot drop out of the window, nor should it cause drafts if the conditioner is left in the window in the winter.
(4) Application problems brought about by consideration of air cooled vs water cooled units.
(5) Comparative advantages of single room type coolers vs central station systems in new and existing buildings.
(6) Problems brought about in applications to the export market where loads are unusual and power varies both in characteristics and voltage regulation.
(7) Application to low voltage lines.
(8) Vibration problems brought about by application of units to bedrooms located in upper floors of frame houses.

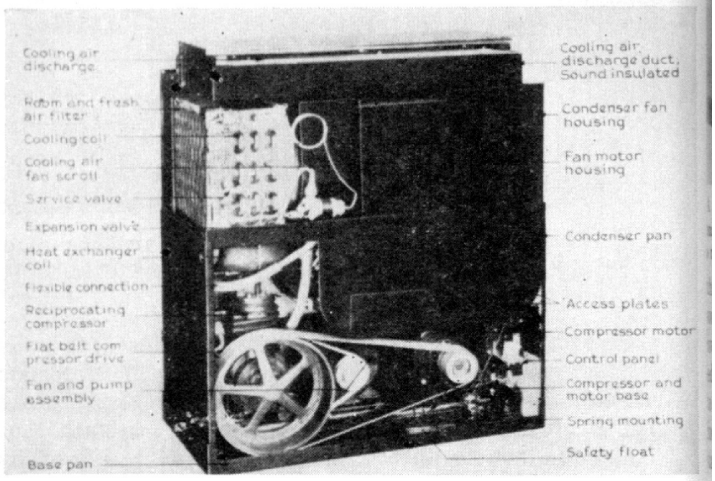


Fig. 8. Photo showing arrangement of machinery in General Electric model being sold in 1937.

## History and Evolution of Room Type Air Conditioner Design

In 1922 the first moving picture theater was air conditioned. Apart from earlier pioneering trials, this installation represented the first departure from industrial applications in the science of air conditioning. Its success demonstrated that air conditioning was not only effective in providing much needed human comfort in the theatre, but also was profitable to the proprietors by increased patronage through the sum-

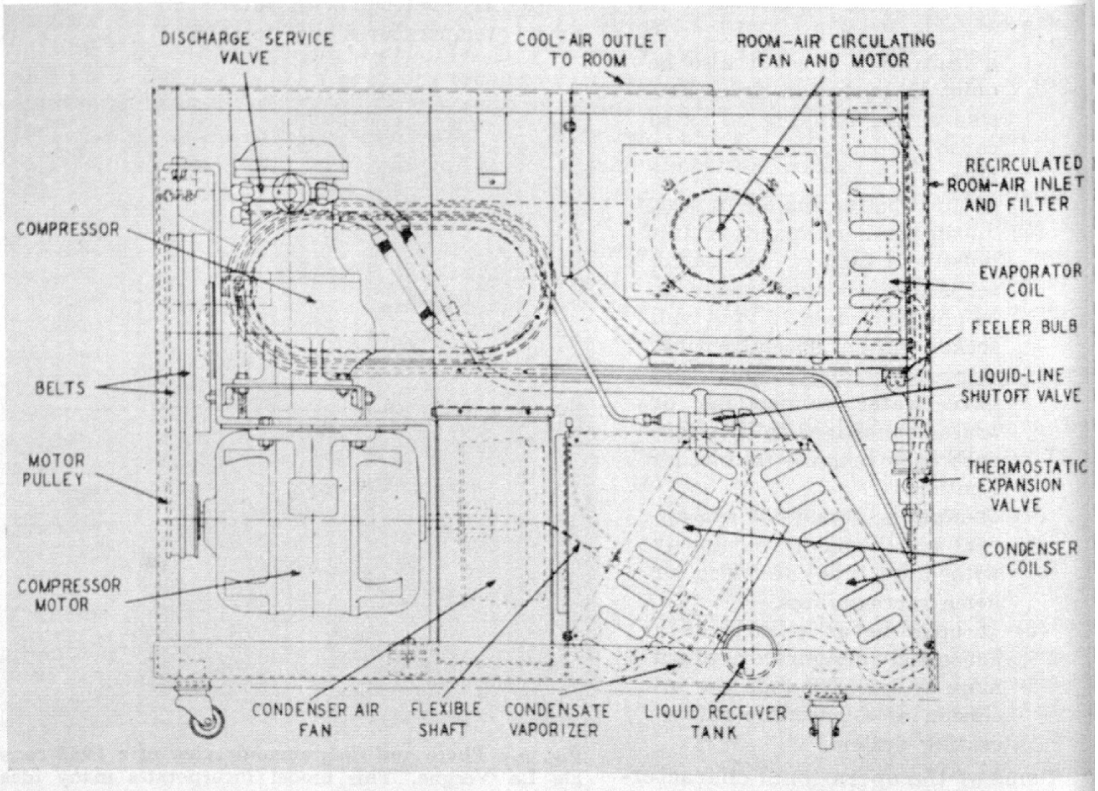


Fig. 7. Diagrammatic view of Philco-York conditioner brought out about 1935. It was rated at 6264 Btu per hour and was powered by a ¾-hp motor.

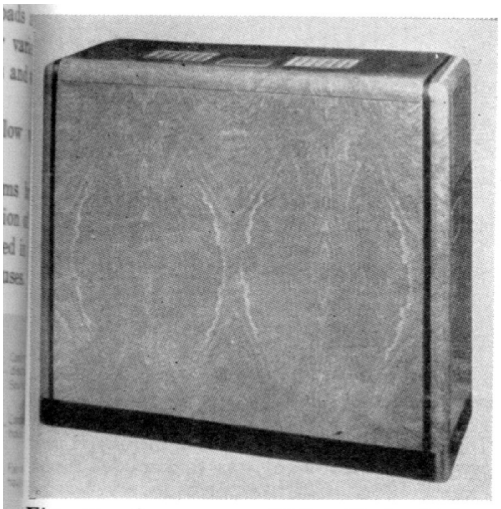

Fig. 9. A postwar Philco-York ¾-hp console conditioner with a styling that blends into most types of room furnishing.

mer months. The success in theatre cooling soon spread to other fields where provision for human comfort guaranteed increased patronage.

Prior to 1930 comfort applications were principally confined to costly central station type installations. In that year the first unit type equipment was successfully applied to conditioning a railway coach. The use of this type equipment spread rapidly to conditioning small commercial establishments such as restaurants, dress shops, drug stores, cocktail lounges, etc. The popularity of the self-contained type of equipment increased for all applications since the purchaser was assured of a low cost, factory engineered, compact, attractively styled unit. The installation of such a unit did not require costly building changes, piping, or electrical wiring, and usually met all safety codes.

The largest market of all—the professional or executive office and home—still offered a serious challenge to the engineer due to the many problems involved in the design of a satisfactory unit meeting the rigid requirements of such applications. The illustrations show in part how designers in the past and contemporary designers are handling the many problems brought about by the peculiar requirements of room-type air conditioners.

Figure 1 is an outside view of the first Frigidaire room cooler. This model is believed to be the first room cooler to be marketed commercially. (It should be noted that the first coolers were of the console type and water cooled. The window type did not appear until 1932.) This model was introduced around 1928. It is interesting to note that the appearance parallels the domestic refrigerator designs of that time.

In 1929 *Electric Refrigeration News* describes a Philco-York self-contained conditioner. A perusal of *Electric Refrigeration News* issues from 1928 to 1931 indicates considerable interest by such companies as Frigidaire, Kelvinator, York, General Electric, Copeland, Universal Cooler, Carrier, Strang, and several others.

A most interesting console model was introduced in 1931 by De La Vergne and is shown in Fig. 5. Remarkable foresight and vision in design were shown since this model incorporates many of the ideas being used today in current models. This unit, Model AA1.5, employed a vertical welded 2-cylinder hermetic type 2-hp compressor direct connected to a motor operating at 1750 rpm, an unheard of speed in those days. This unit was also one of the first air cooled consoles available.

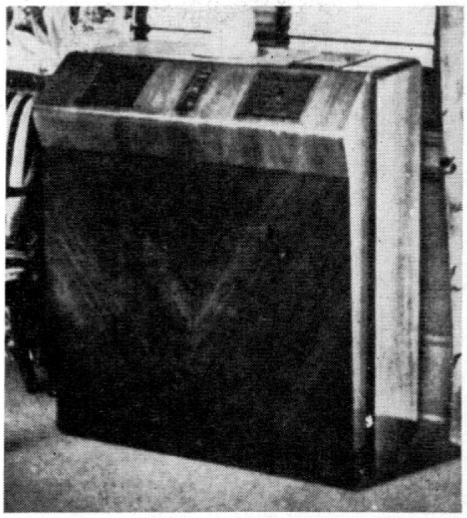

Fig. 10. Carrier's 1-ton console brought out in 1949. Room air enters at top of unit in back and is discharged through grilles in front.

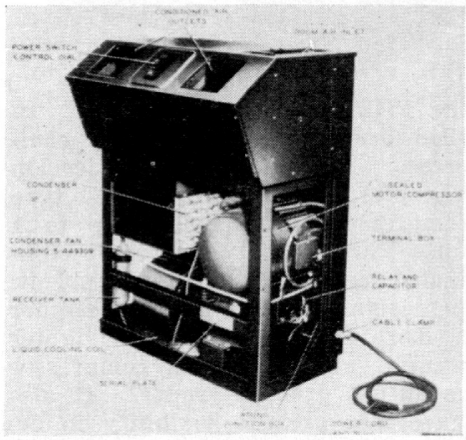

Fig. 11. Front view of the chassis of model shown in Figure 10. Evaporator fan can be reversed to provide room exhaust.

The unit was extremely compact for such a capacity, being only 52 in. wide, 42 in. high, and 19 in. deep. This compares favorably with models currently available. It is interesting to note that reverse cycle heating was available as an option with a heating capacity of approximately 20,000 Btu per hr. Switch over

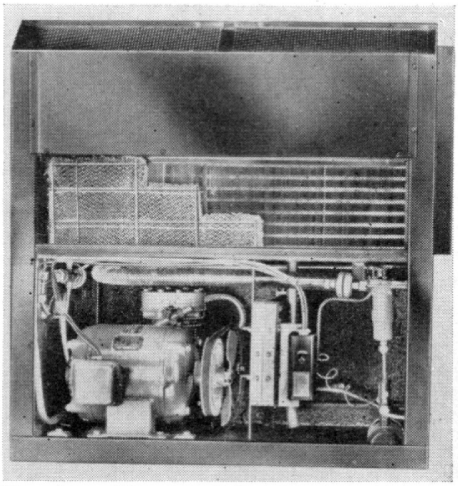

Fig. 12. Chassis of Remington unit pictured in Figure 2. Condenser is of the concentric tube design, a departure from usual practice.

from summer to winter operation was accomplished by operating a 3-way cock. One of the disadvantages of this unit, particularly when classified as a portable unit, was its weight—1200 lb.

In the years from 1932 to 1936 a number of water cooled consoles were marketed. In 1933 General Electric came out with units of ½ and 1 hp with 4500 Btu and 8500 Btu capacity, respectively. Frigidaire, Kelvinator, and York marketed water cooled console units and introduced improved models during these years.

Interesting units were introduced by Kelvinator in 1934. These were available in capacities from 6600 to 15,000 Btu per hr. They were of the "high boy" design. This unit varied in weight from 580 to 875 lb. The down draft cooling coils and the means for controlling the humidity are interesting features of this model. A humidistat positioned a by-pass evaporator coil damper by means of a damper motor.

One of the first console models introduced by Carrier came out in 1932. This water cooled unit, known as Model 50B, was of the high boy design and the interior view is shown in Figure 6. A conventional open type 2-cylinder compressor was used. The refrigerant is controlled by a thermostatic expansion valve. The unit was of 1-ton capacity.

Another early air cooled console was introduced by Philco-York around 1935. This model, shown diagrammatically in Figure 7, was known as BA-75. It had a capacity of 6264 Btu per hr and was powered by a ¾-hp motor. To more effectively kill compressor vibration, running at comparatively low rpm by today's standards, the compressor was mounted above the motor. This arrangement allowed a convenient

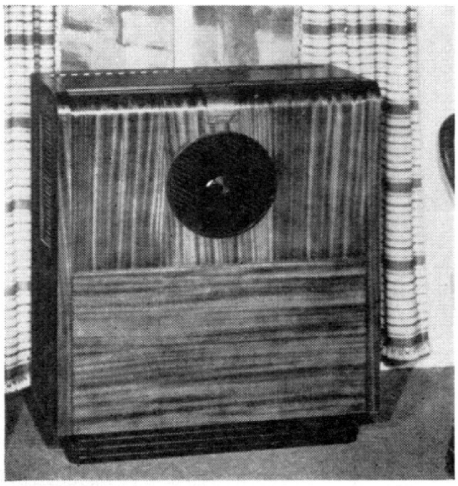

Fig. 13. A ¾-hp Fedders console, above. Room air enters from side and is discharged through rotatable grille in front.

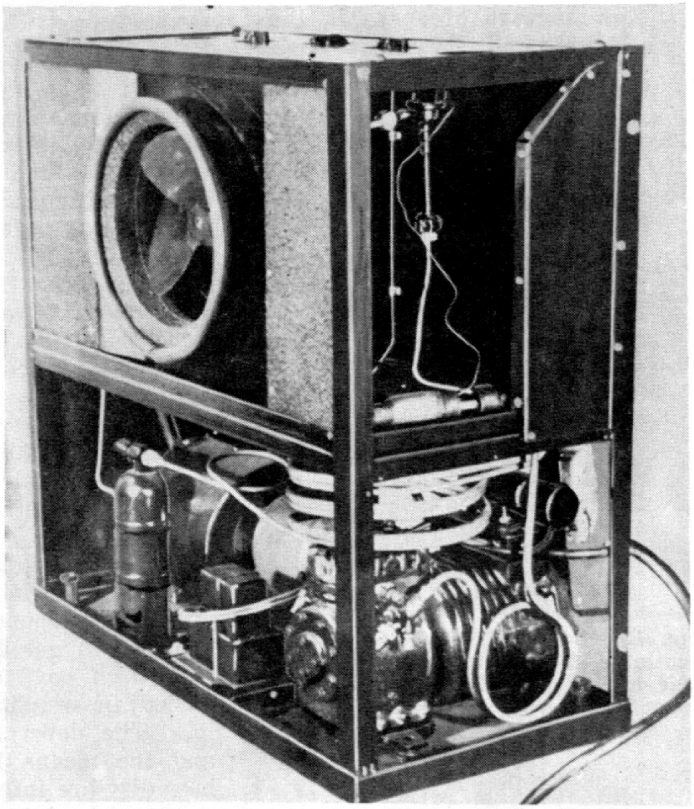

Fig. 14. Chassis of Fedders unit, right, showing general arrangement of parts.

means of driving the condenser fan and condensate disposal slinger disc. Receiver was submerged in the condensate to provide liquid subcooling. Design of the unit is considerably more compact than the previous high boy models.

An unusual console design was introduced by General Electric in 1937. This model (AF1A), Figure 8, was more or less conventional in its use of a belt driven low speed compressor, except that an evaporative condenser was used instead of an air or water cooled condenser. The water spray pump and machine compartment ventilating fan were driven off the compressor flywheel by means of a V-belt. A flat belt was used for the compressor drive.

Frigidaire came out with a model that employed a hermetically sealed compressor with capillary feed about this time. The condenser fan of this model was unusual in that it was a cross between a centrifugal and a propeller. It was exceptionally quiet.

Another interesting design brought out by Carrier in 1936 was a model (50D) employing a 2-pole evaporator fan motor which produced relatively high static pressure in a plenum chamber which contained a plurality of small, high velocity jets. Air was drawn through the evaporator coil by induction.

The development of console conditioners from 1938 to 1942 did not show many major changes in design. Immediately following the war the 1942 models were offered. In 1946 designers were forcing compressor manufacturers to develop hermetic and semihermetic type compressors in capacities up to 1 ton. This type of compressor eliminated several important problems in design. It allowed the designer a more compact design, a lighter weight, and made the compressor mounting problem easier. It also gave him greater flexibility in design since the condenser fan on air cooled models need no longer be so tied in with the compressor motor.

### Postwar Console Models

Figure 9 shows the exterior view of a 1949 Philco-York ¾-hp console conditioner. Attention should be called to the styling which blends in with almost any type of interior furnishing. This unit is equipped with a 0 to 100% integrating type fresh air damper, as well as room exhaust desirable for odor removal.

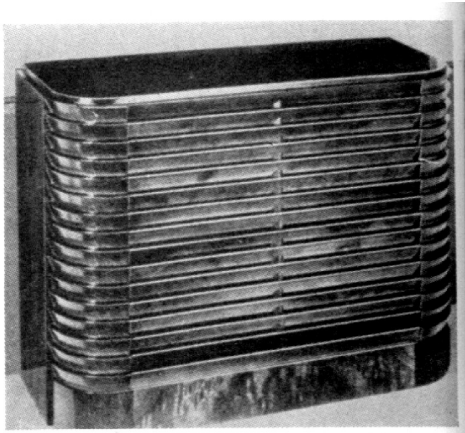

Fig. 15. One of the first Philco-York window conditioners was this model rated at 3675 Btu per hour.

An external view of a 1949 Carrier 1-ton console is shown in Figure 10. It is housed in a die stamped steel cabinet with two-tone color treatment. The room air enters the unit through a grille in the top at the back and is discharged through a grille on the top at the front. Figure 11 shows a front view of the chassis with the front panel removed. The 4-blade evaporator fan driven by a two-speed reversible fan motor is of interest. This fan can be reversed to provide room exhaust. The separate air condenser fan can be seen driving a centrifugal blower.

A Remington water cooled console rated at 10,500 Btu per hr is shown in Figure 2. This particular cabinet is suitable with modern type furniture. It should be noted that the evaporator air enters the grille in the front of the cabinet and is discharged through the long narrow grilles in the upper front corner of the cabinet.

Figure 12 is the chassis of the Remington unit with the front panel removed. The evaporator coil filter can be readily seen. The motor and belt-driven compressor are at the

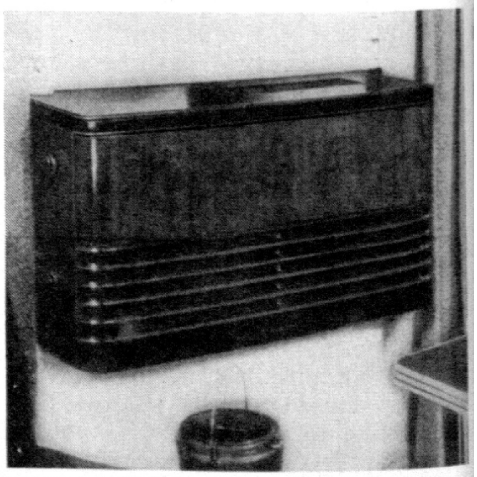

Fig. 16. A model of Westinghouse which was widely sold before the war. It was a hermetic type with a five-year warranty.

left. The water cooled condenser is of interest since it deviates from the usual shell and tube or shell and coil design. This condenser is of the concentric tube design with longitudinal fins in the anular space or gas side resulting in a compact design. A machine compartment cooler can be seen above the compressor. This unit is fed by means of a thermostatic expansion valve. The liquid receiver is submerged in the condensate to subcool the liquid refrigerant.

Figure 13 shows an external view of a Fedders ¾-hp console. The cabinet is styled with a modern treatment as indicated by the waterfall front. The cabinet is mahogany veneer selected to blend with most interiors without clash. The room air enters the grilles in the side and is discharged through the rotatable grille in front allowing the air to be directed to any part of the room. Figure 14 is a front view of the chassis showing the general arrangement of parts. This unit also uses an accessible hermetic compressor. A thermostatic expansion valve is used for refrigerant control.

Fig. 17. An early postwar unit, above, was this Pleasantaire with double propeller fans.

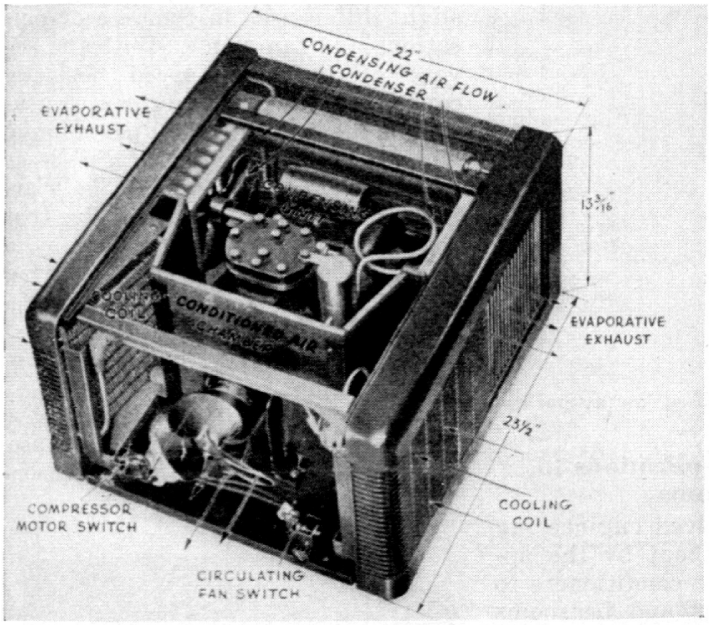


Fig. 18. A chassis view, left, of Pleasantaire model, showing double propeller fans.

## Window Type Room Conditioners

It is believed one of the first window type conditioners offered to the public was one appearing in the June 15, 1932, issue of *Electric Refrigeration News*, Figure 3. It will be noted that this unit is similar to some of today's models in appearance. There is no information as to its performance. It is doubtful whether this unit ever got into mass production.

Apparently there was little further activity in the design of window type units until 1936-37 when Philco-York and Pleasantaire introduced small capacity (⅓-hp) units.

The first production Philco-York CW-40 conditioner of 3675 Btu per hr capacity is shown in Figure 15. This view shows the veneered walnut wood cabinet. No provision is made for fresh air intake, but a room exhaust damper is provided. A single motor drives the compressor, the condenser fan, and evaporator fan. The condenser fan is provided with slinger ring for disposal of condensate. This is the most popular idea on condensate disposal in current designs.

Figure 16 shows the external view of an unusual window unit brought out by Westinghouse in 1941. It is believed that this was the first completely hermetic window type unit sold with a 5-year warranty. The unit was known as Model WB-06 and was rated at 6000 Btu per hr. It also was designed for reverse cycle heating with a heating capacity up to 9200 Btu per hr. This provided year round application.

## Postwar Window Models

Majority of the early 1946-47 units used open type units whereas the 1948-49 units are almost universally equipped with direct connected compressors.

One of the early postwar units was the Pleasantaire Lake Louise shown in Figure 17. The open type compressor, double propeller condenser fans, double evaporator coils, and other components of the Pleasantaire model are shown in Figure 18.

Figure 19 is a late model Philco-York ¾-hp window model brought out in 1948. This unit indicates modern styling in a steel room cabinet. Cooled air is discharged through two 2-way grilles.

In 1949 Philco-York brought out a redesigned ¾-hp sealed hermetic window unit. Figure 20 is a view of the chassis. It will be noted that a blower type fan is used on the evaporator side while a propeller type is used on the condenser side. The condensate is disposed of by a separate slinger ring mounted in front of the condenser fan. A single motor drives both condenser and evaporator fan.

Figure 21 is a room side view of the Chrysler Airtemp ¾-hp window type conditioner. This design is unusual in its treatment of the problem of eliminating the projection out of the window. The unit is set out on the window sill with the rear edge flush with the window line. Two legs support the unit at the front. The unit may also be mounted in the conventional manner if desired.

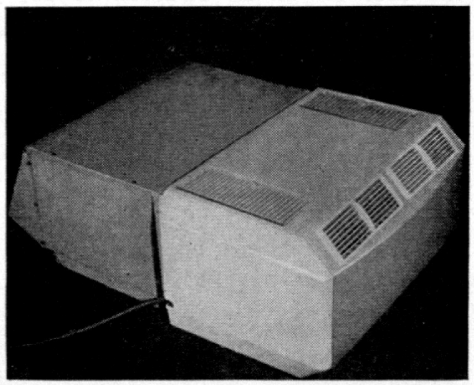

Fig. 19. A late model Philco-York with a ¾-hp hermetic condensing unit.

Figure 22 is an outside view of the Frigidaire ½-hp unit. This unit is also equipped with a sealed hermetic refrigeration system, using a capillary. The compressor is of the rotary type. A 1-hp unit is also available using two ½-hp compressors. These may be sequenced in starting and also may be used for 2-step capacity.

Figure 23 is a Carrier ¾-hp window unit rated at 8500 Btu per hr. This unit employs two propeller fans direct connected to a single motor

to supply condenser and evaporator air. A slinger ring on the condenser fan is used for condensate disposal.

Figure 4 is a Fedders ½-hp window type unit. This unit employs separate fan motor for the condenser and evaporator air. The room air enters through the two side grilles and is discharged through the circular deflecting grille in the front. This grille is rotatable and allows the cool air to be directed to any part of the room. The styling is unique in that a walnut burl center panel is combined with an opalescent bronze finish.

Figure 24 is a view of the Fedders chassis showing arrangement of the parts. This unit employs a V-type evaporator of large face area to reduce air resistance and to prevent fall off in capacity when the filters become loaded. Also shallow evaporator coils are used making it necessary to use low air velocity to get effective moisture removal. The front shroud is designed to eliminate possibility of sweating under adverse operating conditions.

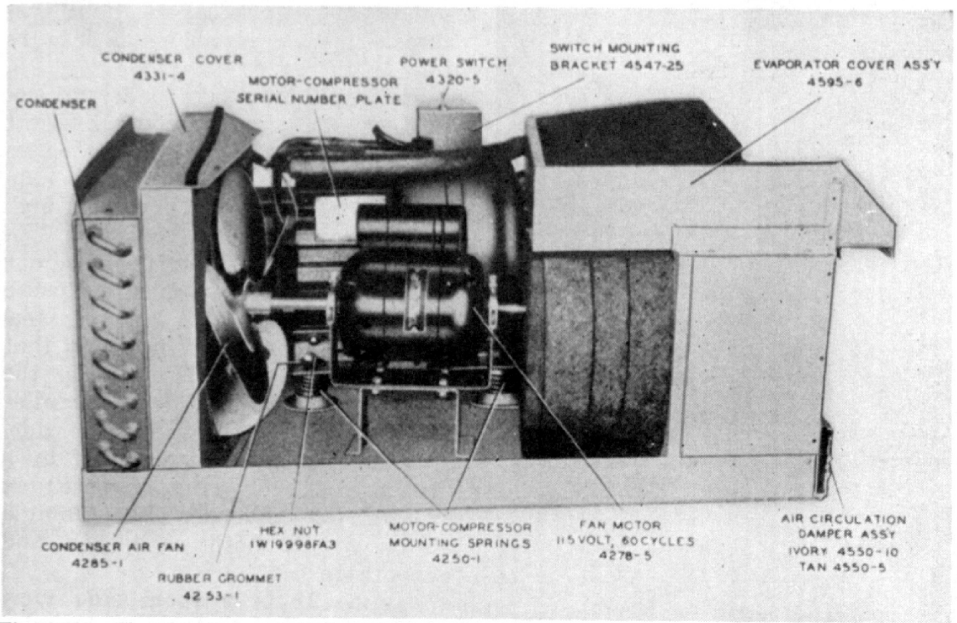


**Fig. 20. Chassis view of Philco-York unit. Blower type fan is used on evaporator side and propeller type for condenser.**

## Problems in Applications to Bedrooms

Some of the unsolved engineering problems brought about by the application of room air conditioners to residential bedrooms and bedrooms in hotels and apartment buildings are summarized in the following paragraphs. It is evident that the greatest potential market for these units is in the home since the number of homes far exceeds the number of offices, hospitals, and other professional and commercial applications.

Perhaps the most difficult problems are noise and vibration elimination and reducing the manufacturing cost of a unit with adequate capacity to a figure which will allow the mass market to purchase. Perhaps the greatest difficulty in applying a unit to a bedroom is that of placing a window type unit on the window sill of a double hung sash window located in a frame house. In frame houses the compressor vibrations are difficult to dampen and they are telegraphed through the studding to other living quarters. It would appear that to minimize or eliminate this difficulty a window mounting must be designed to better cushion the entire conditioner.

Another engineering problem present in bedroom applications is reducing the air noise both inside and out to a point where persons of average nervous temperament will not be disturbed. This brings into prominence the problem of quiet fan design. An approach to minimizing fan noise is to reduce the fan motor rpm, which immediately makes the fan large in diameter and/or deep in pitch, bringing about dimensional difficulties. Noises amplified by the fan blades also must be minimized, perhaps by use of rubber insulated hubs or use of plastic material for fans.

Another annoying noise problem is brought about by the occurrence of beat frequencies produced by slight differences in compressor pulsations and fan rpm's. With the advent of the high speed hermetic compressor the frequencies are usually in the order of 3500 per minute, whereas the frequency of the 3- or 4-blade evaporator fan may be nearly the same. It may also be that the condenser fan is driven by a separate motor which may bring about another source of beat frequencies. It is felt that the beat frequency should be of such nature that it cannot be counted.

The bedroom unit should also have features to permit year round use, which means provision for a reasonable amount of outside air. The mounting for such a unit should be made so that it can be left in the window the year around without causing annoying cold drafts.

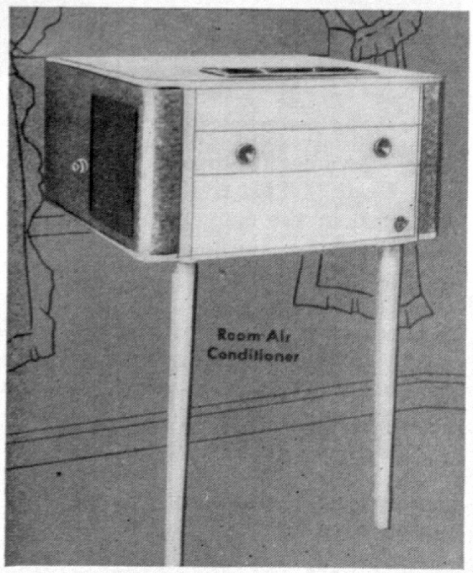


**Fig. 21. An unusual model of Chrysler Airtemp unit which eliminates projection outside of window by utilizing legs to make equipment resemble room table.**

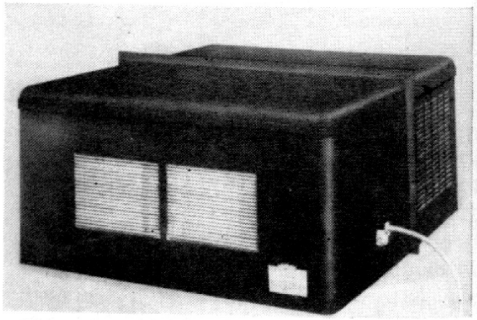

**Fig. 22. This current Frigidaire model has a hermetic refrigeration system and uses a capillary for regulating refrigerant flow.**

The problem of applying room type air conditioners to hotel bedrooms is quite involved. In general, hotels do not like to have objects projecting beyond the window line. This would indicate that some type of window unit capable of being mounted on the window sill with the back of the unit in the plane of the window pane, or possibly a console model, would be desirable. A console model is objectionable due to its cost and the greater space taken by it in the room.

Often hotels will consider buying a large number of single room conditioners rather than put in an ex-

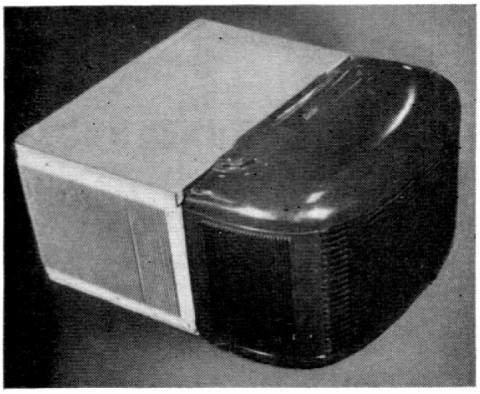

Fig. 23. A modern Carrier unit, left, rated at 8500 Btu per hr with a ¾-hp motor.

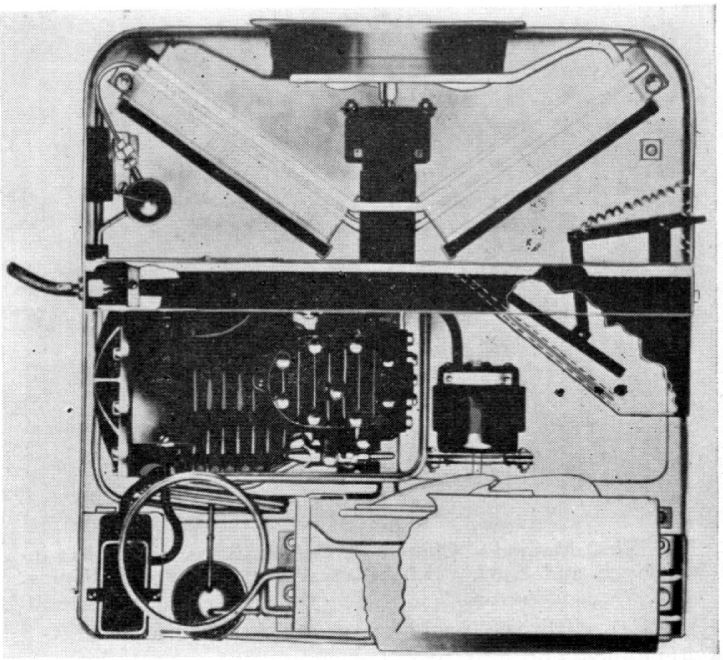

Fig. 24. Chassis view, right, of Fedders model shown in Figure 4. Unit employs a V-type evaporator of large face area.

pensive central station system, which would call for considerable remodeling of the building. A central station system is rather inflexible since it is difficult to have the occupant individually control his room conditions without affecting in some way the rest of the system. A single unit introduces no such problem and the occupant can be entirely independent of the other hotel guests.

A room type conditioner also provides the additional advantage of being readily removable if the hotel manager so desires. It is also possible to attach a coin device, making it possible for the hotel to rent the use of the conditioner on an hourly basis. Some hotels are interested in console-type conditioners with casters so that they may be rolled in and out of the rooms at will. This, of course, would be another way of getting around the vending type coin box. It would appear that in the interest of cost, a special hotel unit could be designed for these requirements.

In the February issue of REFRIGERATING ENGINEERING these problems will be discussed in more detail and recommendations will be given for minimizing or eliminating them.

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## *CHANICAL RAILROAD REFRIGERATION USED FROM FLORIDA TO JERSEY*

A carload of Minute Maid fresh frozen orange juice arrives at a Jersey City warehouse from Florida in a mechanically refrigerated railway car. The juice is held at a sub-zero temperature for the entire trip. The new car makes the 1000-mile run without a stop for servicing, as compared to the four or five re-icing stops required by the conventional refrigerator car. With more frozen foods being shipped each year, the railroads are now experimenting with various types of mechanically refrigerated cars so as to be able to hold sub-zero temperatures and offer competition against truck transportation.