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"Our Embryonic Industry"–

A Discussion of Room Air Conditioners

The Past, Present, and Future of Our Embryonic Major Industry

Herbert L. Laube, Remington Corporation

Last month REFRIGERATING ENGINEERING published a design survey of room air conditioners covering the period from their inception in 1928 to the present time. By text and picture this article reviewed what has been accomplished in the design and application of room air conditioners to date. The accompanying article presents pertinent discussions by several engineering authorities on the engineering improvements that are now necessary to gain widespread public acceptance of this new home appliance. The earlier article and these discussions were given at the Room Air Conditioner Conference held during the 45th Annual Meeting of American Society of Refrigerating Engineers last December.

A good way to introduce this subject is to define a room air conditioner. My definition is as follows:

> A room air conditioner is a substantially self-contained mechanism, the principal component of which is an electrically driven refrigerating machine of less than two hp, either air or water cooled. It is used primarily for summer cooling of the occupants of the room in which it is located, also provides air drying, circulation, ventilation and filtering, and operates at a noise level and is finished in a manner acceptable to the room occupants for whose personal well being it is intended.

It was the inherent and demonstrable advantages of the single room air conditioner that caused it to become an article of commerce 16 years ago. It still offers these same advantages, namely:

1) It provides the least costly refuge from summer heat that an individual can buy.
2) It makes the user independent of outside factors, such as operating schedules, and thus offers a greater degree of individual control than is provided by any other system of air conditioning which has come into commercial use.
3) It lends itself to specialty selling methods and, in general, is commercially attractive.
4) It lends itself to mass production techniques.
5) It can be installed in existing buildings more quickly and easily and with less inconvenience to the occupants than any other system.

Total prewar sales appear to have been 131,000 units, covering about a 10-year stretch. For the five years following 1936, the rate of growth averaged about 25% per year.

Table 1 gives the postwar story. With fewer manufacturers in the field and materials still extremely scarce, production in 1946 was resumed at the 1941 rate.

H. L. Laube, president of Remington Corp. and chairman of the Room Air Conditioner Conference, opens the meeting at the Edgewater Beach Hotel. Members of the Conference Committee, left to right, are M. C. Terry, Philco Corp., J. M. Jennings, Mitchell Mfg. Co., C. O. Wood, Carrier Corp.; Mr. Laube; R. W. Morgan, Fedders-Quigan Corp.; H. J. Prebenson, Air Comfort Corp.; and P. B. Moore, York Corp.

Specifications of Postwar Window-Type Room Air Conditioners

Manufacturer	Model	Year	Dimensions, in. Width	Depth	Height	Projec. into rm.	Net wt, lb	Controls Fresh air damper	Pump out	Thermostat	No of fan motors	Fan type Evap	Cond	Performance data Air circulation, cfm Evap	Outside air while cooling	Pump out	Capac, Btu/hr	Basis for capac rating†	Moisture removed per hr	Power, kwhr	Refrig control	Type of condenser in system	Condensing system mfr
½ HP UNITS																							
Ajax	—	1949	28½	26¾	16½	10	192	yes	no	extra	1	propel	propel	210	60	—	5880	A	2.45 lb	816	capil	welded herm	Servel
Carrier	51F1	1949	26⅜	26½	12⅜	11	—	yes	no	extra	1	propel	propel	—	—	—	5500	B	—	760	capil	acces herm	Copeland
Fedders	W-5	1949	27 1/16	27⅛	13	12	200	yes	no	extra	2	propel	propel	220	50	—	5500	B	1.5 lb	820	TXV	acces herm	Copeland
Frigidaire	SRA-50	1949	26	29½	13½	15¼	175	yes	no	extra	1	propel	propel	200	35	—	4985	B	—	—	capil	welded herm	Frigidaire
Harlanco	HAC-5	1949	27 1/16	27⅛	13	12	200	yes	no	extra	2	propel	propel	220	50	—	5500	B	1.5 lb	820	TXV	acces herm	Copeland
Lenco	L-600	1948	26	26	14½	11	180	yes	no	built-in	2	propel	propel	220	50	—	5500	C	2.25 lb	900	capil	acces herm	Copeland
Mitchell	M-10	1946	28½	26¾	16½	10	204	yes	no	built-in	1	centrif	propel	190	—	—	5780	A	2.45 lb	816	capil	welded herm	Servel
Mitchell	M-12	1949	28½	26¾	16½	10	192	yes	no	extra	1	propel	propel	—	—	—	5880	A	—	—	capil	welded herm	Servel
Monitor	AC-5	1947	27 1/16	27⅛	13	12	200	yes	no	extra	2	propel	propel	220	50	—	5500	B	1.5 lb	820	TXV	acces herm	Copeland
Pacific	50WA	1946	22¼	34½	13⅝	14	200	yes	no	extra	2	propel	propel	—	—	—	5000	B	1 qt	800	TXV	welded herm	Servel Univ
Philco	61C & 61CL	1946	26⅛	36⅜	14⅜	19 5/16	235	yes	yes	extra	1	centrif	centrif	275	60	240	5250	A	1 qt	1000	TXV	belt driven	York
Philco	61CA	1946	26⅛	36⅜	14⅜	19 5/16	235	yes	no	extra	1	centrif	centrif	275	60	—	5250	A	1 qt	1000	TXV	belt driven	York
Philco	61D & 61DL	1949	26 3/32	27⅜	13 9/16	10⅛	182	yes	no	extra	1	centrif	centrif	225	175*	—	5600	A	1.5 pt	1020	capil	welded herm	Tecumseh
Pleasantaire	O-66	1947	22	23½	13½	10½	—	yes	yes	extra	1	propel	propel	260	55	45	5400	B	—	730	TXV	belt driven	Universal
Quiet Cool	G-5	1949	27¾	25¾	13½	9¾	185	yes	no	extra	1	centrif	propel	220	50	—	5850	A	—	850	capil	welded herm	Tecumseh
Remington	T-6	1949	27⅞	27 11/16	13⅝	13	202	yes	no	extra	1	propel	propel	220	50	—	5500	B	1.5 lb	820	TXV	acces herm	Copeland
US Airco	—	1948	26	25	13	11⅝	—	yes	no	extra	2	propel	propel	—	—	—	—	—	—	—	TXV	welded herm	Servel
Vikimatic	—	1949	27 1/16	27⅛	13	12	200	yes	no	extra	2	propel	propel	220	50	—	5500	B	1.5 lb	820	TXV	acces herm	Copeland
York	—	1946	26⅛	36⅜	14⅜	19 5/16	235	yes	yes	extra	1	centrif	centrif	—	—	—	—	—	—	—	—	—	—
York	—	1949	26 3/32	27⅜	13 9/16	10⅛	182	yes	no	extra	1	centrif	centrif	—	—	—	—	—	—	—	—	—	—
¾ HP UNITS																							
Ajax	—	1949	28½	26¾	16½	10	—	yes	no	extra	1	propel	propel	—	—	—	8250	A	—	—	capil	welded herm	Servel
Carrier	51G2	1949	—	—	—	11	—	yes	no	extra	1	propel	propel	300	—	—	8500	B	—	—	2 capil	acces herm	Copeland
Chrysler	—	1948	—	—	—	—	—	yes	no	extra	1	centrif	centrif	—	—	—	—	—	—	—	—	acces herm	Chrysler
Fedders	W-7	1949	27 1/16	27⅛	15½	12	240	yes	no	extra	2	propel	propel	300	50	—	8000	B	—	0	TXV	acces herm	Copeland
Harlanco	HAC-7	1949	27 1/16	27⅛	15½	12	240	yes	no	extra	2	propel	propel	300	50	—	8000	B	—	—	TXV	acces herm	Copeland
Mitchell	M-75	1946	28½	26¾	16½	10	—	yes	no	extra	1	centrif	propel	—	—	—	—	—	—	—	—	—	—
Mitchell	M-34	1949	28½	26¾	16½	10	—	yes	no	extra	1	propel	propel	256	—	—	8876	A	2.7 lb	1252	capil	welded herm	Servel
Monitor	AC-7	1947	27 1/16	27⅛	15½	12	240	yes	no	extra	2	propel	propel	300	50	—	8000	B	—	—	TXV	acces herm	Copeland
Philco	76C & 76CL	1946	26⅛	36⅜	14⅜	19 5/16	205	yes	yes	extra	1	centrif	centrif	275	60	240	7750	A	1.5 qt	1400	TXV	belt driven	York
Philco	76CA	1946	26⅛	36⅜	14⅜	19 5/16	205	yes	no	extra	1	centrif	centrif	275	60	—	7750	A	1.5 qt	1400	TXV	belt driven	York
Philco	76E & 76EL	1949	26¼	34 11/32	14⅜	18⅞	200	yes	yes	extra	1	centrif	propel	300	250*	75	7750	A	2 pt	1210	capil	welded herm	York
Philco	76D & 76DL	1948	26¼	39	14⅜	18½	230	yes	yes	extra	2	centrif	centrif	275	250*	140	7400	A	1 qt	1276	capil	welded herm	York
Quiet Cool	G-7	1949	27¾	30¾	14¾	14¾	—	yes	yes	extra	1	centrif	propel	275	70	100	8900	A	—	1250	capil	welded herm	Tecumseh
Remington	M-8	1949	27⅞	27 11/16	16⅛	13	240	yes	no	extra	2	propel	propel	300	50	—	8000	B	—	—	TXV	acces herm	Copeland
Vikimatic	—	1949	27 1/16	27⅛	15½	12	240	yes	no	extra	2	propel	propel	300	50	—	8000	B	—	—	TXV	acces herm	Copeland
York	21-1, 2, 10, 11	1948	26¼	39	14⅜	18½	—	yes	yes	extra	1	centrif	centrif	275	253*	143	7400	A	1 qt	1276	capil	welded herm	York
1 HP UNITS																							
Frigidaire	ARL100	1948	28¼	32⅛	13½	15¼	275	yes	no	extra	1	centrif	centrif	315	50	—	9000	B	—	—	capil	2 welded herm	Frigidaire

All window models use F-12 refrigerant except Philco models 76E, 76EL, 76D, 76DL and York models 21-1, 21-2, 21-10, 21-11, all of which use F-22.

Specifications of Postwar Console-Type Room Air Conditioners

Manufacturer	Model	Year	Dimensions, in. Width	Depth	Height	Net weight, lb	Controls: Fresh air damper	Pump out	Thermostat	No of fan motors	Fan type: Evap	Cond	Performance data: Air circulation, cfm: Evap	Outside air while cooling	Pump out	Capac, Btu/hr	Basis for capac rating†	Moisture removed per hr	Power, kwhr	Refrig control	Type of condenser in system	Condensing system mfr
Carrier	51B2	1946	34	17½	40¼	—	yes	yes	extra	1	centrif	centrif	—	—	—	9100	B	—	—	TXV	belt driven	Copeland
Carrier	51D2	1946	39	23⅛	42⅜	—	yes	no	extra	1	centrif	centrif	—	—	—	12500	B	—	—	TXV	belt driven	Carrier
Carrier	51H2	1949	34	21¼	40⅛	—	yes	yes	extra	2	propel	centrif	—	—	—	10500	B	—	—	2 capil	acces herm	Copeland
Fedders	F-7	1949	33⅝	18 5/16	35⅞	320	yes	yes	extra	2	propel	centrif	310	250*	225	8850	B	—	1300	TXV	acces herm	Copeland
G-E	FB-706	1946	38	19⅝	36¼	425	yes	yes	extra	2	centrif	centrif	273	50	360	8020	B	1.75 lb	1220	TXV	belt driven	G-E
Philco	91-C	1946	32½	19 5/16	38⅜	325	yes	yes	extra	1	centrif	centrif	315	60	240	9000	A	1.75 qt	1475	TXV	belt driven	York
Philco	91-CA	1946	32½	19 5/16	38⅜	325	yes	no	extra	1	centrif	centrif	315	60	—	9000	A	1.75 qt	1475	TXV	belt driven	York
Philco	101-C	1946	32½	19 5/16	38⅜	335	no	no	extra	1	centrif	centrif	360	—	—	9200	A	2 qt	1225	TXV	belt driven	York
Remington	10A-75	1947	38	20	38	350	yes	yes	extra	1	centrif	centrif	325	75	—	9000	B	—	—	TXV	belt driven	Brunner
Remington	10A-100	1947	38	20	38	400	yes	yes	extra	1	centrif	centrif	400	75	—	11000	B	—	—	TXV	belt driven	Brunner
Remington	10A-150	1947	38	20	38	450	yes	yes	extra	1	centrif	centrif	475	75	—	13500	B	—	—	TXV	belt driven	Brunner
York	3	1946	32½	19 5/16	38⅜	325	yes	yes	extra	1	centrif	centrif	315	60	240	9000	A	1.75 qt	1475	TXV	belt driven	York
York	32-1	1949	32½	19 5/16	39 9/16	325	yes	yes	extra	2	centrif	centrif	400	60	240	8800	A	1.75 qt	1200	capil	welded herm	York

† Basis for capacity ratings: A—80 F db, 67 F wb inside; 90 F db, 75 F wb outside
B—80 F db, 67 F wb inside; 95 F db, 75 F wb outside
C—80 F db, 67 F wb inside; 95 F db, 78 F wb outside

* Denotes cfm of outside air when machine is not cooling
All console models use F-12 refrigerant except York model 32-1, which uses F-22

In the three years since then production has trebled from 29,835 units produced in 1946 to an estimated production of 93,000 in 1949. Retail sales did even better. They almost quadrupled. Inventories carried over from 1948 were moved this year, so that total retail sales appear to have been over 100,000 units in 1949. The retail picture based on the best available statistics is given in the top half of Table 2.

The second half of Table 2 is a projection for four years (1950 through 1953) of the actual figures from 1946 through 1949. The annual rate of growth has been constantly diminished in this forecast. For 1949 the actual rate was 50%. The assumed rate of growth for each of the four following years has been taken as 45, 40, 35, and 30%, respectively.

Boiled down to retail dollar values, here's what these figures say: During its first 10 years the industry sold perhaps 131,000 units. During the past four years the industry has retailed 235,000 room air conditioners for $99,000,000. The projection says that in the next four years it will retail just under 1,000,000 units for just over $300,000,000.

The projection seems conservative when we consider where the room air conditioner is used—in offices and bedrooms, living rooms, and other rooms of the 35,-000,000 wired homes in this country—and that every prospect for one air conditioner, if satisfied with his first purchase, is a prospect for at least one more.

Table 1. Room Air Conditioners Manufactured Since 1946

Year	* Total number of units made	* Total reported factory selling price	* Average factory selling price per unit	Estimated year-end carry-over Units	%	Estimated retail sales, no. of units
1946	29,835	$5,870,000	$197.00	2,835	9.5%	27,000
1947	42,904	9,930,000	231.00	4,739	11 %	41,000
1948	73,638	15,503,000	210.00	11,377	15 %	67,000
1949	93,000	17,670,000	190.00	4,377	4.5%	100,000
Totals	293,377	$48,973,000	——	——	——	235,000

* Sources of figures for 1946-7-8, Bureau of Census, United States Department of Commerce.

Table 2. Postwar Retail Sales, 1946-1953

Year	Number of units sold at retail	Increase over previous year, percent	Estimated retail price per unit (installed)	Total retail price installed
1946	27,000	——	$410	$11,100,000
1947	41,000	52%	470	19,200,000
1948	67,000	63%	430	28,800,000
1949	100,000	50%	400	40,000,000
Totals (46-49)	235,000	——	——	$99,100,000
1950	145,000	45%	$350	$51,000,000
1951	203,000	40%	333	68,000,000
1952	274,000	35%	316	87,000,000
1953	356,000	30%	300	107,000,000
Totals (50-53)	978,000	——	——	$313,000,000

The projection in Table 1 assumes that the ⅓ hp room air conditioner will not again appear on the market—yet there is a real possibility that it may, for better or for worse. The projection also assumes that, as the design of room air conditioners evolves, new models will appear which will be especially well adapted for use in those buildings for which existing models are not well adapted.

Residential Application of Room Air Conditioners

H. J. Prebenson, Air Comfort Corporation

The residential field for room air conditioners remains, at the present moment, practically untouched. The application to living and sleeping quarters in hotels and apartments has had an initial dose at scattered points in the country. I think, therefore, that the industry should develop a product that permits application without any objection in living quarters and bedrooms. If a room air conditioner will meet the requirements for application in the bedroom of a residence the same machine, possibly in larger sizes, should be suitable for all other applications.

On the premise that a "man's home is his castle," we should consider certain fundamental characteristics that must be incorporated in room air conditioners to fit this market. These requirements fall into the following classifications:

1) Quietness is of extreme importance. With the movement of people from urban to suburban areas, we find that many of our modest residences are located in areas completely devoid of city noises. People who occupy such homes are adjusted to nights of quietness and are not easily convinced that the noise of a fan or the rumble of a compressor is going to add to their night's rest.
2) The external appearance of a room air conditioner for residential application is important both from the inside and outside of the house. It is not likely that an owner will tolerate any conspicuous protuberance which will mar the exterior beauty of a Georgian facade. Inside the house, styling and color are very important. There probably will always be a conflict between the interior decorating taste of an owner and the idea of the person who styles the exterior of any unit.
3) A unit applied to residential quarters must do the job which the owner expects. There can be no compromise on capacity but it should be pointed out that unit selection for residential quarters possibly could be less conservative because of the normal storage effect of furniture and decorations. Residential bedrooms are seldom used as sitting rooms and, therefore, conditions will be satisfactory if night temperatures can be maintained at 75 F, or under, during extreme summer weather.
4) Filtering outside air and return air is, of course, an absolute necessity. Even in residential neighborhoods, filters get dirty. The owner must change the filter himself or call on a service organization to do it for him. It is, therefore, important that filters be arranged for easy removal and replacement.
5) The use of a room air conditioner as purely a ventilating and filtering device is of major importance. The owner makes a substantial investment in this equipment and should have the opportunity of utilizing it 12 months a year. He uses it as a cooling and dehumidifying device for approximately three months, and he certainly is entitled to some benefits during the other nine months of a year. This establishes a requirement for the air handling fan to be able to provide full capacity for ventilation with an adequate dampering arrangement so that the amount of outside air can be reduced in the cooling period.
6) Simplicity of controls is important and adequate labelling and concise operating instructions should be a part of every unit.
7) With the application of hermetic compressors, oiling of compressor motors is eliminated. By the same token fan motors should have oil-less bearings.
8) Installation of room air conditioners in a residence demands a completely weatherproof and leakproof window arrangement. The home owner will not tolerate dirt, rain, or snow leakage around the unit, and he will insist on an adequate parting strip to seal off the opening left between the upper and lower sash.
9) Ease of maintenance is a requisite of any room air conditioner. This makes the use of hermetic compressors practically mandatory. No home owner is willing to make a workshop of his bedroom or living room and, ordinarily, will demand replacement if major service problems are encountered. Major servicing is done best in the shop with the least annoyance to the customer.

ERRATUM

Several photos used to illustrate the article "Room Air Conditioners—Past and Present" in the January issue of REFRIGERATING ENGINEERING were incorrectly captioned. The unit shown in Figure 9 is a 1937 1 hp Kelvinator model—not Philco-York. The two views shown in Figures 10 and 11 are of a Philco-York 1949 ¾-hp model—not a 1949 Carrier model as captioned.

Physical Design Requirements

Paul B. Moore, York Corporation

The transition of the room air conditioning industry from its present embryonic stage to a position of recognized leadership as a major industry is dependent almost entirely on the ability of designers to rise above the level of basic engineering and start thinking in terms of physical design features that the distributing outlets and the public can interpret into terms of personal ownership and usage.

No industry can go far toward stabilization and mass markets if ownership of the product is considered a luxury or application is limited by basic design to a small segment of the potential market. Room air conditioners today are in this class because installations are limited by inability of basic designs to fit many types of windows.

Even when applied as designed, they often interfere with such fundamental operations as window cleaning and maintenance and many times so detract from building appearance that building owners and architects rule them out. In other cases operational noises are so high that a neighborhood disturbance is created and a nuisance value is placed on the units.

With this background, it is reasonable to assume that the present practice of depending upon field inspired methods of installation in all but double hung windows must give way to a new approach that will fit all kinds of windows and permit those windows to be cleaned. Physical design in the future will undoubtedly have to start with installation fundamentals and work toward the components instead of designing the easy way and letting the installer worry about how to solve the installation problems.

Operational noise levels must be reduced in the occupied space as well as outside the building. Climatic differences must be reconciled and appearances averaged to harmonize with most decorative schemes. Costs must come down to the economic figures that are associated with mass markets and quality must go up to the level of other major appliances. Unit life must be lengthened by better selection of materials and processes and maintenance simplified to justify long range operation.

Specialized design to meet some particular market or local condition may be justified by reduced costs and easier handling but generally any room air conditioner of the future that is developed for national distribution through established merchandising channels must recognize certain basic physical design requirements that are missing in present designs. Basically a room air conditioner is an extremely high powered refrigeration system, packed into the smallest possible space, which enables it to furnish comfort to the masses at the lowest possible cost. To fully realize this advantage, physical design must be slanted toward greater utility that will make the masses want to buy or at least provide the merchandising people with sufficient inspirational incentives to create such desire for ownership.

Propeller Fans Vs Blowers; Location of Discharge Grilles; High Vs Low Discharge Velocity; Location of Return Grilles

M. C. Terry, Philco Corporation

Choice of the proper type of fan, location of the discharge and return air grilles, and discharge air velocity cannot be reduced to simple rules of thumb. The solution of each of these problems depends upon a number of basic air conditioning design factors.

Propeller Versus Centrifugal Fans—Before considering design factors in detail, it might be well to compare the performance characteristics of propeller and centrifugal fans by analyzing the general relationships between cfm, static pressure, hp, and rpm of typical propeller fans and forward-curved-blade centrifugal blowers or fans.

The performance characteristics of the two types of fans differ in certain respects. At a given rpm the horsepower required to operate a centrifugal fan and the fan noise decrease as static pressure is increased whereas the opposite is true of a propeller fan. In general, the cfm of a propeller fan is reduced by a greater amount with a given increase in static pressure than is the case with a centrifugal fan.

An air conditioner employing a propeller fan is usually so designed that the static pressure against which the fan must operate is relatively low in order to reduce the noise level to a minimum. Incidentally the fan hp is substantially reduced by the lower static pressure. On the other hand, a centrifugal fan is commonly used to operate against a relatively high static pressure, which permits the use of coils and filters of smaller face area, smaller air passages, and the addition of an acoustically treated plenum chamber if necessary.

In selecting the most suitable type and size of fan, curves showing cfm plotted against static pressure should be drawn on the same graph, covering the various propeller and centrifugal fans that will meet the space requirements in the unit. If the curves show that a fan of either type is usable, the type giving the optimum combination of performance and cost would naturally be selected.

The advantage of propeller fans which intrigues most designers is the fact that this type of fan and its simple orifice ring usually seems less costly than a centrifugal fan with its attendant housing or "scroll." However, when a propeller fan is used to circulate the air through the condenser, the additional cost of the condensate "slinger ring," or some equivalent, must be taken into consideration.

The basic design factors that should be considered in selecting the proper type of fan for a unit may be summarized as follows:

1) Console Type Unit—It is common practice to employ a centrifugal fan for handling the condenser air in a console unit due to the relatively high static air pressure imposed by the circuitous air passages and rear duct. A propeller fan can of course be used to handle the condenser air in a console but due to the relatively high static against which it must operate, a higher noise level usually results.

Either type of fan can be used for circulating the air through the evaporator and filter, the choice depending upon other factors considered in this paper.

2) Window Type Unit—Propeller fans for handling condenser air as well as evaporator air can be used to advantage in a small air conditioner, designed primarily to provide cooling and dehumidification, where low cost is a primary requisite and where less importance is attached to maximum ventilation and pump-out or room exhaust.

3) Window and Console Type Units—If a high percentage of ventilation air to total recirculated air is desired, a centrifugal evaporator air fan has been found to be preferable as its capacity will not drop off excessively when required to bring in outside air against a negative wind. Furthermore, a centrifugal fan has less reduction in cfm due to the increased resistance resulting from filter loading.

If a high percentage of pump-out air to the total condenser air is desired, a centrifugal fan should be chosen to handle the condenser air. Under certain outdoor wind conditions, depending upon the locations of the condenser air inlet and outlet openings, the condenser fan is required to pump against an abnormally high static due to the wind pressure.

In designing an air conditioner of a prescribed size and shape, it may sometimes be necessary to so locate the hermetic, condenser, evaporator and fan motor that the type of fan will be dictated by the preferred location of these major parts. On the other hand, the means by which the condensate is to be disposed or sprayed on the condenser may have a distinct bearing upon the selection of the type of condenser fan to be used.

A word about fan speed. Either type of fan should be operated at a low speed to reduce air noise to a minimum. It has been our experience that fan speeds in excess of 1140 rpm create objectionable noise which is difficult to eliminate even by the addition of acoustic material or acoustically treated plenum chambers.

Location of Discharge Air Grilles—There are advantages and disadvantages for every location of discharge air grille, and it is therefore the designer's choice as to the position which will best suit the overall requirements of the unit.

If the discharge air grille is located on top of the unit, it has the advantage of reducing the air noise projected into the space below the level of the grilles. On the other hand, top location of the grille has certain disadvantages: It destroys the continuous panel upon which the user may wish to place one or more articles; it is not practical to employ a grille that can be adjusted to direct the air downwards which is desirable in certain installations, such as bedrooms; and if the grille is located on the top near the rear of the cabinet, there is the further disadvantage that a lowered venetian blind or shade may interfere with the conditioned air stream.

A discharge air grille placed in the front wall of the cabinet has the advantage of permitting adjustable grilles to be used which can be positioned by the user to discharge the air in as many directions as the grille design will permit. A front located grille should be placed as near the top of the cabinet as possible to permit occupants to sit or stand near the unit.

It is obviously undesirable to locate the discharge air grille in the side or end of the cabinet.

High Versus Low Discharge Air Velocity—Generally speaking, the greater the cooling capacity of the unit, the higher the permissible discharge air velocity. Since small units are installed in relatively small rooms, such as bedrooms and dens, they can have velocities as low as 400 to 600 fpm with the air discharged outwards

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toward the ceiling, or as low as 100 to 300 fpm if the air is discharged toward the floor. Down-draft air has been found to be satisfactory in small bedrooms because drafts over the sleeper are thereby reduced.

Larger units having discharge air velocities of 900 to 1100 fpm have been found to provide proper distribution of conditioned air throughout the room without objectionable drafts. This higher velocity is especially necessary when the unit is installed at the end of a long and relatively narrow room.

Design of the discharge air grille is as important as its location and discharge air velocity. The grille or grilles should be so constructed that they can be readily adjusted by the user to properly direct and distribute the conditioned air without creating an objectionable draft upon any occupant. Adjustable grilles should be so arranged that the air quantity cannot be reduced by the user to an amount which might cause frost or ice to form on the evaporator.

Location of Return Air Grille(s)—Just as in the case of discharge air grilles, the location of the return air grille on the unit is often determined as a result of the preferred arrangement of the basic parts within the unit.

There is considerably more latitude in the choice of a return air grille location, than in that of a discharge air grille. Possibly the most important requirement is that the return air grille should be so placed that there will be little or no recirculation of air from the discharge air grille into the return air grille.

On window type units, a return air opening located along the lower front edge of the unit has the following advantages: Recirculation of conditioned air into the return air opening is minimized as the discharge air grille is usually remotely placed from this position; no decorative return air grille is required as the opening is not readily visible; and if there is a radiator in front of the window, which is frequently the case, this grille position insures tempering of the ventilation air during the seasons when cooling is not required.

A return air grille placed in the side of a window unit has the disadvantage of the possible interference of curtains or draperies with the flow of return air. However, it may be found that the most compact design of unit can be accomplished by placing the return air grille in the side of the unit. In this case, a suitable guard can be provided, if necessary, to hold the curtains or draperies clear of the inlet.

In console units, there are several positions where the return air inlet can be placed to give satisfactory performance. The return grille may be placed in the front, on the top, in the end or ends or in the rear of the cabinet, and the location is usually dictated by the general design of the unit.

In a console unit equipped with a heating or tempering coil, the return air grille should preferably be positioned on the top of the cabinet. This grille position has the advantage, during the heating season, of minimizing cold drafts normally created by the air that is cooled by transmission through the window glass and by leakage of cold air around the window frames.

In either window or console units which have a relatively high discharge air velocity, the discharge and return air grilles may be located reasonably close to each other in the top or in the front of the cabinet.

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Noise and Vibration Problems

C. O. Wood, Carrier Corporation

Any room air conditioner design is a compromise between noise, physical size, cooling capacity, and cost. These four factors—noise, size, capacity, and cost—are closely tied together.

Noise is compromised by size, which limits what can be done with thicker panels for less noise transmission, larger air passages for lower velocities, shape of air passages, and parts arrangements for good air flow.

Noise is in proportion to cooling capacity in that a larger capacity requires more air with its accompanying larger or higher speed fans and larger compressor. Both capacity and physical size prohibit use of gravity condenser as used for domestic refrigerators.

Cost is a continual problem in the selection of the most quiet type of motor and fan combination along with the most efficient vibration isolation devices.

Considering the noise problem in more detail we can divide it into several classifications. These are air, compressor, motor, and water noise.

First and probably foremost is air noise and its companion fan noise. An air cooled unit requires two fans and two separate air compartments—one for condenser air, the other for room air. Condenser air must be drawn into the unit, then forced back almost on its own tracks to the outside again. Conditions such as this pose a real problem in designing air passages for smooth flow.

Assuming enough space is available to use thick panels and thus prevent the transmission of condenser air noise into the room, we still have to contend with neighbors who cannot tolerate a noise.

On the evaporator side we are at least blessed with less air requirement than on the condenser side. However, since the recirculated and cooled air must necessarily have access to the room, the problem of masking the noise is greater than for condenser air.

Finally, in the discussion of air noise, it should be brought out that heat transfer surface with its multitude of sharp edges and sounding-board fins is of no help in the reduction of noise.

Now we turn to compressors. Noise from valves, unbalance, and gas pulsation poses a greater problem than on domestic refrigerators because of the larger size and more sound power at the source.

Piping vibration and transmission to megaphoning panels a considerable problem due to the large tubing diameters required.

Vibration isolation must be developed to a fine point. Units are often installed in houses with flimsy walls which act as amplifiers for compressor vibration.

The third troublemaker in the noise problem is motor hum. A room air conditioner requires a minimum of two motors and more often three.

The compressor motor contributes a considerable share of ac hum which may be transferred through the piping and mounts. A ½ to 1 hp motor is not a quiet piece of machinery especially when designed for small space requirements and low cost. The fan motors present problems of resonance with fans in addition to transmission through mountings. Various harmonics of the basic ac frequency often produce standing waves in a room. Where more than one motor is involved we have the possibility of beat frequencies.

Fourth on our list is water noise. Disposing of condensate not only contributes to noise but also helps to dictate the arrangement of component parts so water will drain properly. This is often a handicap in designing the proper relations of parts for low air noise.

Regulation by Legislation

J. H. Jennings, Mitchell Mfg. Company

It would be wishful thinking to assume that manufacturers of room air conditioning equipment would not be subjected to an increased number of regulations and ordinances. This will be the natural result of increased public acceptance and much more widespread use of room cooling equipment.

If and when such new regulations and ordinances are required, they no doubt will be sponsored by three groups or organizations. In this category are municipalities, Underwriters' Laboratories, and public utility power companies.

With specific reference to the increasingly popular window type unit, there is a definite need of providing proper and adequately designed equipment to satisfy safety requirements. Also, there is much to be said toward education of service personnel in order that the installation will be properly made.

Some design factors that must be considered of paramount importance are (1) Proper balance as to weight distribution, (2) Provisions for anchoring unit securely to window, (3) Quiet outside operation to minimize air and mechanical noises, (4) Use of only hermetic type compressors that do not exceed 46 locked rotor amperes, (5) Use of current limiting devices, when necessary, to meet the above regulations. In effect, such a limiting device allows a hermetic motor to start with less current surge than would be required without the use of the device. Generally such a limiter is able to reduce the current inrush to the motor by five or six amperes, (6) Operation of room air conditioners on 230 volt circuits when practical. This, of course, would be economically unsound if high costs were encountered in the installation of new feeder lines, and (7) Underwriters' Laboratories approval.

It would be well to mention that it is becoming increasingly popular for the various municipalities to require a UL label for room coolers. Obviously, certain safety requirements are met and the burden upon the ordinance committee is minimized.

In regard to pressure relief valves and venting of high sides, a Chicago Deputy Inspector stated "room air conditioners of refrigerant capacity not to exceed six pounds and the cooling capacity not in excess of one ton require no method of relief, provided the system uses a capillary tube for refrigerant control and employs no refrigerant receiver. If the system did have a receiver and employed an expansion valve, it did require proper relief."

Generally, electric power companies have accepted a locked rotor ampere rating of 40 amperes plus or minus 15%. This totals 46 amp for use of a ¾ hp air conditioner connected to a 115 volt outlet. Only one exception to this allowable use of a ¾ hp unit has been encountered in one south central state.

Thermostatically controlled ¾ hp units should not generally be connected to 115 volt sources. The intermittent operation will cause heavy current surges at intervals. If a circuit is slightly overloaded, this will cause lights to flicker and result generally in inadequate electrical service within the building. Here again, operation of the unit on 230 volts would be acceptable with thermostatic control.

It is interesting to note that New York City requires a 3-prong polarized connector for ½ and ¾ hp room air conditioners.