Table 16 . . . . Suggested Bonnet Pressure
Inches of Water

Total CFM Through Any One Duct	Suggested Bonnet Pressure In. Water	Total CFM Through Any One Duct	Suggested Bonnet Pressure In. Water
800–1000	0.10	3500 to 5000	0.15
1000–1200	0.10	5000 to 7500	0.25
1200–1800	0.10	7500 to 10,000	0.375
1800–2400	0.13	10,000 to 12,000	0.500
2400 to 3500	0.14	12,000 to 14,000	0.750

board. Special hangers are used to suspend the false ceiling or heating panel from the joists. Steel supporting rods are installed through these hangers and metal lath is attached to the rods. The lath is then plastered to a thickness of ¾ in., making a completely sealed air space above the ceiling. Warm air is delivered to this sealed space through a standard warm air duct, installed in the usual manner. The air is then circulated over the entire ceiling being guided by sheet-metal baffles. After the air has passed over the ceiling, it is returned to the furnace through a return air duct for reheating. The system is closed, and no air is introduced into the heated space from the panel. (See also Chapter 30, Panel Heating.)

Because a warm air ceiling panel system involves a different type of ceiling construction, its installation is practically limited to new construction. Only automatically-fired and thermostatically-controlled furnace-blower units may be used with this system. The standard automatic heating controls consisting of a room thermostat, temperature limit control, blower control (fan switch), and primary control are all that are required. While warm air ceiling panel heating has particular advantages in one-story utility room houses, it can be just as effectively installed in one- and two-story houses with basements.

Complete design and installation procedure is given in Manual 7-A of the National Warm Air Heating and Air Conditioning Association.[11]

SUMMER OPERATION

During hot summer periods a slight cooling effect may sometimes be obtained by the circulation of basement air through the system. This beneficial effect is due to both the increased air movement in the occupied spaces and the small reduction in dry-bulb temperature brought about by passing warm air over the cooler basement walls and floor. In areas of high prevailing dew points, however, this practice may cause objectionable dampness to develop in the basement.

Complete summer air conditioning can be readily combined with forced warm air systems either by using factory-built units incorporating both refrigeration and heating equipment, or in *some cases* by adapting separate refrigeration equipment or well-water coils to *existing* warm air systems.

A more complete treatment of residential summer air conditioning is given in Chapter 46.

GRAVITY WARM AIR SYSTEMS

In *gravity* warm air heating systems the motive head producing flow depends upon the difference in weight between the heated air leaving the top of the furnace casing and the cooled air entering the bonnet of the casing. Hence, the motive head is very small and the system must allow free flow.

A gravity warm air furnace heating plant consists of a fuel-burning furnace or heater, enclosed in a casing of sheet metal, which is placed in the basement of the building. The heated air, taken from the bonnet on the top of the furnace casing, is distributed to the various rooms of the building through sheet-metal warm air pipes. The warm air pipes in the basement are known as leaders, and the vertical warm air pipes which are installed in the inside partitions of the building are called stacks. The heated air is discharged into the rooms through registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace is usually taken entirely from inside the building through one or more recirculating ducts, although in some cases an outside air supply duct is provided.

Gravity warm air heating systems may be designed[12] by following the procedures given in Manual 5 of the National Warm Air Heating and Air Conditioning Association. This publication also contains information terminology, outlet and return locations, and standard sizes of pipe and fittings. The data underlying this information and the design procedure are given in a circular[13] issued by the University of Illinois, and are based on research conducted there.

REFERENCES

[1] *Application Guide for Residential Central Air Conditioning Systems—Winter and Year-Round* (National Warm Air Heating and Air Conditioning Association, Manual 8, Fifth Edition, 1958).

[2] A. P. Kratz and S. Konzo: Performance of a forced warm-air heating system as affected by volume and temperature of air recirculated (ASHVE Transactions, Vol. 48, 1942, p. 393).

[3] *Manual for Adjusting Winter Air Conditioning Systems for Maximum Comfort* (National Warm Air Heating and Air Conditioning Association, Manual 6, 1956).

[4] *Warm Air Perimeter Heating* (National Warm Air Heating and Air Conditioning Association, Manual 4, 1956).

[5] *Four-Inch Pipe Warm Air Perimeter Heating* (National Warm Air Heating and Air Conditioning Association, Manual 10, 1956).

[6] *Code and Manual for the Design and Installation of Warm Air Winter Air Conditioning Systems* (National Warm Air Heating and Air Conditioning Association, Manual 7, 1953).

[7] *Calculating Heat Losses* (National Warm Air Heating and Air Conditioning Association, Manual 3, 1956).

[8] S. Konzo, R. J. Martin, D. S. Levinson, and R. W. Roose: Proposed design procedures for large mechanical warm air heating systems (ASHVE Transactions, Vol. 53, 1947, p. 177).

[9] *Code and Manual for the Design and Installation of Warm Air Winter Air Conditioning Systems and Year 'Round Air Conditioning Systems* (National Warm Air Heating and Air Conditioning Association, Manual 9, 1956).

[10] S. Konzo and A. F. Hubbard: Automatic controls for forced-air heating systems (ASHVE Transactions, Vol. 40, 1934, p. 37).

[11] *Code and Manual for the Design and Installation of Warm Air Ceiling Panel Systems* (National Warm Air Heating and Air Conditioning Association, Manual 7-A, 1950, 3rd ed.).

[12] *Gravity Code and Manual for the Design and Installation of Gravity Warm Air Heating Systems* (National Warm Air Heating and Air Conditioning Association, Manual 5, 1954).

[13] A. P. Kratz and S. Konzo: *Simplified Procedure for Selecting Capacities of Duct Systems for Gravity Warm Air Heating Plants* (University of Illinois, *Engineering Experiment Station Circular* 45, December 1942).

CHAPTER 19

CENTRAL SYSTEMS FOR AIR CONDITIONING

Features of Systems, Zoning, Humidity Control, Cooling Load, Heating Load, Air Quantity and Temperature Differential, Unitary-Central Systems, Low- and High-Pressure Induction Convectors, High-Velocity Systems, Fan and Coil Units, Evaporative Cooling, Precooling, Sensible Cooling with Unwetted Coils, Selection of System, Location of Apparatus

THE term, central, applied to an air conditioning system implies that the equipment such as fans, coils, filters and their encasement are designed for assembly in the field rather than in a factory as a unit. As a central system usually serves several different rooms, or spaces, individual controls are required for each room.

FEATURES OF CENTRAL SYSTEMS

One advantage of a central air-supply system is that one apparatus serving many rooms may involve a lower investment cost than that for a number of self-contained plants, each serving a single room. A central system may occupy basement or attic space that is relatively unimportant, whereas individual factory-assembled apparatus placed in each room may occupy otherwise valuable space. Another advantage of a central system is accessibility for servicing, since it is possible to provide doors in the encasement for cleaning and inspecting all of the component parts in a manner usually superior to that practicable with compact factory-assembled equipment. In addition service is concentrated in one or just a few places.

Central air-conditioning systems usually are connected by ducts with the various rooms served, and preferably have exhaust fans that may effect complete removal and disposal of any desired proportion of the air. The return-air fan may return air to the supply system for recirculation, as a measure of economy of fuel or refrigeration.

Central air-conditioning systems are served by heating and refrigerating equipment which may be located at some distance from the air-supply apparatus, and which may serve one or more central air-supply systems.

Fig. 1 is a sketch of a typical year-round central system. Outdoor air enters from an intake preferably on that side of the building least exposed to solar heat, and not close to the ground or to a sun-heated or dust-gathering roof. The outdoor-air damper is split into two sections, minimum outdoor-air and maximum outdoor-air, with the maximum outdoor-air damper interlocked with the return-air damper in such a manner that as the outdoor-air volume increases the return-air volume decreases. The return-air duct or connection could come from a return-air fan. All the air passes through filters which must have ample room on both sides of the filters for servicing. The filters may be of a mechanically-cleaned type, a replaceable-cell type, or may be electronic as described in Chapter 24.

The cleaned air passes to the equipment that changes its temperature and humidity. Except in very warm climates, heating or tempering coils are required to warm the entering outdoor air to a temperature above freezing, the heat being supplied by means of hot water or steam. Cooling coils provide the necessary sensible cooling and dehumidification. The coils may be chilled by direct expansion of an approved refrigerant within the tubes, or by a pump-circulated liquid such as water or brine. A water-tight drainage tank must be installed under the cooling coil and should extend for a distance toward the fan.

Reheater coils, utilizing steam or hot water, reheat the air in warm weather for control purposes or bring the air to its final temperature in cold weather. For humidification in dry weather, water sprays are used either separately as shown or combined with the cooling coils having the spray nozzles directed against the coil surfaces. The spray water may be circulated by a small pump from the water tank under the spray chamber.

The general requirements for the control of the various components of the central station apparatus are covered in Chapter 43. The functioning of a typical set of controls as illustrated in Fig. 1 is as follows:

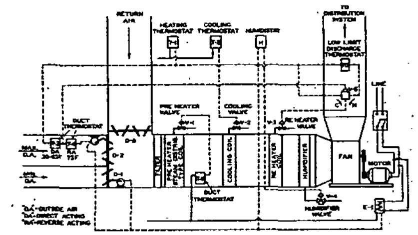

Fig. 1 . . . . Typical Year-Round Central System

Whenever the fan is started, solenoid air valve or relay E-1, actuated by the fan motor starter, opens minimum outdoor-air damper D-1, places humidistat H in service, and allows duct thermostats T-3 and T-4 to control the maximum outdoor-air damper D-2 and the return-air damper D-3.

When the fans stop, E-1 is de-energized to close the outdoor-air dampers and also to close humidifier valve V-4.

Thermostat T-1 positions steam valve V-3, on the reheater coil, to maintain a constant space temperature. As the space temperature rises, T-1 positions reheater valve V-3 to a closed or to a minimum open position, as determined by low limit discharge thermostat T-5. Duct thermostat T-6, in the preheater discharge, positions preheater coil valve V-1 to maintain a constant preheater discharge temperature.

On rising outdoor temperature, between 30 F and 65 F, duct thermostat T-3 located in the outdoor-air intake, moves maximum outdoor-air damper D-2 toward the open position