Resistor with Focusing Reflector

An example of the focusing-reflector-type heating unit is the copper-bowl parabolic of circular *glow* heater for portable use. This has an incandescent wire-coil resistor on a conical ceramic core, screwed into a lamp-type central receptacle. Usual ratings are 600 and 1000 watts for 110 or 120 volt service. Heat emitted by radiant effect is 75 to 85 per cent of total delivery.

For permanent installation, low-temperature focusing units are made with tubular resistors mounted within sectional trough-type reflectors resembling industrial fluorescent lighting fixtures. They may be suspended from ceiling or bracketed from a wall. Rated capacities are 500 to 1500 watts per linear foot of unit. Installations of this kind are mainly in public and industrial buildings, to handle the perimeter heat loss at windows, doors or wall openings. In a modified form, such units are employed for infra-red heating and drying in industrial processes.

Steam Radiator with Immersion Element

For portable use, radiators (convectors) of light-weight 2-column construction are equipped with an immersion element screwed into a bottom opening at one end. Usually, after charging with water and antifreeze compound the radiator is sealed. A safety valve or thermal relief plug is provided, to protect against excessive pressure in case heat dissipation is unduly curtailed by clothing, bedding or other insulating material placed over the unit. The steam-and-water intermediate heat-transfer medium has no effect on overall thermal efficiency, but gives the unit operating characteristics adapted for certain applications.

Ceiling Panel-Type Installations with Conductive Rubber

Rigid panels of electrically conductive rubber with a rating 22 watts (75 Btu) per sq ft, for 115 and 230 volts service, are built in standard sizes 3 x 4 ft, 4 x 4 ft, and 4 x 8 ft; an earlier type rated 17 watts (55 Btu) has been discontinued. Panels consist of a layer of special rubber about 0.01 in. thick placed between insulating layers of phenolic resin impregnated paper bonded to one side of $\frac{3}{16}$ in. thick rigid asbestos board which is then finished on both sides with paper suitable for receiving paint or wall paper. Electric terminals are provided on each panel and standard raceway moldings are furnished for wiring connections, or optionally, conventional junction boxes of a distribution wiring system can be used. The weight of panels is 1.8 lb per sq ft.

An alternative form of sheet-type panels employs the conductive rubber construction but omits the rigid asbestos backing board; it is attached to conventional ceiling materials by a pressure-type adhesive resembling that used for acoustical tile.

Under normal operating conditions that cause cycling under thermostatic control, the surface temperature is about 100 F. When panels are turned on in a cold room or with continuous operation, the maximum temperature reached is 120 F. The position of heated panels on the ceiling of a room should be as near as possible to exposed walls, especially at windows and doors, to counteract cold-wall effect and to keep occupants never farther than 3 ft horizontally from a heated area. Ceiling area not required for heating is covered with ordinary gypsum or other wall board. Since it is not permissible to cut heating panels, the entire pattern for a ceiling must be planned in advance both for appearance and for economy. Attachment to ceiling joists, headers or furring strips is made by wood screws in countersunk holes drilled within the $1\frac{1}{2}$ in. fastening margin provided around the four sides of each panel. Lighting fixtures must not be fastened or cut into the active area of a panel.

Adequate thermal insulation above or on back of panels is mandatory to protect all wiring from excessive temperature and to assure economical heating service. The minimum thickness of mineral or fiber insulation (glass or rock wool, cellulose fibers, loose asbestos, etc.) is 4 in. at top story and 2 in. for intermediate floors, whereas 6 in. and 3 in., respectively, should be the minimum corresponding thicknesses of expanded mica insulation. Metallic foil or other electrically conductive insulating material should not be used with conductive rubber panels, owing to possibility of trouble from electrostatic effects.

A thermostat of high sensitivity type with an integral manual cut-off device should be provided in each room. To obtain economy of operation, a time switch or clock is advocated for lowering the room temperature to 55 F at night or when rooms remain unoccupied.

Ceiling Panel-Type Installations with Embedded Conductors

Resistors or *cables* for embedding in plastered ceilings to form panel-type heating installations are electrically insulated with a special compound resistant to high temperature, water absorption, aging effects, and chemical action with plaster, cement and soil. Cable units are furnished in standardized lengths between 20 ft and 1000 ft, rated from 50 to 3000 watts per unit, for 120, 220 and 240 volts. They have an outside diameter about $\frac{1}{8}$ in., the maximum safe operating temperature is about 165 F, and the test voltage is 2500. Non-heating leads 8 ft long are attached to each unit, allowing the unit to be terminated at thermostats or in switch boxes without causing erratic operation of thermostat by heat from cable. Units are identified in regard to rating, by label and by color code. It is not permissible to alter the length of cable or leads, nor to install any cable unit lacking a visible identification label.

For plastered ceilings, the lathing used is of gypsum or other non-metallic fire resistant type. The cable is temporarily secured to lath with strips of $\frac{3}{4}$-in. cotton tape spaced not over 16 in. apart. Each element is tested immediately after fastening on lath, for completeness of circuit and for insulation resistance of at least 100,000 ohms measured to adjacent plaster or structural members.

The minimum spacing between cable passes or turns should be $1\frac{1}{2}$ in. Leads from cable to junction boxes should be placed in loom. A clearance of at least 2 in. is required from any metal lath, such lath being permissible only for reinforcement along corners at walls. Clearance is likewise necessary at any metal objects, and this applies also to non-heating leads, as a precaution against magnetic hum. Cables must be kept away from local areas of ceiling that would be additionally heated by recessed or surface-type lighting fixtures. All general wiring for power and light is run above thermal insulation over the heat panel areas, or at least 4 in. above the heated ceiling surface.

Plaster should be applied in three coats with the first coat trowled in the same direction as the elements. A superfine sand finish is recommended, since a putty finish coat has a tendency to crack. While new plaster is drying out, the range and rate of temperature changes (either increase or decrease), should be kept low. Vermiculite or other insulating plaster must not be used, since it causes cables to overheat.