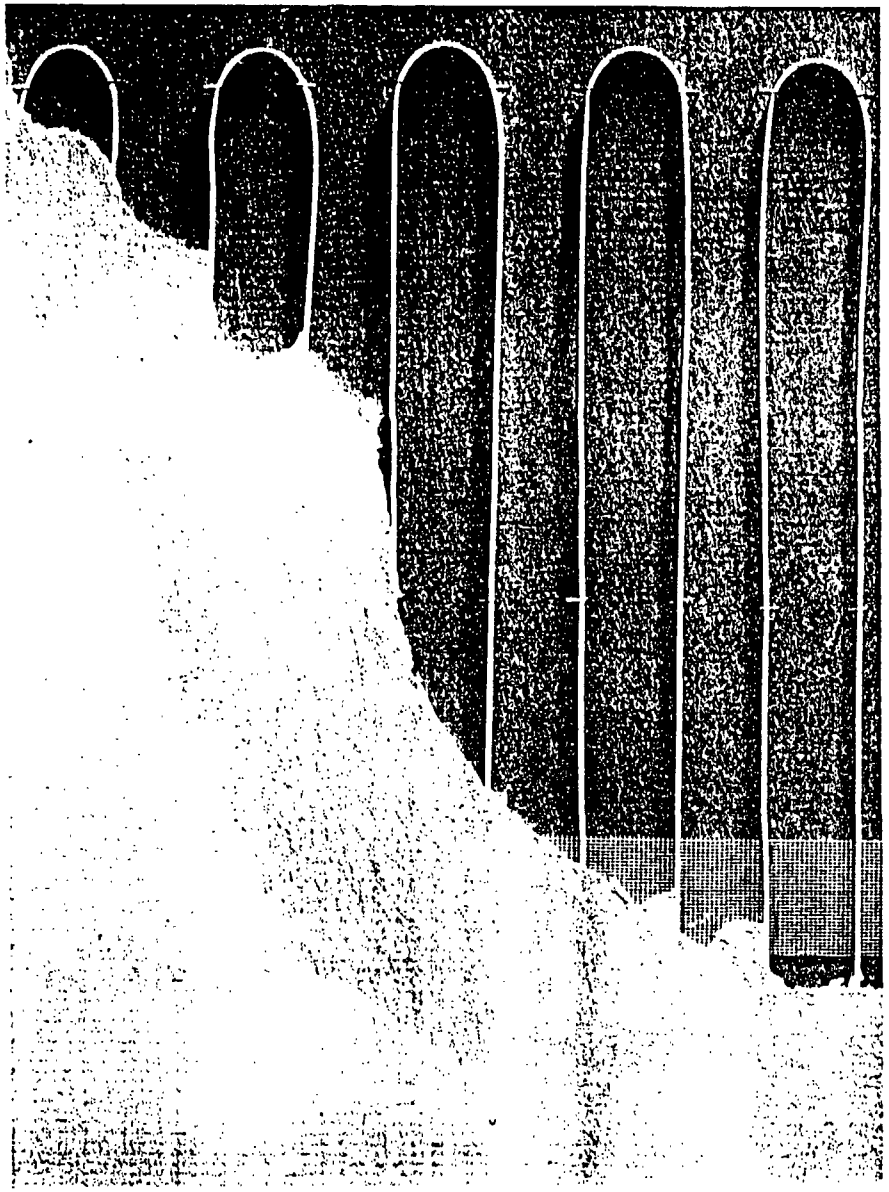
PLAINTIFF'S EXHIBIT
USG-772



technical data and application directions

USG® Plaster Cable Heat System

UNITED STATES GYPSUM

BB016 1278

technical data & application procedures

USG® Plaster Cable Heating System

The USG® Plaster Cable Heat System radiates natural warmth from the ceiling, heating only objects in the room. The homeowner enjoys clean, quiet, draft-free "sunshine" comfort while the air remains healthfully cool.

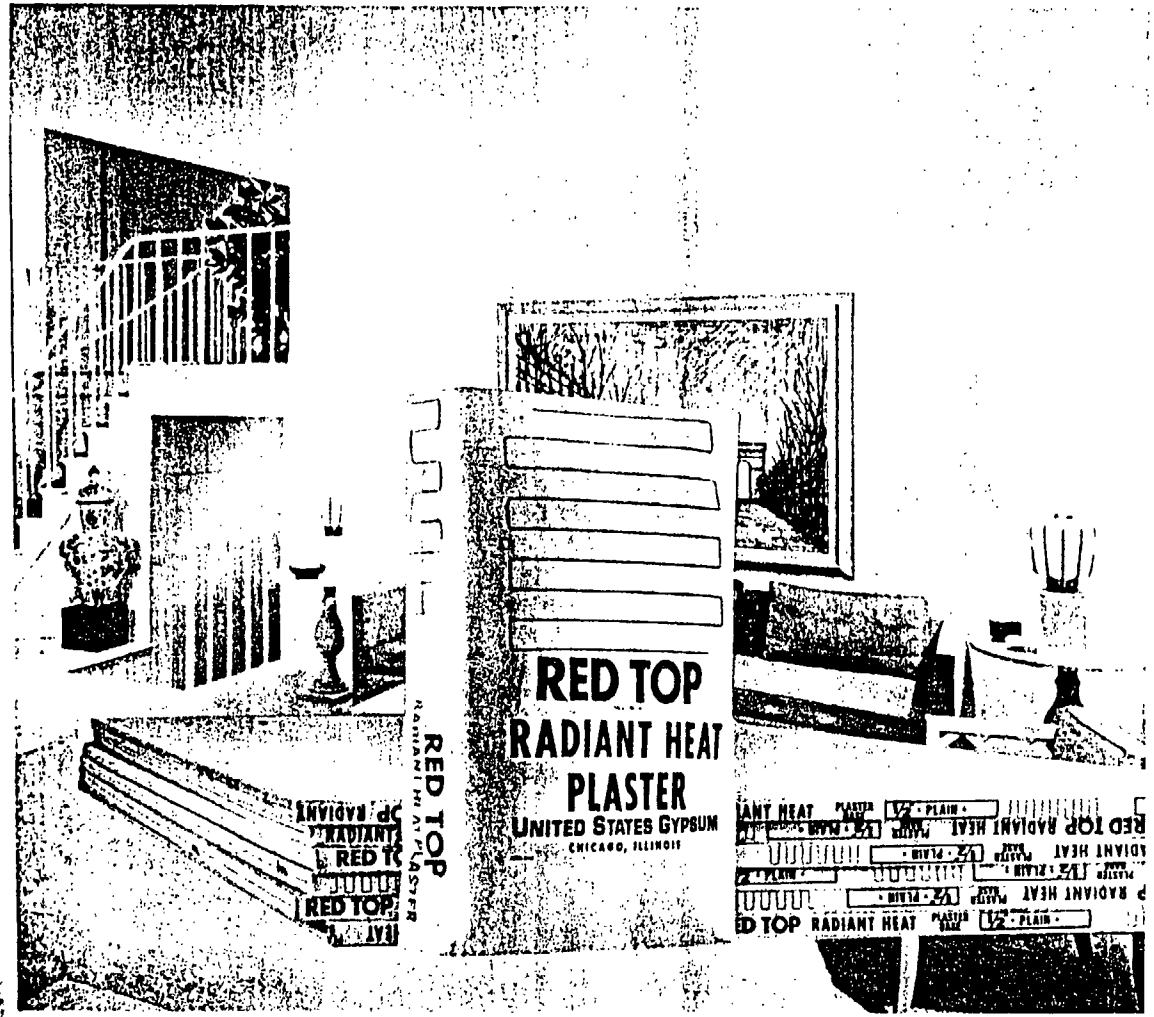
Since electric cables concealed in the ceiling plaster are the heat source, the space usually needed for furnace, flues and ductwork is saved. And there is no costly upkeep or complicated repair work; no filter changing or cleaning. There is complete freedom of furniture arrangement since there are no registers, radiators or cold-air returns; frequent cleaning and decorating are things of the past.

For the comfort and convenience of radiant heat and the beauty of a durable plaster ceiling, install the USG Cable Heat System, now job-proven on more than four million sq. ft. of ceiling application.

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This information covers the products, electrical control components and recommended procedures for applying the USG Plaster Cable Heating System on wood frame ceiling construction, monolithic concrete slabs, furred or suspended ceiling construction and remodel or work in frame conversion structures.

1 Site conditions

In cold weather, the building temperature must be maintained at not less than 55°F. for 24 hours prior to, during, and after lathing and plastering until the permanent heating system is operating (Sec. 40). Ventilation must be provided to maintain proper drying conditions.

All materials should be delivered to the job in the original, unopened containers or bundles, stored in a place protected from exposure to the elements and from damage by tampering, and used in strict accordance with the manufacturer's directions.

2 Materials & accessories

All materials and thermostatic controls must be as manufactured or sold by the United States Gypsum Company. U.S.G. does not make or sell radiant heat cable.

RED TOP Radiant Heat Plaster Base. Round Edge, 1/2" (or 5/8") thick, 48" wide, and in lengths as long as practical (up to 14') to minimize the number of end joints.

Where a fire rating is required, use Type X plaster base.

Nails and/or screws as listed in Sec. 7.

RC-1 SHEETROCK Resilient Channel, where required.

RED TOP Radiant Heat Plaster.

IMPERIAL Joint Reinforcing Tape, Type P or S.

USG Metal Furring Channel.

USG Cold Rolled Channel.

USG Control Joint No. 75, USG Casing Bead No. 60 or No. 66, both short flange 3/4", where required.

USG Electric Controls: Line Voltage Type 800-A or B Thermostat, Humidistat 843.

3 Wood framing requirements

Framework must meet the minimum requirements of FHA and local codes.

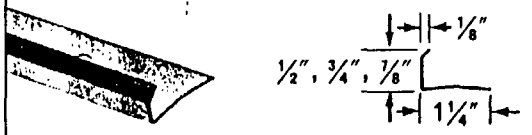
Framing members should be straight, true, of uniform dimension, and framing must be properly aligned.

All framing lumber must be of a good grade for the intended use, and 2" × 4" nominal size or larger should bear the grade mark of a recognized inspection agency using grading rules for lumber recommended by American Lumber Standards Committee.

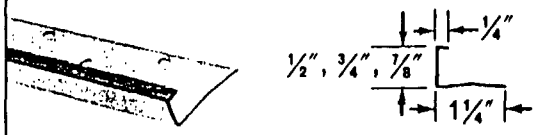
The lumber should have a moisture content not in excess of 15% at the time of gypsum base application. Use of kiln dried lumber for joists is recommended.

METAL COMPONENTS

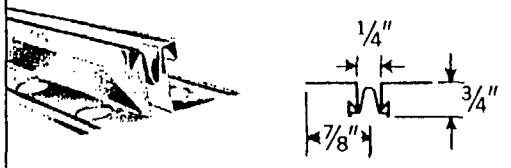
USG Casing Bead
No. 60 semi-square edge, short flange



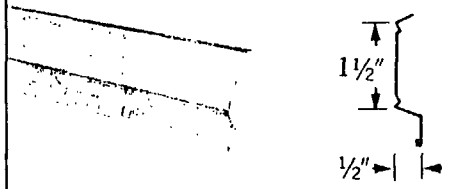
USG Casing Bead
No. 66 square edge, short flange



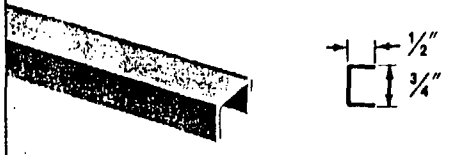
USG Control Joint No. 75



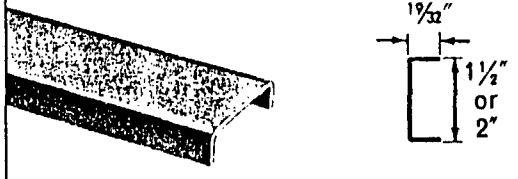
RC-1 SHEETROCK Resilient Channel



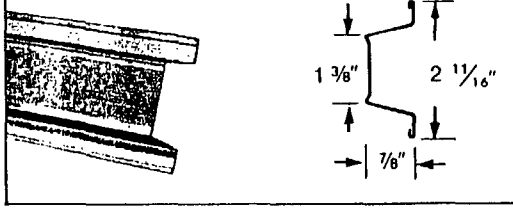
USG Cold Rolled Channel



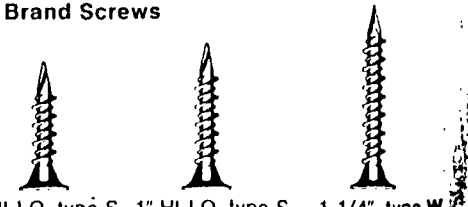
USG Cold Rolled Channel



USG Metal Furring Channel



USG Brand Screws



7/8" HI-LO, type S 1" HI-LO, type S 1-1/4", type W

Do not attach base to extremely hard (dense) or soft framing members.

4 Insulation recommendations

Use the type and amount of insulation as specified by the designer of the cable heating system, or insulate according to minimum All-Weather Comfort Standards R-24, 6" THERMAFIBER Insulating Wool Blankets or R-24, 7" THERMAFIBER Blowing Wool. See U.S.G. Product Bulletin f-1908.

5 Ventilation recommendations

The ventilation control devices must be as specified by the architect or building contractor and the attic area above ceiling insulation adequately ventilated. Refer to U.S.G. Catalog of Aluminum Louvers, RB-45, for additional information.

6 Electric cable

Use an approved electric radiant heating cable of adequate wattage to properly heat the areas in which it is used (the cable is not sold or supplied by United States Gypsum). The designer of the cable heating system should indicate the type, wattage and spacing of cable for each ceiling area. Space cable no closer than 1-1/2" o.c. as specified by the National Electrical Code. Do *not* place the electric radiant heating cable in operation until the plaster is thoroughly dry (Sec. 40).

Note: When using RED TOP Radiant Heat Plaster, cable sheath temperatures up to 150°F. are permissible providing the cable does not exceed 2.75 watts per lin. ft. and a watt density of 25 watts per sq. ft.

7 FASTENER GUIDE

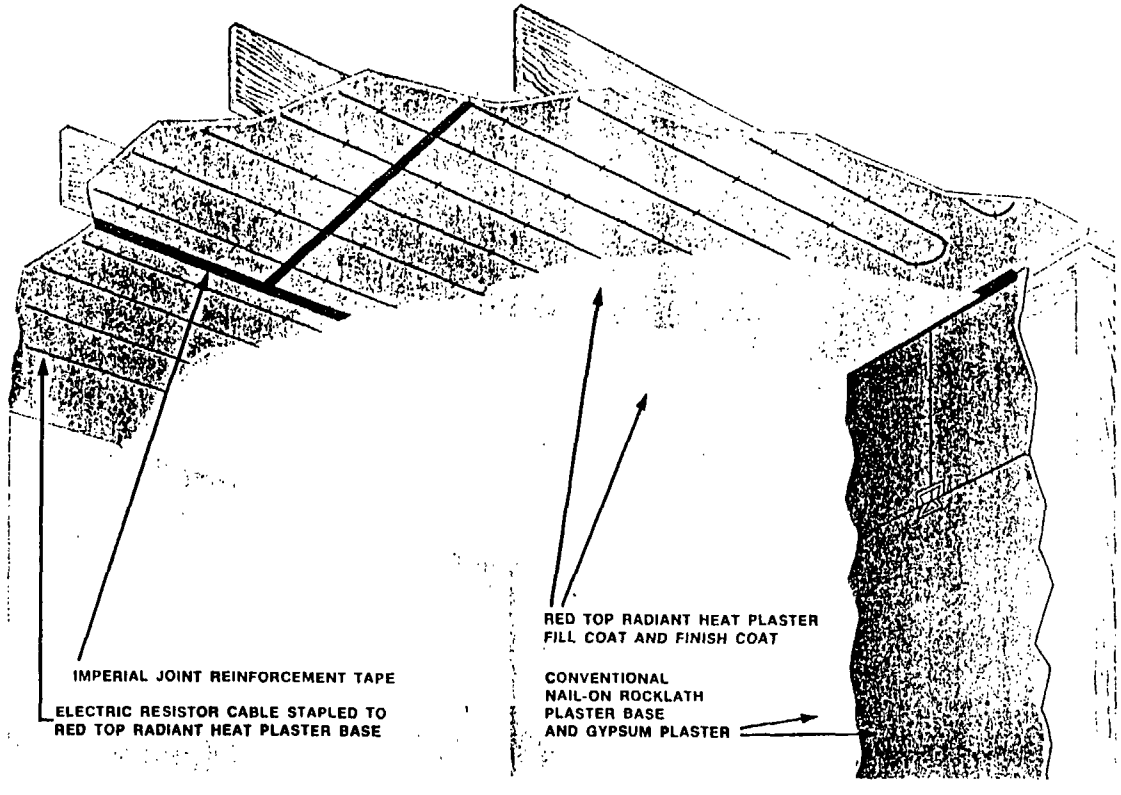
FOR NEW INSTALLATIONS

plaster base	framing	max. joist spacing c to c	attachment	fastener spacing c to c
1/2" RED TOP Radiant Heat Plaster Base	Wood	16 in.	Nails—Min. 1-1/4" long, 12-1/2 Ga. Dia. Min. 15/64" Head, Annular Ring or Barbed Shank, Blued, Polished, or Cement Coated	7 in.
		24 In.	Screws—1-1/4" USG Brand Type W	
			For Type X Base, 1-5/8", 5d Cooler Type Cement Coated Nails	6 in.
	RC-1 Resilient Channel	16 In.	Screws—1-1/4" USG Brand Type W for channel to framing; 7/8" USG Brand HI-LO Type S	12 in.
5/8" RED TOP Radiant Heat Plaster Base	Wood	24 in.	Nails—Min. 1-3/8" long, 13 Ga. Dia. Min. 15/64" Head, Annular Ring or Barbed Shank, Blued, Polished or Cement Coated	7 in.
			Screws—1-1/4" USG Brand Type W	12 in.
	RC-1 Resilient Channel	16 in.	Screws—1-1/4" USG Brand Type W for channel to framing; 1" USG Brand HI-LO Screws, Type S	12 in.

FOR REMODELING OVER EXISTING CEILINGS—NOT EXCEEDING 1" IN THICKNESS

plaster base	framing	max. joist spacing c to c	attachment	fastener spacing c to c
1/2" RED TOP Radiant Heat Plaster Base	Wood	16 in.	2-7/8", 10d Cooler Type nail, cement coated or 2-1/2" USG Brand HI-LO Screw Type S Bugle Head	7 in.
5/8" RED TOP Radiant Heat Plaster Base	Wood	16 in.	As Above	6 in.
		24 In.		
1/2" RED TOP Radiant Heat Plaster Base—Type X	Wood	16 In.	As Above	6 in.

Direct application of plaster and base to wood framing



8 Direct application of plaster base to wood framing

Apply RED TOP Radiant Heat Plaster Base to ceiling joists before the wall materials are installed. When structural relief is used, see Sec. 34. To minimize the number of end joints, use the maximum lenghths practical. Install the plaster base across the ceiling joists with all end joints occurring over framing members, and staggered in adjacent rows. End joints should be job-beveled, as shown in detail drawing. Nail from the center portion of the base toward the ends and edges.

While driving the nails, hold the base in firm contact with the underlying support. Space nails approx. 7" o.c. (6" for Type X base) and not less than 3/8" from edges and ends of the base, except at the intersection with the walls. This provides for a floating ceiling angle where perimeter relief is not used (Sec. 11). Set the heads of the nails flush with the surface of the paper or slightly dimpling . . . but not breaking . . . the paper. Cut and fit the plaster base for electrical outlets, etc.

9 Resilient application of plaster base to wood framing

Attach RC-1 SHEETROCK Resilient Channels at right angles to wood joists with 1-1/4" USG Brand Screws Type W driven through the pre-punched holes in the channel flange. *Do not use nails.* Locate channels within 6" of the wall-ceiling intersection, spacing them not more than 16" o.c.

Extend into all corners and fasten to corner framing. Do not cantilever channels more than 6". See that channel ends occur directly under a joist and are spaced 1/8" apart with both flanges screwed to the support. Stagger splices so they do not fall directly over plaster base edge joints. Use RED TOP Radiant Heat Plaster Base of maximum practical length and apply with the long dimension at right angles to the channels and with end joints centered over the channel, staggered and neatly fitted. End joints should be job-beveled, as shown in detail drawing. Fasten plaster base channel with 1" USG Brand HI-LO Screws Type S spaced 12" o.c. in the field of the base and along abutting ends. Drive screws at least 3/8" from ends or edges of base.

10 Perimeter isolation

Perimeter Isolation *should be used* for all Radiant Heat Plaster–Plaster Base ceilings. The isolation should accommodate both plaster and plaster base, using 3/4" ground casing bead (USG No. 60 semi-square or No. 66 square, both short flange). Attach the bead to the ceiling joist, allowing sufficient space for the finished wall thickness plus an additional 1/8". The 1/8" space will provide positive relief. Secure a flexible dust membrane behind the radiant heat plaster base and partition surface to seal the 1/8" opening.

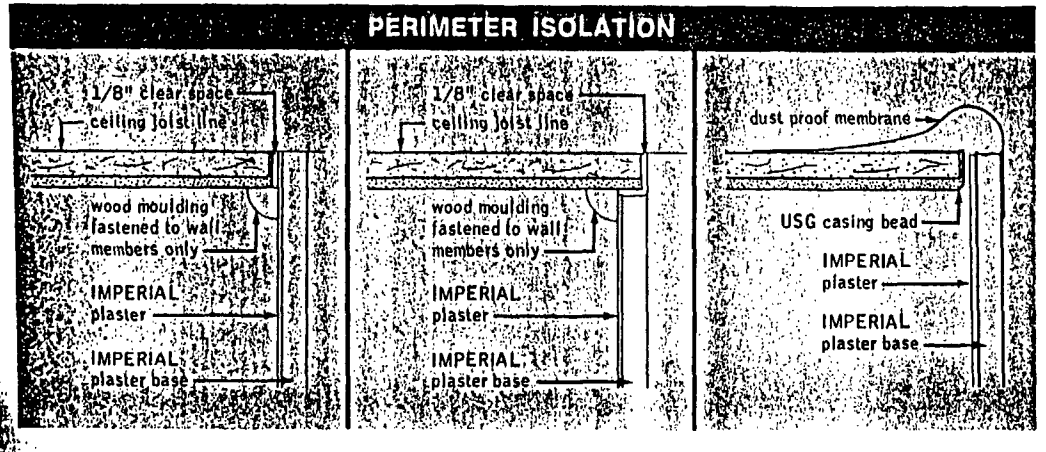
11 Floating ceiling angles

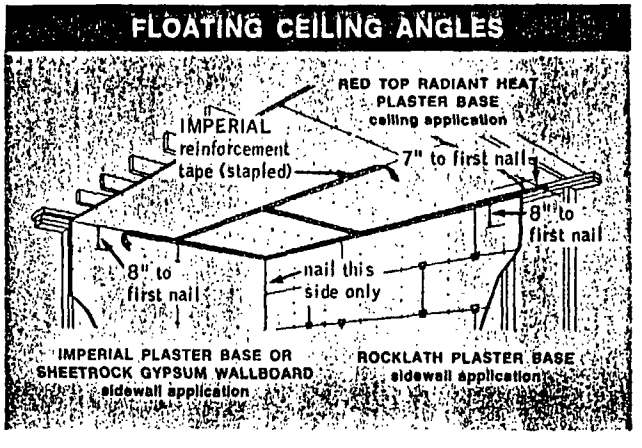
When perimeter relief is not used, follow recommended framing practices for floating ceiling angles. RED TOP Radiant Heat Plaster Base must fit snugly into all ceiling angles but at the wall/ceiling intersection, space the first nail nominally 8" from the wall intersection. Follow nail spacing as specified for remainder of the ceiling area.

On sidewalls, apply all gypsum plaster base or wallboard to overlap and maintain firm contact at ceiling line in order to support the ceiling plaster base previously applied. Along the ceiling intersection, omit nails directly at the ceiling angle. Space the first nail nominally 8" from the ceiling intersection.

12 Application of joint reinforcing tape

Apply IMPERIAL Tape Type P to all ceiling joints (edges and ends) by aligning tape





over the joint and lightly pressing along the entire length. To insure firm, wrinkle-free attachment, press tape in place by using a steel finishing knife or trowel. For wall and ceiling angles, center tape and press into the angle by hand; then press firmly in place with veneer plaster corner tool. Do not overlap tape at intersection.

(Alternate) Attach IMPERIAL Tape Type S using a spring-driven stapler and rosin-coated, flattened galvanized wire staples with legs not less than 3/8" in length. Extend tape over the full length of all edge and butt joints but do not overlap at intersections. Place two staples, one on each side of the joint, at the end of the tape. Keep the tape taut and place staples 12" o.c. along the length of the tape, alternating from side to side. Staple the other end of the tape with two staples, one on each side of the joint. In the ceiling/wall angles, staple tape 12" o.c. to the ceiling plaster base only.

13 Application of radiant heating cable

After the RED TOP Radiant Heat Plaster Base and IMPERIAL Tape have been applied, install electric radiant heating cable with flattened galvanized staples in accordance with design requirements and cable manufacturer's specifications. Attach the cable to the ceiling in such a manner that it is kept taut and does not sag away from the plaster base. Embed all cable connectors and non-heating leads into, but not through, the plaster base so they do not project beyond the heating cable.

14 Mixing of RED TOP Radiant Heat Plaster hand application

Do not hand mix. For best results use a heavy-duty drill capable of producing a *minimum* of 650 rpm *under load*, such as a Black & Decker 362-1 Gypsum Mixer. This type mixer in combination with a cage-type mixing paddle will assure speedy, complete mixing. Slower operating drills will adversely affect the setting properties of the plaster. Since this material will set in approximately one hour, mix no more material than can be applied in 30 minutes. Do not retemper.

Place approximately 12 to 17 qts. of water in a 12 to 15-gal., smooth-sided metal container, about 14" in diameter. With mixer operating slowly, add one bag of plaster. Mix for a minimum of two minutes to disperse all lumps completely, but do not mix longer than five minutes. Keep mixing equipment and tools clean to prevent acceleration from set plaster or other contaminants.

15 Fill coat application RED TOP Radiant Heat Plaster

Apply RED TOP Radiant Heat Plaster fill coat of sufficient thickness to completely cover the cable. Trowel the plaster parallel to the direction of the cable but do not use the cable as a screed. Level this fill coat with a trowel, rod or darby to fill any low spots or to remove any high ridges, etc. Use a serrated darby or lightly broom the plaster surface prior to set to provide a key for the finish coat. The average thickness of the fill coat should be 3/16".

16 Finish coat application RED TOP Radiant Heat Plaster

Apply finish coat after the fill coat has developed sufficient suction (in good drying weather, about two hours after the plaster has set; in damp and/or cold weather overnight, unless good supplementary heat and ventilation are provided). Use RED TOP Radiant Heat Plaster 1/16" to 3/32" thick, to bring the total plaster thickness to 1/4". Scratch in a tight thin coat over the entire area, immediately doubling back to the full thickness. Fill all voids and imperfections. It is advisable to scratch and double back with the same mix of plaster. When the surface has become firm, hold the trowel flat and final-trowel, using water sparingly. Do not over-trowel. Best results are obtained by continuous application of an entire ceiling. Always work to a wet edge to avoid dry joinings.

17 Option for sand float finish

See Section 15 for fill coat application. For a sand float finish, add up to 20 lbs. of clean, white silica sand per 80-lb. bag of RED TOP Radiant Heat Plaster.

depending upon the texture desired. The quantity of sand added must be the same for each bag. Apply the 1/16" to 3/32" thick sand float finish as outlined for the trowel finish, except that when the surface has become firm, but before setting, float to the desired texture using a sponge, carpet or other float. Use water sparingly.

18 Option for spray texture finish

See Section 15 for fill coat application. For a spray texture finish, add up to 20 lbs. of clean, white silica sand per 80-lb. bag of RED TOP Radiant Heat Plaster, depending on the texture desired. Use a hand-held hopper gun to spray-apply a 1/16" texture finish coat. Do not mix more material than can be sprayed in 30 min. Keep equipment clean to prevent acceleration from set plaster or other contaminants.

19 Option for simulated acoustical finish

If a simulated acoustical finish is desired, spray-apply a maximum 1/8" thickness of IMPERIAL QT Texture Finish or similar product over the full 1/4" thickness of RED TOP Radiant Heat Plaster. Follow manufacturer's specifications.

Use of this type of finish at the maximum 1/8" thickness will slightly decrease operating efficiency of the heating system since simulated acoustical finishes are formulated with insulating-type aggregates.

20 Mixing of RED TOP Radiant Heat Plaster machine application

Place approximately 12 to 16 qts. of clean water in a 12 to 15-gal. smooth-sided clean container, with the mixer operating, and add one bag of plaster. Mix for a minimum of three minutes to disperse all lumps completely but not longer than five minutes. Dump the radiant heat plaster basecoat mortar directly through the 8 × 8 mesh hopper screen of the E-Z Coater Machine. If necessary, adjust the amount of water on subsequent mixes so that 60 to 80% of the mortar will flow through the screen of the hopper without shaking the hopper.

Keep mixing equipment, hopper screen and hopper clean to prevent acceleration from set plaster or other contaminants. A minimum hopper setting time of 2-1/2 hrs. is to be maintained at all times.

The plaster is manufactured to give a setting time of 3-4 hrs. If a quickening of the hopper set is noticed, the setting time can be lengthened by adding a sufficient amount of commercial retarder to the mixing water to give a maximum hopper setting time of four hours.

21 Application over RED TOP Radiant Heat Plaster Base

Apply RED TOP Radiant Heat Plaster machine application, using the E-Z Coater Machine, made by the Plastering Development Center, Inc., Division of Essick Manufacturing Co., Chicago, Ill. Operate the E-Z Coater Machine in strict accordance with the manufacturer's directions using a 30-in. pole texturing nozzle (Part No. 1-104).

Spray radiant heat plaster in a double spray procedure, to completely cover the heating cables; the first coat approx. 1/8" followed immediately by a cross-spray to a total of 3/16". Allow the material to take up (stiffen), then level, fill and work out air voids with a trowel, rod or darby. Roughen the base coat to provide a key for the finish coat with a serrated darby or by lightly brooming prior to set. Allow the material to set and dry sufficiently to provide proper suction for the finish coat.

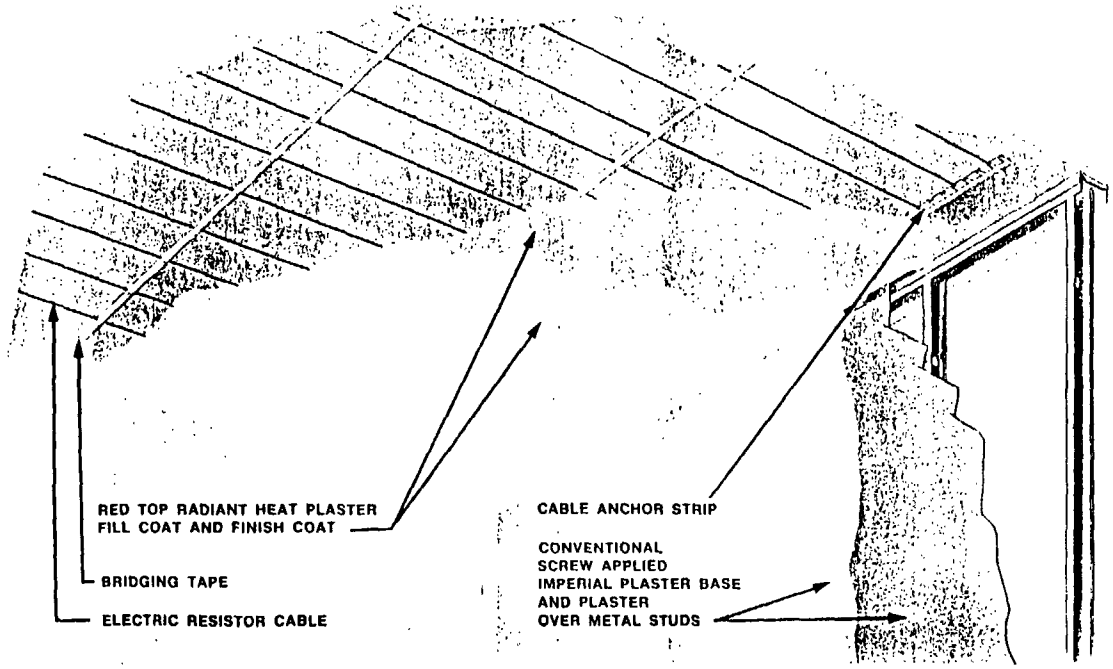
22 Application of finish coat over radiant heat plaster

Smooth trowel finish (for mixing, Sec. 14; for application, Sec. 16).

Sand float finish (for mixing and application, Sec. 17).

Simulated acoustical finish (Sec. 19).

Direct application of plaster to monolithic concrete



23 Application of RED TOP Radiant Heat Plaster to Monolithic Concrete

Materials: The plaster bonding agent must be of high quality and used as directed by the manufacturer.

RED TOP Radiant Heat Plaster as manufactured by United States Gypsum Company.

USG Electric Controls (Sec. 2).

Electric Cable (Sec. 6).

24 Surface preparation

See that the concrete surface is structurally sound and clean, free of dirt, dust, grease, wax, oil or other unsound conditions. Coat all metal components in the concrete surface to prevent rusting.

Remove form ridges to make the surfaces reasonably uniform and level. Locate ceiling areas which due to uneveness require filling prior to installing electric cable and plastering. Treat these areas with a plaster bonding agent, following manufacturer's directions, and then apply RED TOP Radiant Heat Plaster as a leveling coat, and allow to set.

25 Application of radiant heating cable

After the ceiling surface has been leveled, apply the electric radiant heat cable according to design requirements and cable manufacturer's specifications. Attach the cable to the ceiling in such a manner that it is kept taut and does not

sag away from the ceiling. All cable connectors and non-heating leads must be securely attached to the ceiling. If further detail is required, contact the nearest U.S.G. sales office.

26 Application of plaster bonding agent

Apply plaster bonding agent as directed by the manufacturer.

27 Mixing of RED TOP Radiant Heat Plaster

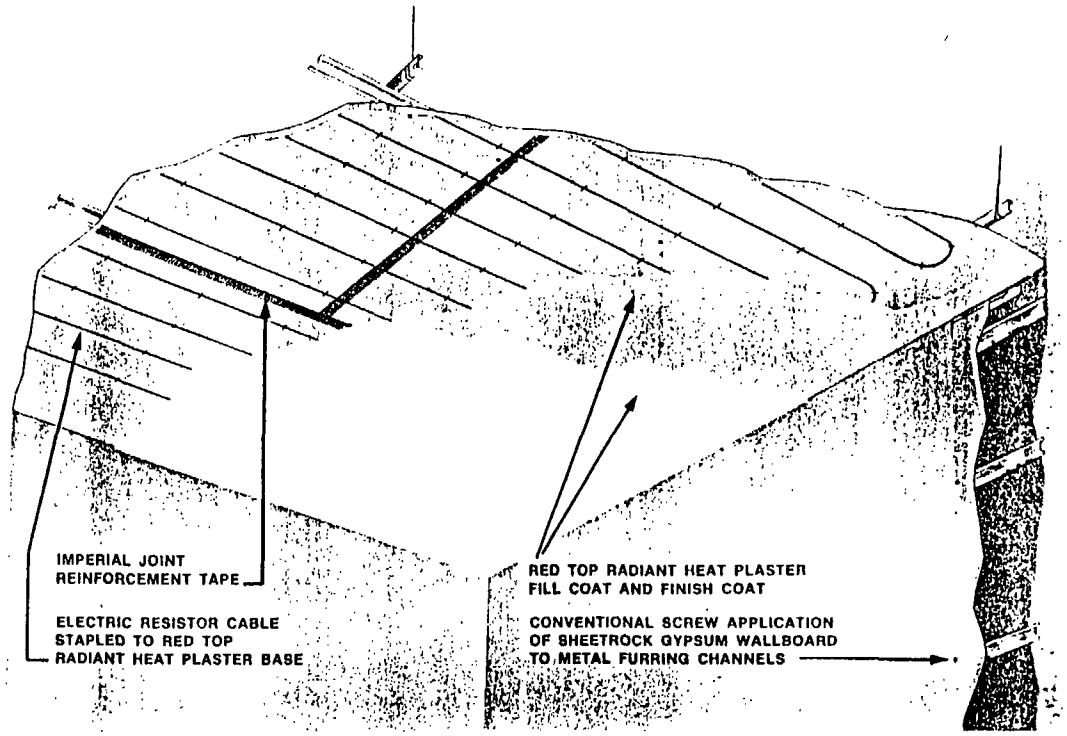
See Section 14

28 Application of RED TOP Radiant Heat Plaster

Apply RED TOP Radiant Heat Plaster to a total thickness of 3/8" in two coats over the level surface. Trowel a 5/16" fill coat of plaster parallel to the direction of the cable, completely covering the cable and anchor devices. For balance of procedure and application of the 1/16" finish coat, see Sec. 15 & 16.

Caution: Temperature of concrete ceiling with bonding agent and cable applied must be above 32°F. before plastering is started, with air temperature above 55°F.

Direct application of plaster and base to suspended or furred grillage



29 Furred or suspended ceiling construction

Materials: All materials as listed in Sec. 2.

9-ga. galvanized hanger wire.

USG 16-ga. 1-1/2" Cold Rolled Channel.

USG Metal Furring Channel.

USG Metal Furring Channel Clips.

16-ga. galvanized tie wire.

18-ga. galvanized tie wire.

Insulation as in Sec. 4.

Ventilation as in Sec. 5.

Electric Cable as in Sec. 6.

30 Furred ceiling on steel joists

Erect metal furring channel at right angles to the steel joists, 16" o.c. and securely saddle tie with two strands of 16-ga. tie wire to each steel joist. Do not let channel into or come in contact with abutting masonry walls. To make end splices, nest channels at least 8" and securely tie at the lap. At light troffers or any openings that interrupt the furring channels, install additional 3/4" furring channels at each side of the troffer or interruption and securely wire-tie to steel joists.

31 Grillage erection

Space 9-ga. hangers not over 4'-0" o.c., in the direction of the main runners and not over 4'-0" in the direction at right angles to the 1-1/2" main runner channels, and within 6" of the ends of main runner runs and boundary walls, girders or similar interruptions of ceiling continuity.

Place main runners not over 4'-0" o.c., properly positioned and leveled, and saddle tie along runner. Do not let main runners into or come in contact with abutting masonry walls. Locate runner channels within 6" of the walls to support the ends of the furring channels.

Space metal furring channels 16" o.c. and securely fasten with metal furring channel clips or saddle tie with two strands of 16-ga. tie wire to main runners or main support members. Do not let channels into, or come in contact with, abutting masonry walls. Provide end splices by nesting channels at least 8" and securely wire tie. Install metal furring channel clips on alternate sides of the main runner channel. Wire tie metal furring channel to 1-1/2" channel and to main support members when clips cannot be alternated.

At light troffers or any openings that interrupt the main runner or furring channels, reinforce grillage with 3/4" cold rolled channels wire-tied atop and parallel to the main runner channels. Isolate the plaster base and plaster surfaces from all structural elements, dissimilar wall or partition assembly, or other vertical penetration.

All casing bead (Sec. 10) must be accurately cut and mitered and should provide full plaster grounds when securely installed. Attach with 18-ga. tie wire 6" o.c. and allow a space sufficient for the finished wall thickness plus an additional 1/8". The 1/8" space will remain after walls and ceilings are finished and will provide positive relief. Secure a flexible dust membrane behind the Radiant Heat Plaster Base and partition surface to seal this space.

32 Application of plaster base

Fasten the RED TOP Radiant Heat Plaster Base to the furring channels before installing the wall materials. To minimize the number of end joints, use the maximum lengths practical. Apply the plaster base across the furring channels with all end joints occurring over a furring channel and staggered in adjacent rows.

End joints should be job-beveled as shown in detail drawing. Cut plaster base for neat fit on electrical outlets, etc. Attach plaster base to furring channels with 1" USG Brand HI-LO Screws Type S spaced a maximum of 12" o.c. in the field of the board and along abutting ends. Drive screws no closer than 3/8" from the edges of the boards. Use a power-driven screwdriver, driving the screws so that the heads are slightly depressed below the surface of the board.

Application of joint reinforcing tape

See section 12.

Application of radiant heating cable

See section 13.

Mixing and application—RED TOP Radiant Heat Plaster

See sections 14 to 21.

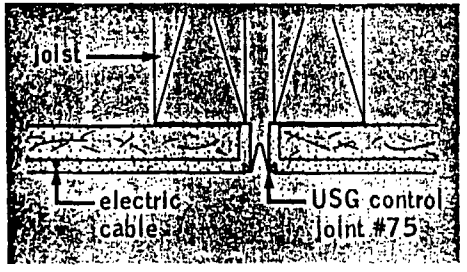
33 Remodel work in residential wood frame construction

Follow same procedure for installation of USG Plaster Cable Heat System as outlined for new wood frame construction (Sec. 8).

See Sec. 7 for fastener size and spacing.

34 Recommendations for structural relief and ceiling angle treatment

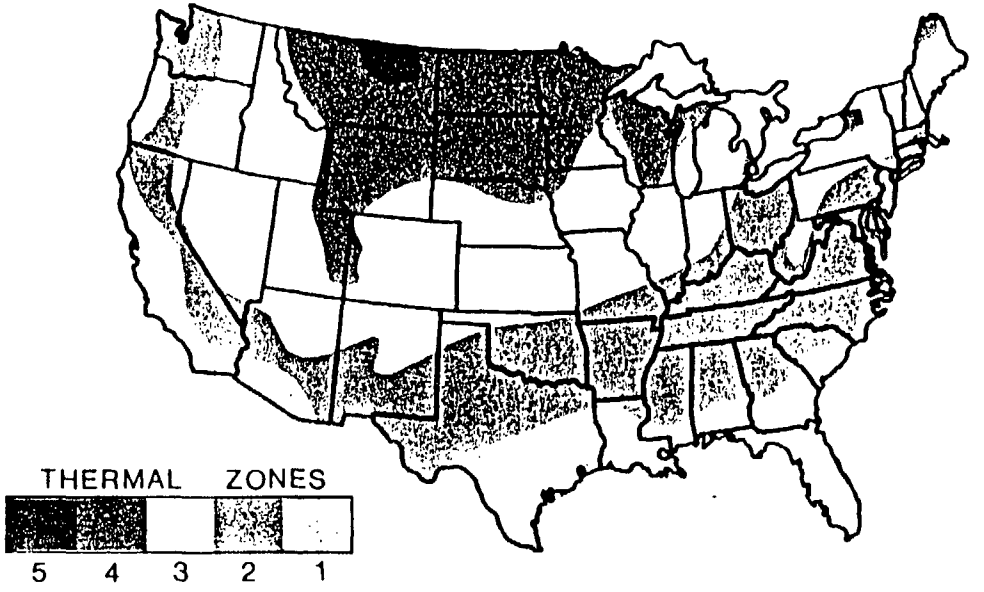
In wood frame residential construction where individual ceiling areas exceed 500 sq. ft., or where room lengths greatly exceed 25 lin. ft., a control joint must be used. For standard 1/2" radiant heat plaster base and 1/4" radiant plaster installations, use USG Control Joint No. 75. The use of two or more separate heating cables, each controlled by a separate thermostat, on a continuous ceiling surface is not recommended. If such an installation is necessary, separate the areas by an expansion device or divide by a header.



In Thermal Zones 3, 4 and 5 where RED TOP Radiant Heat Plaster and Plaster Base ceilings are attached to wood members which also support a roof (example: flat roof constructions), positive structural relief *must be provided.*

Ceiling angle treatment

Perimeter isolation (Sec. 10) is the only *sure* protection against the possibility of angle cracking. Other optional methods of angle treatment are described for informational purposes only.

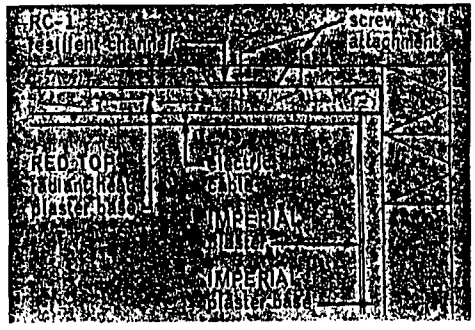


35 IMPERIAL Plaster walls

Apply IMPERIAL Plaster Base to walls after ceiling plaster base is in place. Overlap and maintain firm contact at the ceiling line in order to support the ceiling plaster base when floating angles are installed. At the ceiling angles, apply IMPERIAL Joint Reinforcement Tape, Type P (pressure sensitive application). As an alternate, use IMPERIAL Tape Type S, stapling every 12" along the ceiling edge only (Sec. 12). If IMPERIAL Basecoat Plaster is being used in two-coat application, apply basecoat plaster to walls before plastering the ceiling. Continue with the embedding and finish coats of RED TOP Radiant Heat

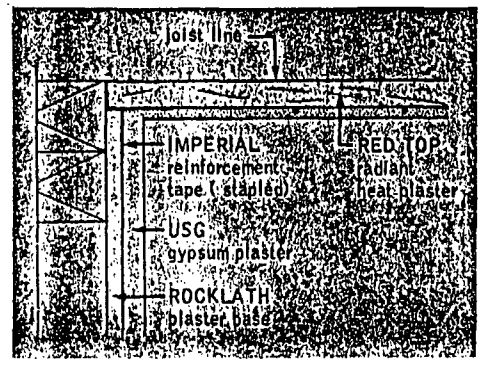
Plaster on the ceiling. Finally, apply DIAMOND Finish Plaster, STRUCTO-GAUGE Plaster-lime or Keenes-lime-sand float finish plaster to the IMPERIAL Basecoat Plaster, cutting the angle flush at the ceiling corner.

For one-coat IMPERIAL Plaster application on walls, complete the radiant heat ceiling installation first, applying both fill and finish coats of RED TOP Radiant Heat Plaster. On walls, use IMPERIAL Finish Plaster in scratch and double-back application to a thickness of 1/16" to 3/32". Make ceiling angle flush.



36 Conventional plaster walls

Install sidewall ROCKLATH Plaster Base after the ceiling plaster base is in place, *following procedures outlined in Sec. 35.* Apply basecoat plaster to walls before plastering the ceilings. Apply the embedding and finish coats of RED TOP Radiant Heat Plaster on the ceiling, cutting the angle flush at the wall surface. Add finish plaster coat on the walls, making the angle flush at the ceiling surface.



37 Gypsum wallboard walls (smooth trowel ceiling)

Erect wallboard after application of ceiling plaster base, maintaining firm contact at *ceiling line using floating angle* construction. Complete the radiant heat plaster application and conceal wall-ceiling angle with conventional wood molding, attaching to partition framing only.

38 Decorative wall paneling

Erect wall paneling or other wall surfacing material after completing the ceiling application of radiant heat plaster. Conceal wall-ceiling angle with conventional wood molding attaching to partition framing only.

39 Painting

The plaster must be dry, sound, clean, free of dust, grease or oil. De-energize the radiant heat cable at least 6 hours prior to the start of painting. Provide supplementary heat, if necessary, to maintain the room conditions at the desired temperature (min. 55°F.) until the paint is dry. Re-energize the cable only after the paint is thoroughly dry.

40 Precautions for energizing cable system

Do *not* energize the heating cable until the plaster is thoroughly dry. When either or both the completed radiant heat plaster ceiling and room temperature are below 55°F., the thermostatic elevations should be made in 5°F. increments for each 24-hour period until a temperature of 55°F. in both room and radiant heat plaster is attained.

When the completed radiant heat celling and room temperature are at 55°F. or higher, the thermostat elevation may be made to the desired temperature without incrementally spacing the thermostat settings.

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