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December 1, 1947

RADIANT HEATING TECHNIQUE OF INTEREST TO CONTRACTORS

by

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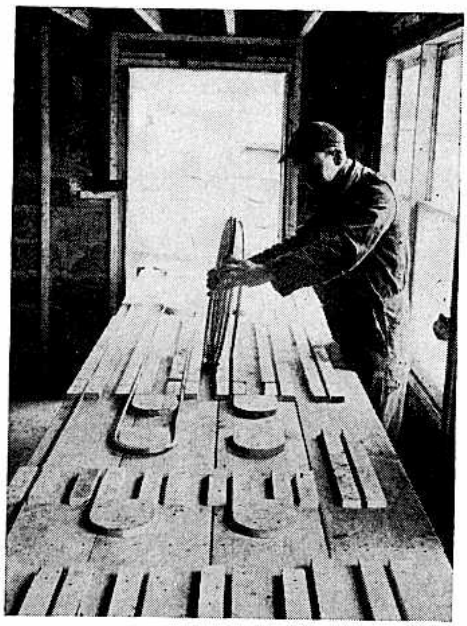
REVERE COPPER AND BRASS INCORPORATED
Executive Offices, 230 Park Avenue, New York 17, N. Y.

*Doremus L. Mills**

Reviews Radiant Heating Technique with Which Heating Contractors Should Be Fully Conversant

WHETHER he realizes it or not the average heating contractor has had and will continue to have a relatively important effect on the progress of radiant heating in this country. He has had a comparable



Coil of ⅜-in. copper water tube is unrolled between guide strips nailed to top of a bench. Guide strips are positioned for desired spacing of tubes. Wood bending templates are located to give proper over-all length of heating coils. Couplings can be soldered to tube ends while the coil is on the bench and thus save time

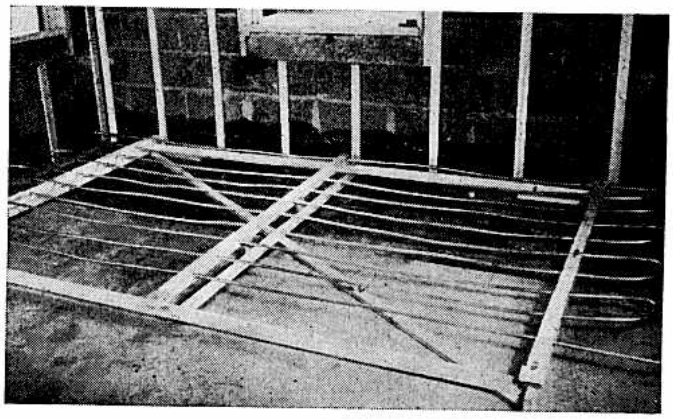
effect on the public acceptance of many heating devices that have been developed.

In making these statements we are not referring to the large heating contractor who does only contract work based on definite specifications, but rather to the smaller contractor who has direct dealings with the architect, builder, or home owner.

In many cases his opinions are regarded as authoritative. If he likes a certain type of boiler or specialty, commendation from him results in many sales. On the other hand, if he discourages the use of certain products in his field the chances are that, in many cases, they may not be used.

Unfortunately, adverse comments to prospects by the contractor regarding certain products or systems, or his reluctance to install them, may be directly due to an incomplete knowledge of their function or proper installation. It is apparent that this is the case with many contractors with respect to radiant heating.

In order to correctly understand present conditions



Completed coil is laid on a simple wood frame or frame is slipped under coil while it is on bench. Blocks nailed to cross members keep rows of tube in alignment

affecting radiant heating we may go back to the time when radiators were first introduced. There were only a few contractors then who could properly figure requirements for a radiator heating job. As a result, many discouraged the use of a radiator system in favor of other methods of heating with which they were familiar.

On the other hand the enterprising and progressive contractors realized that they must understand the use of this new method of heating if they were to keep abreast of progress.

The above analogy is not entirely correct because of the fact that there is much greater hesitancy with respect to recommendations relating to radiant heating systems than there was when radiator heating was involved, principally due to the fact that if a radiator were installed and did not prove to be satisfactory it could, in most cases, easily be replaced by a larger or smaller unit. Corresponding changes would not be possible in the case of a radiant heating installation where the heating coils are all embedded in concrete or plaster.

Eventually contractors became familiar with methods

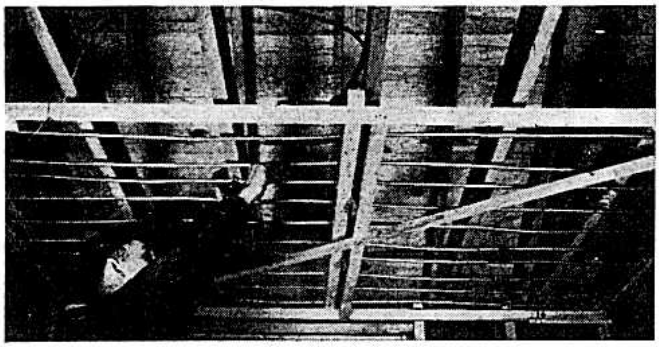
* President, Central New York Chapter, ASH&VE.

of determining the requirements for radiator heating or they could obtain assistance from manufacturers or distributors. The same situation will develop in the case of radiant heating, in fact there are already simplified methods of determining radiant heating requirements and there are indications that further simplification applicable to installations in the 5- or 6-room residence is still possible.

No Need for Skepticism When Planning a Radiant Heating Job

THE heating contractor, therefore, should not be skeptical of his ability to do a radiant heating job if he will take the time to study the subject. So many radiant heating installations are now operating successfully in this country that it should no longer be thought of as an experimental method of heating.

There are, it is true, refinements yet to be made involving proper method of control and more factual



Wood frame with coil of copper tube on it can easily be lifted to ceiling where it is temporarily wired to ceiling joists. Pipe straps or pipe hooks are then nailed to joists until a sufficient number are attached to permit the frame to be removed, when the remainder of the supports can be attached

data are needed on such matters as proper allowance for fabric floor coverings.

A great deal of research can yet be done in this field. There is, however, sufficient information available regarding both design and installation details to make possible satisfactory installations in most cases.

The public interest in this method of heating is increasing greatly. For that reason if the contractor ordinarily making heating installations in the average residence is to get his share of the potential business he must learn something about the principles of radiant heating and how to figure the requirements for an ordinary job. If he doesn't, he will find that a competitor will get the business.

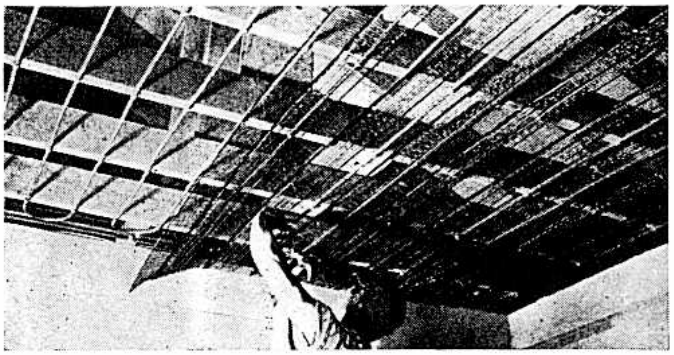
There are many contractors, of course, who have always been willing to let a salesman or an engineer employed by a manufacturer or distributor do estimating work for them. This is an easy way of doing things and many contractors are content to adopt that method. Those who do, however, are apt to find that their opinions are not regarded as highly by their customers as those who can speak from first hand knowledge.

At the start it may be advisable for the contractor to seek help from the distributor or from a manufacturer but, in such cases, if possible, he should go over the necessary procedure for determining the requirements with the individual who did the work so that he himself can learn to do this work eventually without assistance.

Some Important Characteristics of Radiant Heating

IT MAY be helpful at this point to bring to the attention of the reader some of the characteristics of radiant heating that differ from those of the conventional system and also to explain some of the limitations.

In the first place the matter of room air temperature must not be over-estimated in a radiant heating installation. As far back as 1923 research work conducted by the American Society of Heating and Ventilating Engineers definitely established the fact that room air temperature is not a proper index of comfort conditions. An example of this fact is characterized by what has been



The copper tube is attached to the ceiling joists and expanded metal lath, preferably ⅜ x ⅝ mesh, is nailed to the joists below, but in good contact with the tube

Plastering is done in the regular way just as if no radiant heating coils were installed. The plasterer thus has an unobstructed area for his work and much more uniform panel surface temperatures exist than if the copper tube were installed below the metal lath and completely embedded

called "cold 70" which means that the occupants of a room under certain conditions may be uncomfortably cool although the air temperature is 70 F or more. The principal causes of such discomfort, in most cases, will be the low temperature of the enclosing surfaces of the room or improper distribution of the heat sources.

As heat always passes from a warm body or substance to a cooler body or substance the body heat of the room occupants in the case referred to above is being lost more rapidly to the enclosing room surfaces than it can be produced. For that reason a person sitting near a cold wall or a large glass area will feel cold in a room heated by a conventional system.

Such a condition would not be so apt to exist in a well designed radiant heating system because of the fact that a radiant heating system, if properly designed and installed, produces the proper heat balance between room

air temperature and the mean radiant temperature of the enclosing room surfaces and also because the heat source is spread out over a comparatively large area.

In conventional heating systems the average surface temperature tends to fall more and more below the room air temperature as the outdoor temperature falls. The opposite is true in radiant heating. A given change in panel temperature will have a greater influence on overall surface temperature than it will on room air temperature.

The "Why" of Warmer Walls

THIS condition by which warmer walls exist in a radiant heating system than would be the case if a conventional system were used for the same room or building, results in a difference in heat loss requirements. For example, the Btu requirements for a given job, if determined by an accurate method for radiant heating, would be greater than those for a conventional system when the outdoor temperature is comparatively high.

When the outdoor temperature is zero or below, the opposite would be true and the Btu requirements for radiant heating in that case would be less than those for a conventional heating system. This is largely because the heat output of a radiant heating panel is a direct function of the heating load and therefore, at a given mean water temperature in the heating coil, the heat emission from the panel will increase as the outdoor temperature drops.

The characteristics of a properly designed radiant heating system that have been referred to in this paper could be combined and set down as the A-B-C's of radiant heating. They are substantially as follows:

1. The heat sources are always invisible. Pipe coils carrying the heating medium are generally embedded in panels located in one or more of the enclosing surfaces of a room.

2. The heat sources are comparatively large but are operated at comparatively low surface temperatures.

3. If it is a forced circulation hot water system a series of pipe coils will correspond to a series of radiators in a conventional system.

4. Comfort conditions are produced by setting up three heat balances in rooms to be heated, namely:

(a) On the room occupants;

(b) On the room structure;

(c) On the ventilation rate—(ASHVE Transactions 1941 and 1942).

5. When these heat balances exist:

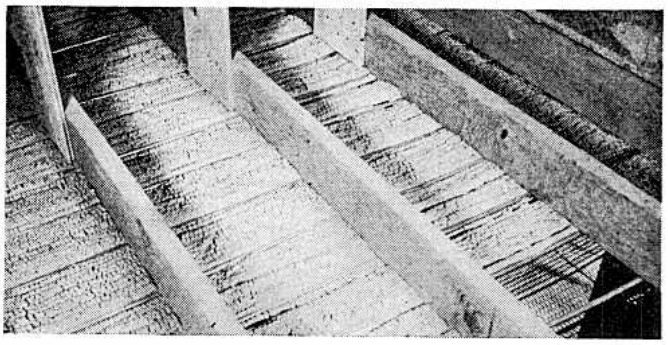
(a) The heat output from a panel will be a direct function of the heating load;

(b) The room air temperature will be an inverse function of the heating load, hence the room air temperature will have no fixed design value;

(c) The ACTUAL comfort air temperature of a room will vary inversely the same number of degrees as the mean radiant temperature is above or below an ASSUMED comfort air temperature of 70 F and vice versa; that is, if the room air temperature is 68 F the mean radiant temperature must be 72 F.

Conditions such as these are seldom considered by the designer of a conventional heating system for they could not be produced by one. He would be content to design the system to produce a given room air temperature at a given or assumed outdoor design temperature. Then if the outdoor temperature dropped below the design point the room air temperature would have to be increased in order to make the room occupants comfortable.

These points are brought to the reader's attention to indicate the basic differences in performance between a radiant heating system and a conventional system. Because of these basic differences it should be apparent



The penetration of the plaster through the expanded metal lath is sufficient to produce satisfactory heat transfer from the tube to the panel surface in the room. It is not necessary to completely embed the copper tube. The space between the joists above the lath will be filled with rock wool or other suitable insulation

that design procedures for the two types of systems should not be the same, for no conventional radiator, convector, or warm air heating system can meet the heat balance requirements that a properly operating radiant heating system satisfies.

How to Design a Radiant Heating System

HOW then can the heating contractor design a radiant heating system if he is called upon to do so, assuming that a given job may not be large enough to justify the services of a consulting engineer? In the first place he must take time to learn how, just as he had to learn how to design and install a conventional system.

He may hesitate to undertake a radiant heating job because he may think it's something new about which he doesn't know enough. That was the general feeling when radiator systems were first introduced. Actually the design procedure for radiant heating is not difficult and any man who has designed a conventional heating job could easily learn the principles of radiant heating with a little study. Good judgment would also help.

A design procedure would first have to be selected. Several methods have been published by manufacturers and are readily available. While these may differ materially they can be used in most cases with a fair amount of success.

One method combining accuracy and simplicity is developed in graphical form and is applicable to all except unusual cases. Numerous mathematical calculations are eliminated by the use of this method. It, of course, would be preferable to select a system which gives references to dependable sources of information for basic statements. Unfortunately some rather rad-

(Continued on page 81)

Doremus L. Mills Reviews Radiant Heating

(Continued from page 35)

ical statements are made by some authors without source references, hence they may be of questionable value.

The design of a radiant heating system entails a decision as to panel location. The author has found a surprisingly widespread lack of knowledge on this point. Many believe that warm floors are only possible if the heating panel is located in the floor. Actually, if the radiant heating system is properly designed, the surface temperature of the floor in an ordinary room will always be higher than the room air temperature. For further information on this subject the reader is referred to a report published early in 1946 by the "Purdue Housing Research Foundation" entitled, *Radiant Heating—Floor, Wall, or Ceiling?*

The statement above, relating to floor surface temperatures, can be accounted for by a consideration of the utilization of heat transfer principles in a radiant heating system.

Conduction takes place only within the panel and represents the transfer of heat from the heating medium, such as the hot water in a pipe coil, or warm air in ducts, or furred spaces, to the panel surface.

The heat emission (or heat given off) from the surface of the panel consists of *radiation* (heat rays) and *convection* (circulation of air that has been heated by coming in contact with the warm panel).

Theoretically, radiant heating utilizes *radiant energy* to the fullest extent while reducing the amount of heat transferred by convection. The report referred to in the preceding paragraph gives the relative values of heat emission from panels in different locations in a room and is well worth studying.

The matter of tube or pipe size and spacing is an important one for the contractor to know about yet it is generally misunderstood. Experiments conducted at the University of California and reported on in the *Journal* of the ASH&VE for August 1947 produced some interesting data that may be surprising to some readers.

It should be unnecessary to remind the reader that a hot water system of radiant heating, like any other hot water system, must be properly vented if it is to circulate satisfactorily. It may be necessary to vent each coil separately; a group of coils from the same header may be vented; or one main vent may suffice, depending on how the system is installed.

Any contractor who is familiar with the venting requirements of a hot water heating system should be able to arrange for the proper venting of a radiant heating system.

As a further aid in proper circulation it is generally advisable to provide balancing or flow adjusting cocks for individual coils or groups of coils. These are usually located on the return ends of the coils. In some cases they may be grouped in a convenient location.

Automatic controls are perhaps *more* important for radiant heating systems than for conventional types. Good literature on this subject has been published by leading manufacturers of control devices. If controls are not properly selected or installed, disappointing and unsatisfactory results are bound to occur in a radiant heating system. For this reason the contractor should study the literature on this subject.

Space limitations prevent a fuller discussion of this big subject of radiant heating and the contractor's part in it. Our advice is to study the technical literature that is available, then use common sense in applying the knowledge thus acquired. There is no rule of thumb by which a satisfactory radiant heating system can be designed, but the time spent in studying the subject should be well worth while.

Detail sheets showing how to construct the bench for forming coils and the frame for handling the completed coils, both shown on page 32, will be sent upon application to Revere Copper and Brass Incorporated, 230 Park Avenue, New York 17, N. Y.

ADVANTAGES OF COPPER TUBE FOR RADIANT PANEL HEATING

Copper Water Tube is widely recognized as being a most satisfactory piping material for Radiant Panel Heating installations.

Easily Bent

It is easily bent cold by hand. Simple bending templates made of wood are useful to produce uniform bends and even spacing of the rows of tubes in a heating coil. Photographs showing an easy method of fabrication are available from any Revere Office.

Long Lengths

Copper Water Tube is furnished in 60 foot coils. These long lengths require fewer joints than short length pipe and hence reduce fabricating time and expense.

Small Sizes

Heating coils formed from small sizes of Copper Water Tube — $\frac{3}{8}$", $\frac{1}{2}$", and $\frac{3}{4}$" — may be used. For a given panel rating and mean water temperature, tube size is relatively unimportant from the standpoint of heat input to the room.

Light Weight

These small sizes of copper tube are light in weight and can be made into heating coils that are very easily handled and installed. Their use simplifies or eliminates some construction problems that occur when heavy, large diameter pipe is used.

Expansion and Contraction

The coefficient of expansion for copper is almost identical with that of gypsum plaster. It is not sufficiently different from ordinary concrete to cause any concern as to fracture of the tube or loosening of the bond in the limited temperature ranges common to Radiant Panel Heating. The figures given in the Carnegie "Pocket Companion" for different materials used in Radiant Panel Heating installations are as follows:

Copper	.0000093	Plaster	.0000092
Wrought Iron or Steel	.0000067	Concrete	.0000079

The above are per degree F, per unit of measurement.

Soldered Joints

Joints made with solder type fittings do not appreciably increase the outside diameter of the tube. They are quickly and easily made at low cost and are amply strong.

Conductivity and Corrosion Resistance

The high thermal conductivity of copper and its high resistance to corrosion are well known. They result in quick heat transfer and absolute freedom from rust accumulation in the heating coils.

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