RADIANT HEAT
with
COPPER TUBING

A Practical Research Program

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type panel system of forced circulation hot water using sinuous coils throughout made of ⅜-in. Type L soft temper copper tube on 4-in. centers. All coils are double as shown in Fig. 2. The average length of each tube-run between supply branch and return branch headers is 75 ft with 92 ft as a maximum length of single tube coil and 64 ft as a minimum.

Main supply and return lines are 1½-in. Type L hard temper copper tube and the flow system is designed on the reverse return principle (Fig. 2). Branch headers are ¾-in. and 1-in. Type L hard temper copper tube. The system is down fed with the mains running the length of the building slightly above the coils in the attic space above a central hallway.

Each coil is vented by a tee located in each return header (Fig. 5) just ahead of its connection to the return main. The tee branch faces up, and from it a ⅜ in. Type L copper tube rises approximately 12 in. with a 180° return bend at the top continuing downward to a petcock located in an access box flush with the hung ceiling of the hallway or other convenient place. This venting arrangement seemed preferable to automatic vents in this particular installation.

Balancing cocks are located in the return header of each coil so as to be accessible through the same boxes

Fig. 4. (Below) Completed lathing on ceiling, ready for plastering.

Fig. 5. (Above, right) Vents and adjusting cocks are shown circled. Access boxes not yet installed.

Fig. 6. (Below, right) Wiring metal lath to supporting channels.

Fig. 4 ▼

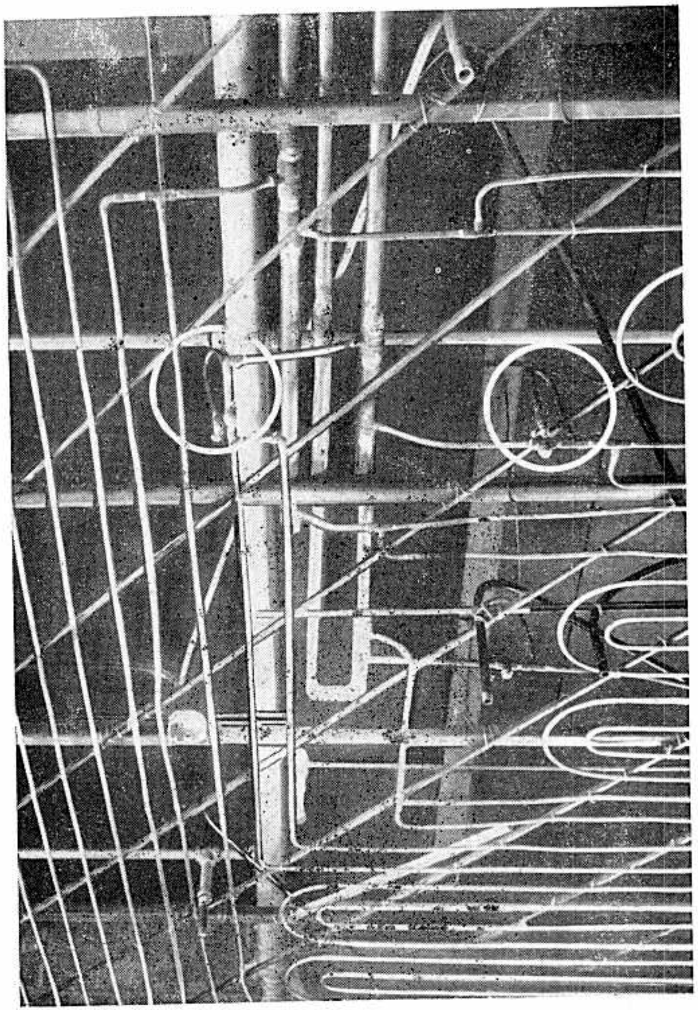
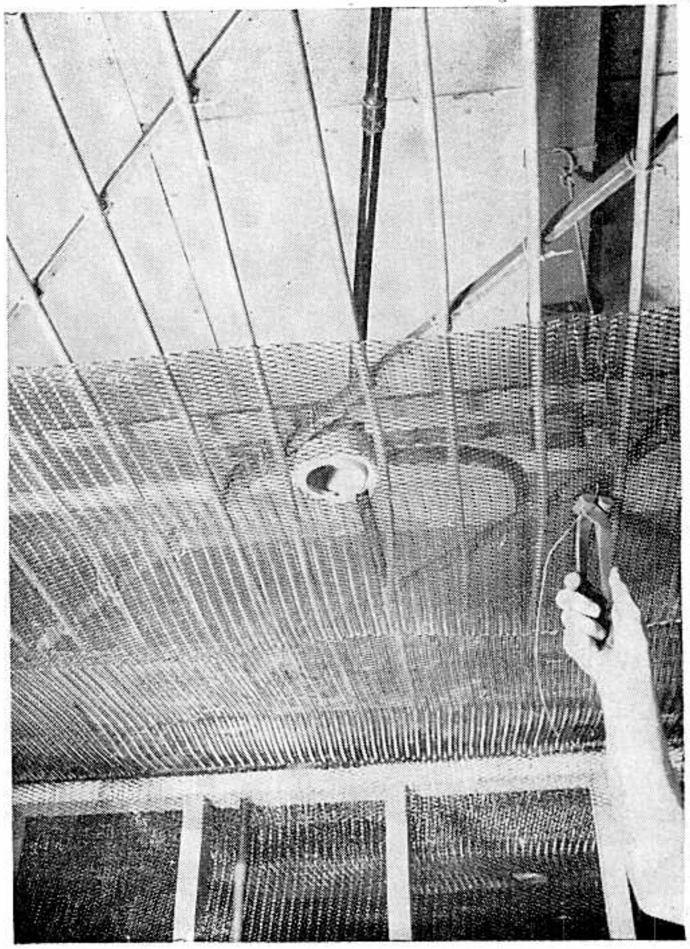


Fig. 5 ▲

Fig. 6 ▼



in the ceiling that are provided for the venting petcocks.

The ceiling system was designed to maintain optimum comfort with 120F panel surface temperature when outside air is at —10F and the ventilation rate, varying from room to room on account of the use of exhaust fans in some laboratory spaces, ranged from ½ to 2 air changes per hour. The design method used was a graphical adaptation* of the rational heat balance procedure.

A total of 3,600 ft of ⅜-in. copper tube was used for the ceiling coils with a total design flow rate of 15 gpm based on a temperature drop of water through the coils of 10F. The total head loss for the system is calculated at approximately 10 ft.

All ceiling coils were made by uncoiling the copper tube from standard 60-ft coils into wood strip guides attached to the top of a temporary bench erected inside the building. Return bends were made around wood forms (Fig. 3) properly spaced at each end of the bench. Where necessary, soldered coupling joints in the straight lengths of tube were made right on the bench.

After the coils were formed it was an easy matter to lift them into position on the ceiling by means of a simple wood jig and then wire them to supporting members. The metal lath was then applied on the underside of the coils ready for plastering (Fig. 6). This provides an even surface for plastering (Fig. 4) as though no tube were installed. A detailed account

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*A Graphical Design Procedure for Radiant Panel Heating, F. W. Hutchinson, Revere Copper and Brass Incorporated, 1945.

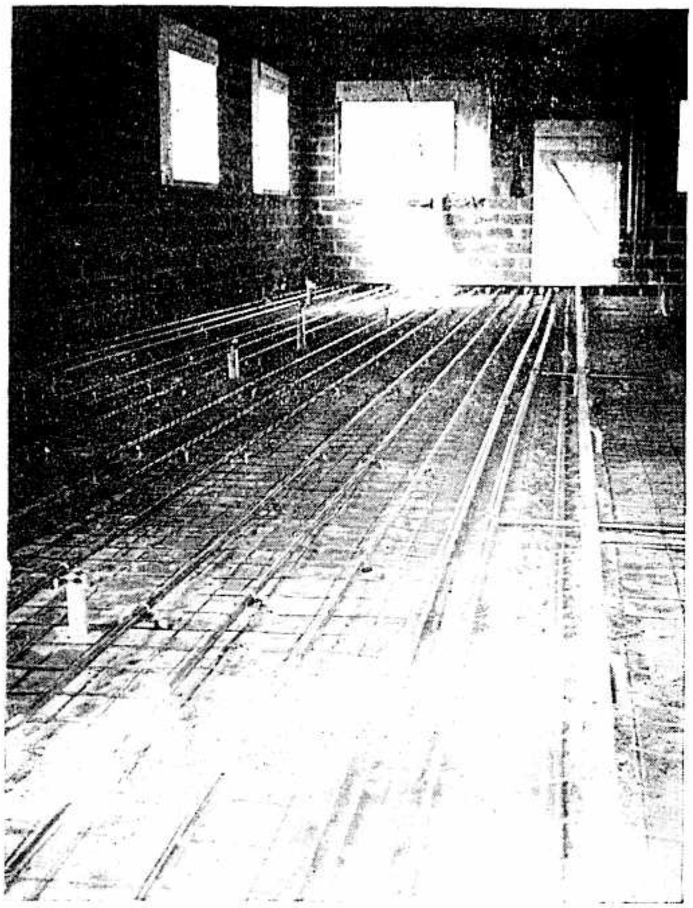


Fig. 7 ▲

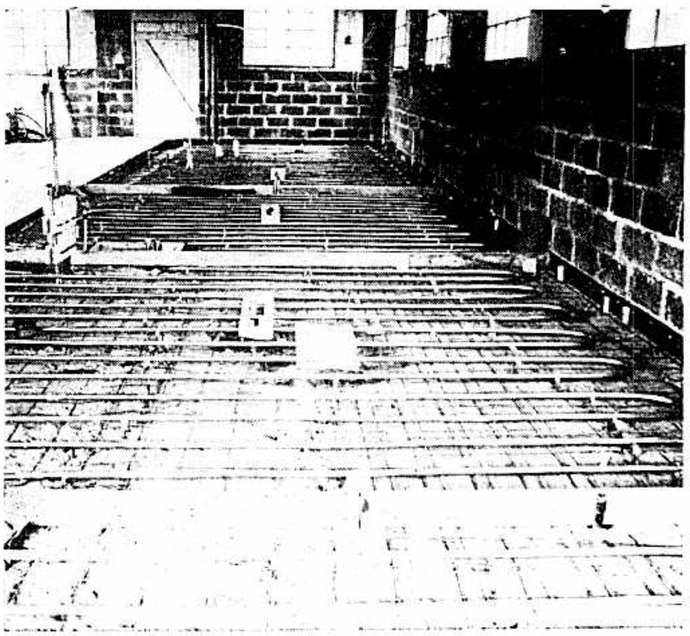
Fig. 8 ▼

Fig. 7. (Above, left) Grid coils in position before pouring concrete.

Fig. 8. (Below, left) Supply end of grid coils showing thermometer well and main cut-off valve. Individual cut-off valves are in return headers.

Fig. 9. (Below) Sinuous coils in floor, ready for pouring concrete.

Fig. 9 ▼



of the easy method of forming the coils and the means of transferring them from the bench to the ceiling will be given in a later article.

Experience with the 3600 ft of ceiling coil showed that an average journeyman and helper, without previous experience on this type of installation, could be expected to bend, jig, raise, and wire into place approximately 700 to 900 ft of copper tube per 8-hour day with all couplings bench soldered as part of the operations.

In addition to the service heating system, 1750 ft of ¾-in. copper tube were installed in floor coils solely for experimental purposes. Five sinuous type floor coils (Fig. 9) each approximately 11 ft by 11 ft were installed at four different embedment depths in one half of the concrete floor. These depths are ½ in., 1 in., 1½ in. and 2 in. below the finished floor.

Since the coils are in every other respect identical it is expected that test results will provide reliable data as to the influence of depth of bury on energy dissipation rates and effectiveness of control. All floor coils have a uniform tube spacing of 9 in. on centers and the floor systems are so arranged as to permit operation entirely independent of the ceiling system.

The other half of the floor, which is divided longitudinally, is experimentally heated by means of grid type coils (Fig. 7) using ¾-in. Type K hard temper tube in 57-ft straight lengths. Four grid coils separately valved (Fig. 8) are embedded at four different depths below the finished surfaces of the concrete floor similar to the sinuous coils. Tests on these floor sections are expected to provide data on the effect of the difference between the coefficients of thermal expansion of the tube and the concrete and also to assist in checking analytically transient effects associated with intermittent versus continuous operation of the circulator.

All floor panels are arranged to permit accurate metering of flow rates and to allow determination of the temperature of water to and from the coils. This will be done by means of flow meters and thermocouples with mercury thermometers for check purposes. Thus the rate of energy dissipation from the coil on the panel surface and also in the opposite direction can be determined with precision. Thermocouples are likewise located at ¼-in. intervals under the coils to permit determination of the temperature gradient from coil to ground with consequent evaluation of the rate of energy loss from the rear of the panel. Ground losses are being further checked through use of a thermocouple grid located directly under the center of each floor coil and extending into the ground a depth of 5 ft.

Thermocouple grids are located in respective sections of the system to permit determination of both the horizontal and vertical temperature gradients so that data on tube spacing and varying depths of bury can be both checked and extended.

In order to restrict the heat flow between adjoining floor slab sections and between the floor slabs and outside walls, strips of 1-in. Celotex were inserted around all edges of each portion of the floor slab in which the experimental coils are located.

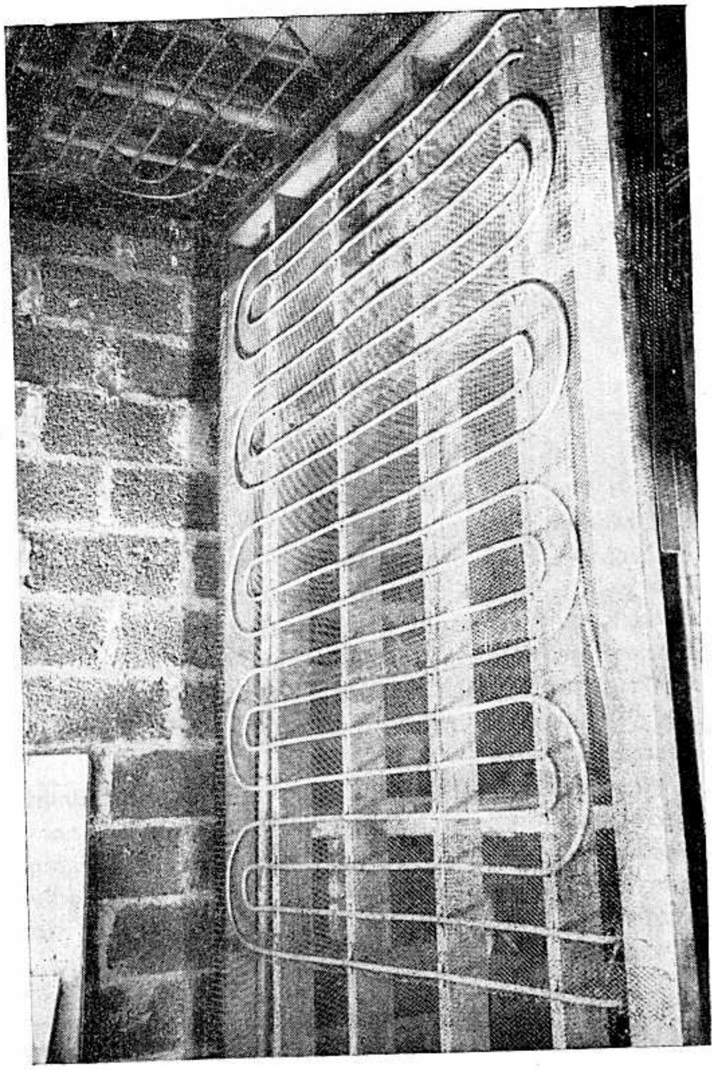


Fig. 10. One wall coil installed in front of metal lath. Ceiling coil behind lath.

After the pouring of the entire floor was completed, the concrete contractor stated that no more time was required in pouring over the coils than for an ordinary floor slab without coils.

One wall panel is being installed in a narrow room with excessive exposure, and unlike all other coils of the installation the copper tube in this wall panel (Fig. 10) is fixed on the room side of the expanded metal lath. During the plastering operation it is expected that interesting data will be obtained as to the relative difficulty and time required to plaster a coil fixed below rather than above the lath.

Radiant Heat with Copper Tubing—

Fabrication of Heating Coils

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This is the second of a series of articles covering the radiant heating installation at the metallurgical laboratory of Revere Copper and Brass Incorporated. The system, of which a general description appeared in last month's issue, will be used as a source of fabrication, performance, and heat transfer data, as well as serving the laboratory building as a heating system. This month, fabrication techniques are described.

As a result of the increasing number of radiant heating installations, a larger number of heating contractors are seeking practical information regarding many of the installation details that are commonly necessary. It is with this in mind that this article is written.

WHEN the contractor is planning his installation procedure, early consideration, undoubtedly, will be given to methods of fabricating the coils that are to be embedded. If the contractor has a choice of materials to be used for the piping system, he will naturally make his selection on the basis of high thermal conductivity of the metal from which the piping is made (bearing in mind that when coils are embedded no radiation or convection from the surface of the piping takes place) its workability, ease of handling, weight, lengths available, and cost of making the necessary joints and connections.

Copper tube combines so many advantageous features as a piping material for radiant heating coils that methods of capitalizing on all these advantages should be of interest to many contractors.

In the first place, it will generally be desirable to purchase copper tube in soft temper, 60-ft coils. This length is commonly carried in stock by distributors and reduces the number of couplings required for the ordinary sinuous coil. In planning the size of the coils as to length of run, the pressure drop through each coil should be determined and held to a proper amount. This will depend in general on the flow rate through the coil, the length of the mains, the size of the tube used for the coils and the pump capacity.

Field fabrication of sinuous coils for radiant heating is a comparatively simple matter if copper tube is used. In the building described in a previous article (H&V: 10:47:p 65), a simple bench (Fig. 1) was constructed 36-in. wide by approximately 25 ft long. On top of the bench, narrow wood strips of ½-in. material were nailed parallel to the long edge of the bench. These strips were spaced the proper distance apart to accommodate the copper tube so that it would be straight as it was unrolled from the circular coil in which form it was shipped. The center to center distance between

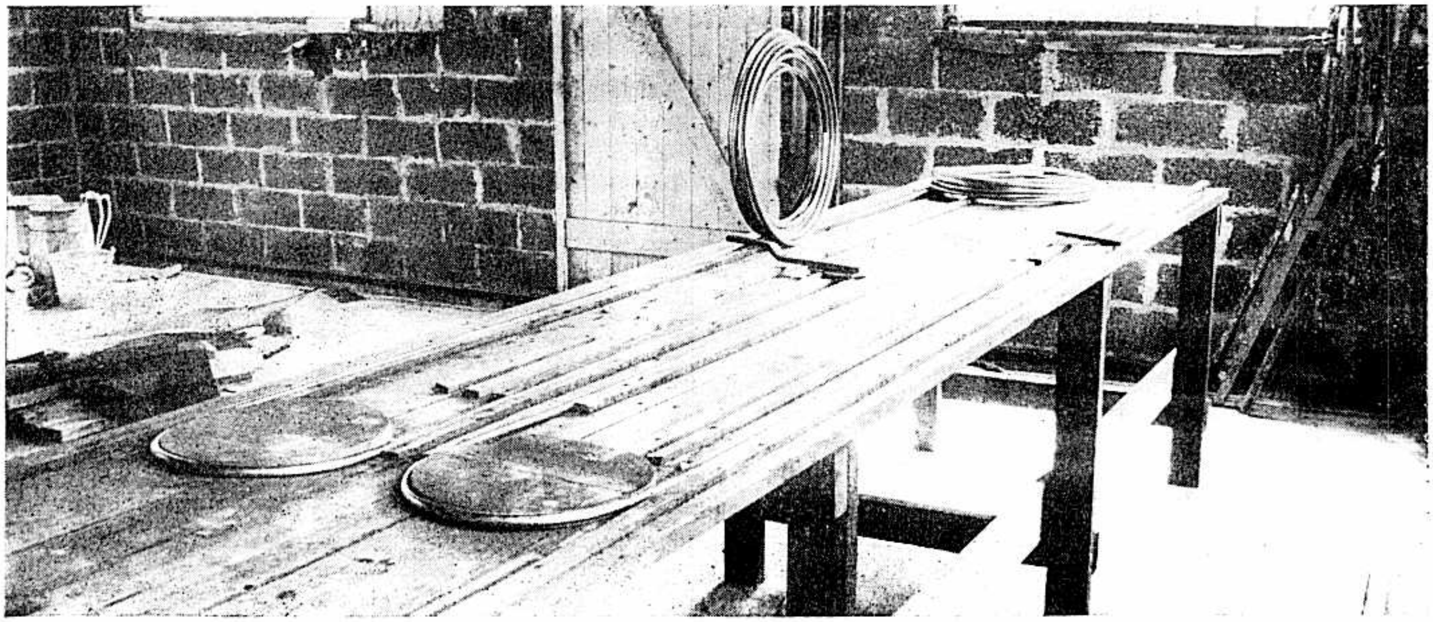

Fig. 1. Temporary bench with coil partly formed. Bench is made wide enough to accommodate two large return bends.

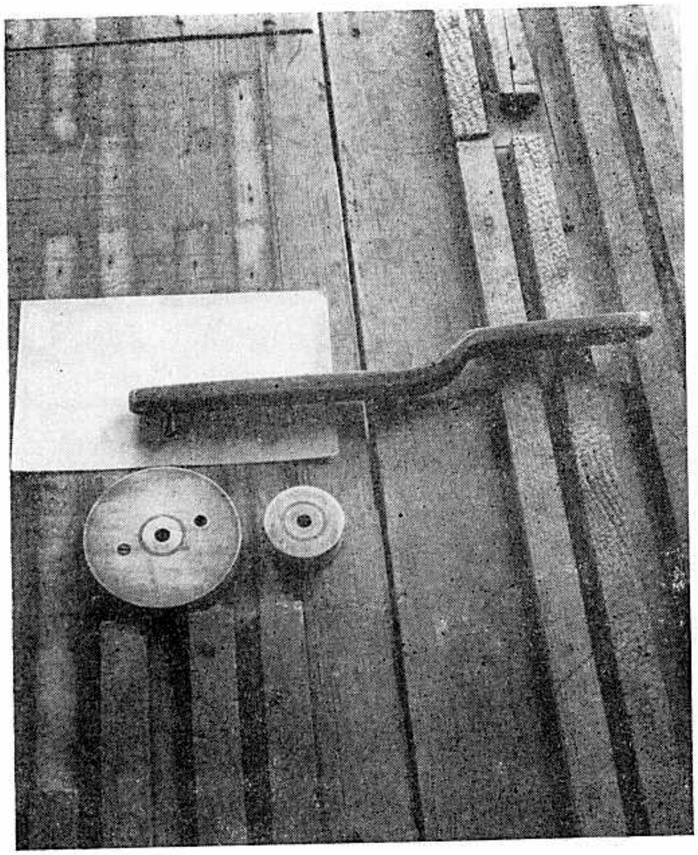

Fig. 2. Metal sheaves and handle for bending.

each pair of strips corresponded to the center to center spacing of the tubes in the heating panel.

Wood discs made of ¾-in. material were cut on a band saw with a radius equal to the radius of the inside of the return bends of the finished coil. These discs were used in forming return bends and were fastened to the bench so as to line up with the spacing strips. They were spaced at a lengthwise distance to correspond with the length of the finished coil.

In this particular installation, large-radius bends were altered with return bends on 2-in. radii. To facilitate the bending of the copper tube on a 2-in. radius, a metal sheave approximately ¾-in. thick was made and was fastened to the top of the bench. (Fig. 2). Around the perimeter of the sheave, a groove was cut corresponding to one-half the outside diameter of the copper tube. In the center was a hole to accommodate a fixed pin on the handle used in the bending operation. This handle was approximately 12-in. long by 1-in. wide and ⅜-in. thick, as this seemed to be heavy enough stock for use in this case. At one end of the handle was a fixed pin which entered a centrally located hole in the sheave referred to above and acted as an anchoring center.

A second sheave similar to the first but approximately 2 in. in diameter was made. This sheave was held in position by a second fixed pin in the handle of the bending device which entered a centrally located hole in the small sheave. The tube was bent by drawing the handle radially so that the small roller sheave would revolve along the tube and keep it in contact with the groove in the fixed sheave as it was being bent around the larger sheave. These sheaves are necessary for bending Type L copper tube on short radii so as to prevent the tube from collapsing.

When the bend is about to be made the bending wheel is brought up to position in contact with the tube and the handle is then put in place by having the two fixed pins engage the hole in the fixed sheave and in the small sheave. The latter will, in general, be considerably smaller in diameter than the fixed sheave.

In starting to form the sinuous coils the copper tube was unrolled on the bench from the 60-ft coil in which form it was furnished. The unrolling was done between the guide strips on top of the bench, thus keeping the tube straight. Opposite the starting end of the bench the copper tube was uncoiled around the wood disc (Fig. 3) and held tightly against it. As the tube was bent around the disc it entered the second pair of guide strips and the uncoiling of the tube continued until the starting end of the coil was reached. At this point the larger of the metal sheaves was located (Fig. 4) to form the short radius return bend. The bending operation was then repeated and more tube was unrolled until the complete heating coil was formed, ready to be put into position.

At each end of the bench as many wood discs were located as the width of the bench would accommodate (Fig. 1) depending on the tube spacing which, of course, determined the size of the discs. When the

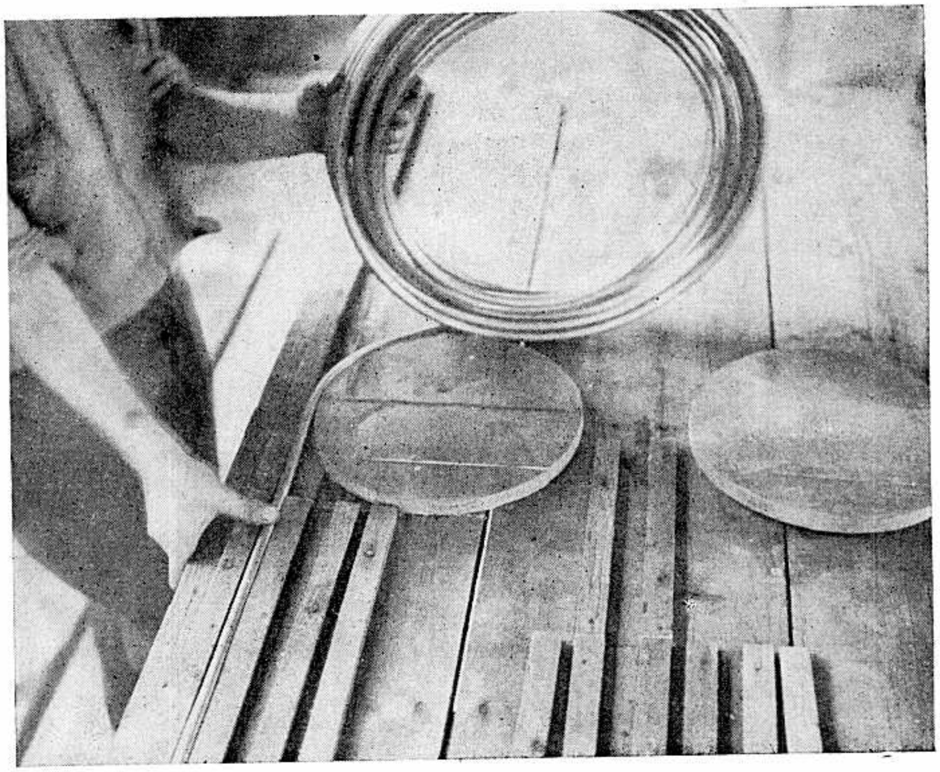

Fig. 3. Forming large return bends of coils.

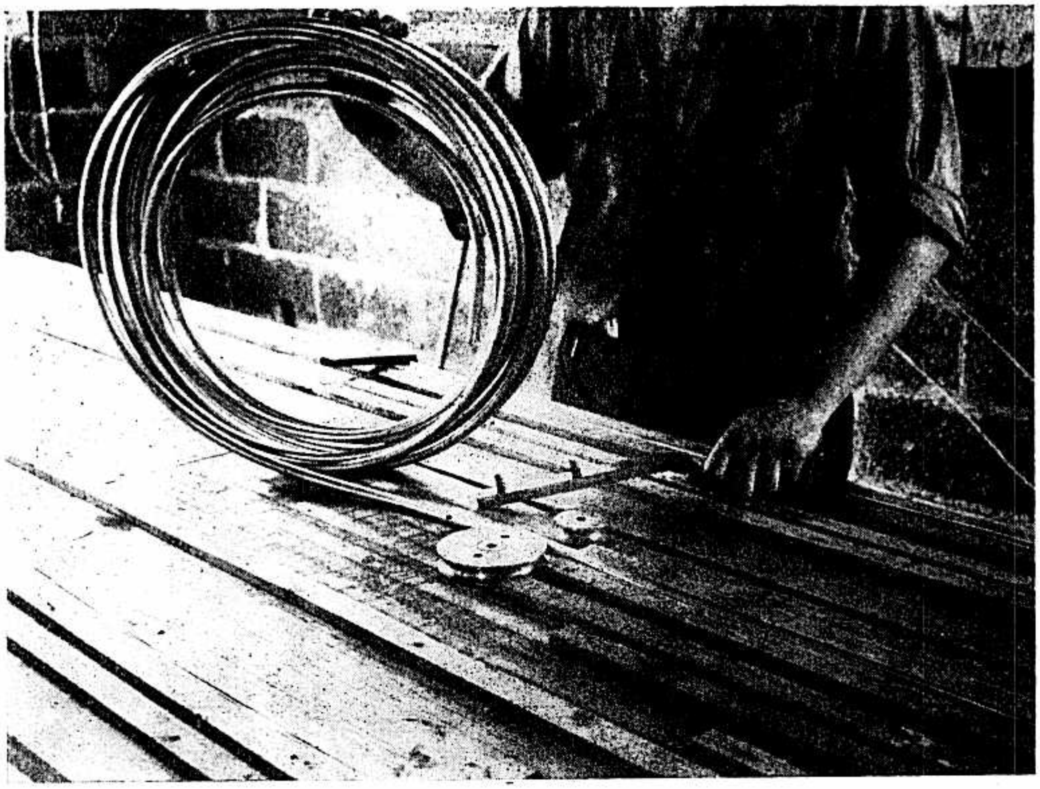

Fig. 4. Small return bend about to be formed.

end of the 60-ft coil was reached, a solder type coupling was applied right on the bench and the uncoiling of a second coil of copper tube continued. In cases where the sinuous coils were considerably wider than the bench, extension pieces were applied to accommodate the coils temporarily.

As a means of easily handling the completely formed coils, a light wood frame (Fig. 5) was constructed of 1-in. by 2-in. material. On the cross members of this frame were small blocks of wood which held the copper tube in proper alignment and spacing. After the bending had been completed, the coil was raised slightly and the frame was slipped under the coil on top of the bench. The copper tube was then wired to it temporarily in four places (Fig. 6). It was then an easy matter to handle the coil. In the case of the ceiling coils, two men could carry the frame with the coil on it, raise it to the scaffolding platform and temporarily wire it into position on the ceiling. As soon as this was done the copper tube was permanently wired in place. After the copper tube had been wired to its supporting members in a sufficient number of places the wood frame was taken down and the wiring operation was continued until completed.

It was found that the use of the wood frame greatly facilitated the handling of the coils after they were formed. It not only saved time but it eliminated the necessity of measuring the spacing of the rows of tubes, as the tubes were all properly spaced when they were placed in position.

Furthermore, forming the coils on the bench was found to be much easier and quicker than attempting to unroll the copper tube on the ceiling and bend it overhead.

A method of fabrication similar to that described above was used for constructing the floor coils. It was found, however, that in bending the ¾-in. copper tube a little work-hardening took place so that at the completion of the bending, the coils were not as flat as could be desired. In order to flatten the coils, each completed coil was placed on a portion of the concrete floor that had been poured and was suitable for traffic. In such cases the frame was on top of the coil as it lay on the floor. This was the reverse of the position of frame and coil when ceiling coils were being handled. In this way, blocks of wood could be used in hammering

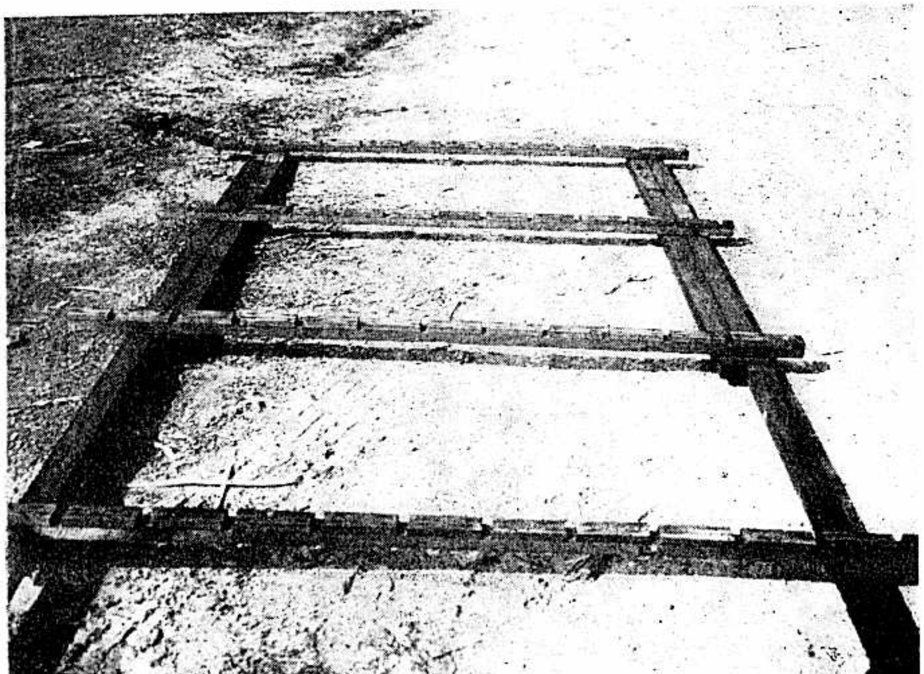

Fig. 5. Wood frame for ⅜-in. copper tube spaced 4 in. on centers.

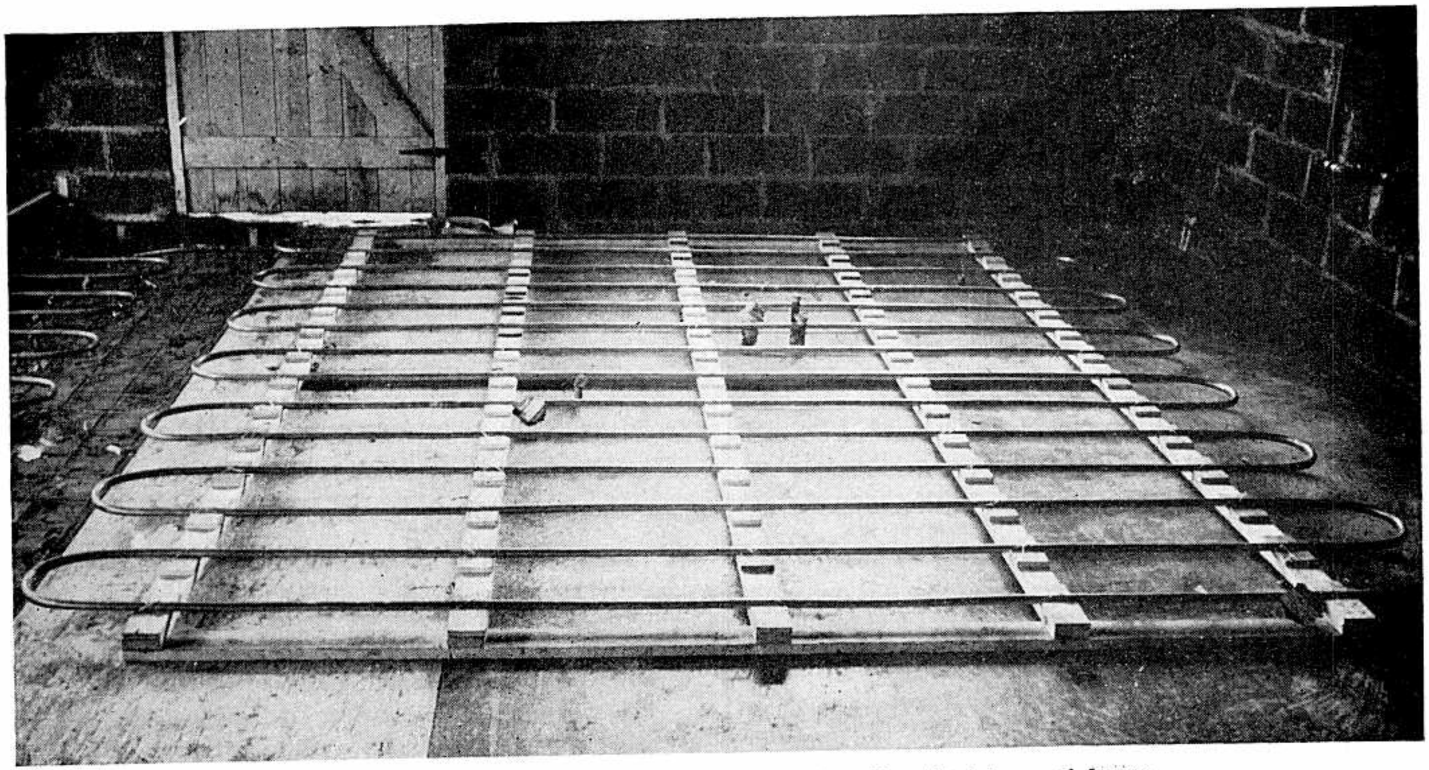

Fig. 6. ¾-in. copper tube on 9-in. centers temporarily wired to wood frame.

coils flat without damaging the copper tube in any way. When the coil was flattened it was transported to its proper location on the floor. When the coil was unwired from the frame, the copper tubes rested on insulated wire saddles (Fig. 7) that held them at the proper depth below the finished floor surface.

These saddles were devised for this installation as a means of assuring extreme accuracy in depth of bury for test purposes. Undoubtedly, other means of properly supporting coils in a floor slab can be devised, but in any case insulation should be provided between the coils and the supports to prevent undue heat loss through the supports if they are of material that has high thermal conductance value.

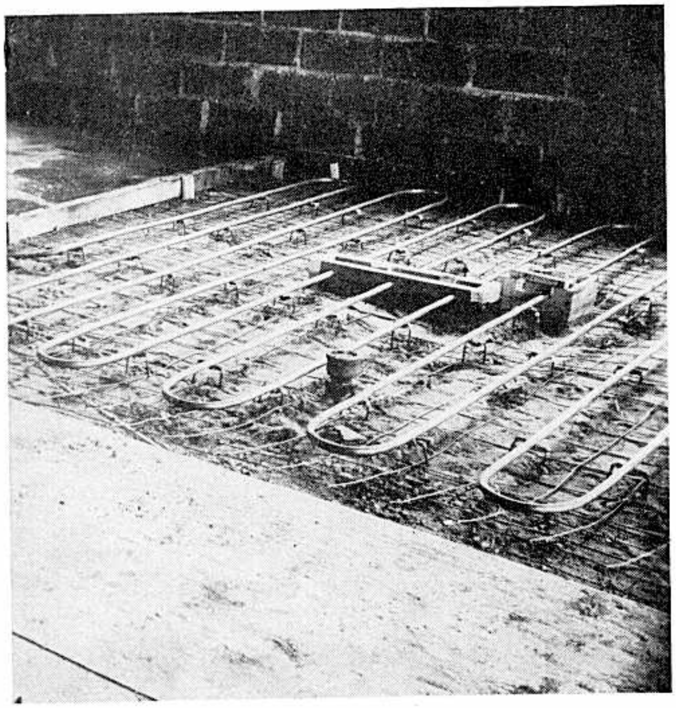

Fig. 7. Wire saddles support copper tube at desired distance below finished floor surface.

It should be noted that the wood discs referred to above, used for forming the return bends of the coil, will be limited as to radius by the size of the copper tube to be bent and by the center to center spacing. If the radius of the return bend is short and there is danger of the copper tube collapsing in the bending operation, metal sheaves already described should be used.

Soft temper copper tube can be bent by hand in its cold state on comparatively short radii, but when the radius is short, the entire circumference of the tube must be supported by the bending sheaves in order to prevent collapsing of the tube. In such cases the peripheral groove in each sheave must coincide with one-half of the outside surface of the tube in cross section so that the tube wall is supported around its entire circumference.

When forming the coils, a sufficient length of the straight portion of the tube should be left for connections to mains or branches. It has been found advisable in most cases to place all of the coils in their proper locations before the mains and branches are installed. By doing so, sections of the mains and branches can be made right on the bench by soldering the tees, elbows, or other fittings in their proper places.

Time can be saved by fabricating branch headers on a bench. This can be done in most cases where solder type fittings are used. All such header assemblies for the building described were bench fabricated. It was then necessary to make only the few remaining connections to the coils and ends of headers in their final location.

Radiant Heat with Copper Tubing –

Embedding Coils in Radiant Heating Panels

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This is the third of a series of articles covering the radiant heating installation at the metallurgical laboratory of Revere Copper and Brass Incorporated which will be used as both an actual heating system and a source of experimental data. This month the authors discuss plastering and suspension methods and point out some of the cost items to be considered.

THE erection of a new building to be used as a Metallurgical Laboratory by Revere Copper and Brass Incorporated, Rome, New York, and referred to in former articles in this series presented an excellent opportunity for experimental work with the three separate radiant heating systems that are installed. As the building is designed for daily occupancy results of such experiments should have greater practical value than similar experiments which might be conducted in a laboratory by the use of small test panels.

Considerable difference of opinion exists regarding the effectiveness of different methods of panel construction. This effectiveness of a given panel will theoretically depend, to a large extent at least, on the spacing of the tubes in the coils, the depth of bury behind or below the radiant panel surface, and the mean water temperature in the coil. While some theoretical studies have been directed toward the development of data relating to these points, there seem to be few published reports of such studies.

The purpose of this article is to describe methods of embedding radiant heating coils of copper tube in panels that are to be used to develop data by actual test rather than by theoretical calculations. It is hoped also that the information presented will be helpful to contractors in installing panel systems.

In the building referred to, $\frac{3}{8}$-in. Type L soft temper copper tube (actually $\frac{1}{2}$ in O.D.) has been used for the ceiling coils comprising the independent service heating system. Type K tube could, of course, have been used in place of Type L. The Type L tube was installed because at the time it was required it was more readily obtainable than Type K.

The ceiling in which the radiant heating panels are located is hung approximately 24 in., below a flat roof. The roof construction was designed to reduce heat losses to a minimum. The top or weather side of the roof is built up roofing. Below this is 1 in. of Celotex, 2 in. Gypsum plank, 1 in. air space, and 1 in. Celotex. This much of the structure is supported on I-beams and purlins. From these, heavy wire supports carry 2 by 2-in. angle irons spaced 36 in. apart parallel to the short dimension or ends of the building. The span is approximately 24 ft. Small steel channels $\frac{1}{2}$ in. high by $\frac{3}{4}$ in. wide are wired to the underside of these angle irons diagonally and spaced on 12-in. centers as in Fig. 1.

The copper tube used for the heating coils is wired to the supporting channels. All of these ceiling coils are of the sinuous type and the rows of tubes are parallel to the longitudinal sides of the building except in the case of one room where they are parallel to the ends of the building and at right angles to the longitudinal sides. It will be apparent that this construction was necessary only because of the hung ceiling. In residential work, the heating coils can be attached to supporting members by copper tube straps.

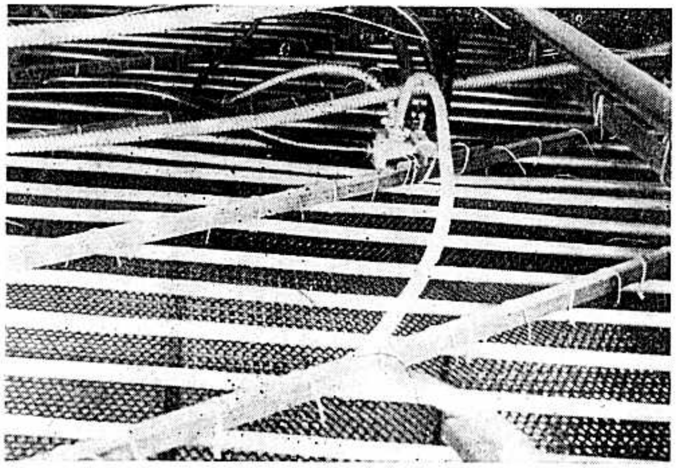
Fig. 1. View looking down above the hung ceiling showing angles, channels, and copper tube.

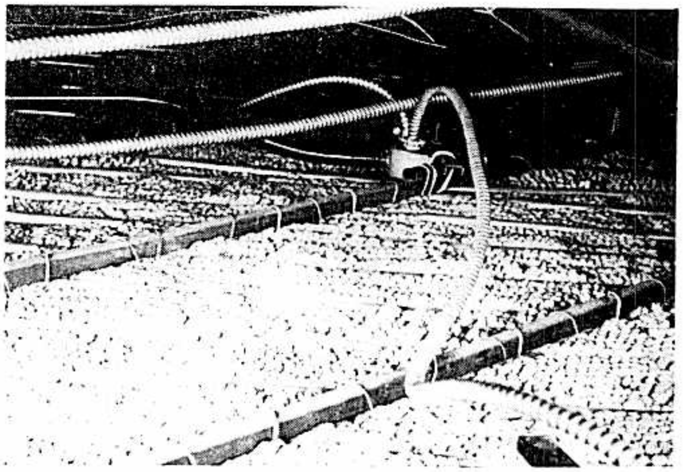
Fig. 2. Top side of hung ceiling showing penetration of plaster.

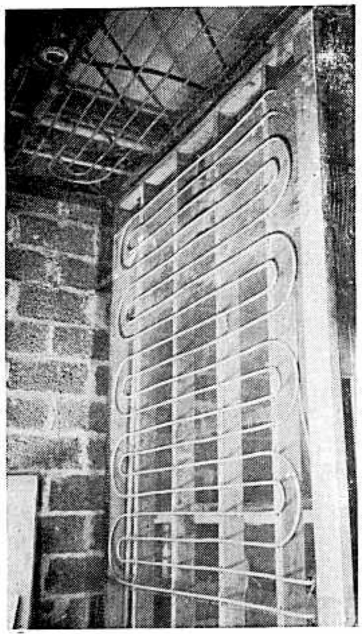

Fig. 3. Wall panel with copper tube coil on room side of metal lath.

Fig. 4. Scratch coat of plaster partially applied to wall panel.

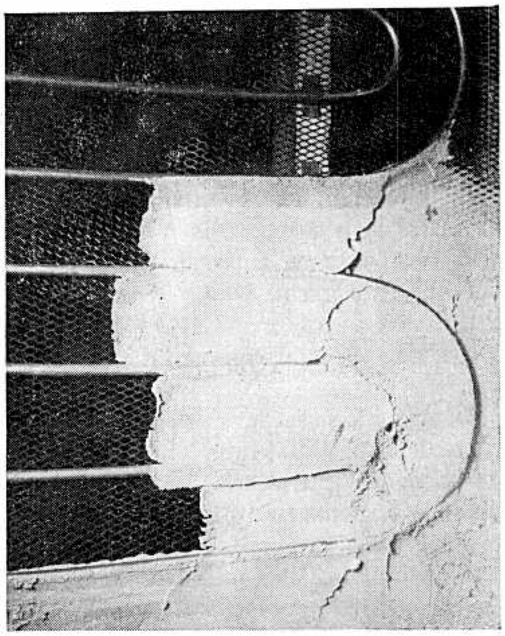

Fig. 5. Short trowel strokes are shown where scratch coat of plaster must be filled in between rows of copper tube.

An improved type is now available that snaps over the tube so that it stays in place without the necessity of holding it for nailing. Hard brass staples are also available.

After the copper tube had been wired in place and the system had been complete in every respect pressure tests were put on the system. The sequence of these tests to determine possible leaks in the system is very important with respect to other operations in the construction of the building. It is obvious that tests for leaks should be conducted before any plastering is done and, in cases where the copper tube is behind or on the top side of the metal lath, before the metal lath is applied. This procedure should be followed to avoid the additional expense that would necessarily be incurred if leaks in the system should develop after the piping system had been inclosed by other materials.

The first test on the system was made with compressed air at 100 lb pressure. The duration of this test was 72 hrs. An ordinary dial type pressure gage was installed in the line, with a cut-off valve on the inlet side of the gage. Leaks would, of course, be indicated on the gage and their exact location could be found by soaping the joints. The air test was applied first to permit the discovery of leaks before the system was filled with water. If leaks occur in a system during a water test it is generally necessary to drain the entire system in order to repair the leak. The joint should then be taken apart and both the tube end and the socket of the fitting cleaned before resoldering.

It has been found that in most cases imperfect joints are the result of improper cleaning. Careful cleaning of the inside surface of the socket of the fitting and the outside surface of the tube entering it is most important. It is suggested that where tube and fittings larger than 1 in. are used, both be pretinned before soldering the joint. It will also be found that time can be saved by making as many joints as possible on a bench.

After the air pressure test was completed, the system was again tested to 60 lb city water pressure for 24 hr. When the system was filled, the compressed air line at 100 lb pressure was again connected to it. This combined air and water test was conducted over a period of 48 hr.

When the tightness of the system with respect to air and water leakage was determined, expanded metal lath was applied to the underside of the copper tube used for heating coils. The metal lath was securely wired to the channels to insure tight contact between the metal lath and the copper tube. This is important so that the plaster as it penetrates the metal lath will make good contact with the copper tube in the coils with the minimum amount of plaster being used.

The plastering contractors engaged for this job had never worked on a radiant heating installation before. Ordinary gypsum plaster was used and the contractors were instructed to keep the plaster sufficiently moist so that the first scratch coat would penetrate the metal lath and in that way make good contact with the copper tube. The plasterers were instructed to apply the plaster in a normal manner as though there were no tubes above the metal lath. As the plaster penetrated the lath it tended to hug the surface of the tube as shown in Fig. 2. There was sufficient space between the hung ceiling and the roof to enable a camera operator to take photographs on the top side of the metal lath and hence show the amount of penetration of the plaster (Fig. 2). Judging from many observations, the contact of the plaster and the copper tube was satisfactory.

It may be obvious that in panel construction of this kind it is not necessary for the heating coils to be completely embedded in the plaster. If, at least, the lower half of the copper tube is in contact with the plaster, a sufficient portion of the tube will be embedded to produce good heat transfer.

By placing the copper tube on the top side of the metal lath an unobstructed plastering surface resulted. This enabled the plasterer to apply his plaster just as though no radiant heating coils existed. On the completion of the work, the plastering contractors stated that in their opinion no greater time was required to plaster the ceilings where the copper tube was located on the top side of the metal lath than if there had been no tube.

No insulation has been installed on the top side of the metal lath as there is no ventilation or air movement in the space between the hung ceiling and the roof and also because very little heat loss is expected in the reverse direction from the heating panels due to the low thermal conductivity of the roof construction.

Because of conjecture as to the effect of the different types of plaster that might be used for radiant heating panels, acoustical plaster was applied to the ceiling of one of two rooms that are identical except for the type of plaster on the ceilings. Both of these rooms will have radiant heating coils installed as described above. The acoustical plaster was applied over the scratch coat under the supervision of a representative of the plaster manufacturers. It is the intention to make comparisons of the heat output from the ceiling panels in these two rooms, one having a standard smooth coat of plaster and the other the more porous acoustical plaster. Results of these tests will probably be published at the end of the approaching heating season and we believe should be of considerable interest.

A room on the north east end of this building is L-shaped in plan. In the narrow portion of it a window, approximately 6 ft by 6 ft is located. Directly opposite this window, a wall panel containing a sinuous copper tube coil is located in order to offset the excessive heat loss that will undoubtedly occur in this portion of the room. This wall coil is in addition to the ceiling coil.

This size and spacing of the copper tube in this wall panel is exactly the same as that in the ceiling panels. The supply connection to this wall coil is at the bottom with the return connection near the ceiling, the bottom of the coil being located approximately 4 ft 6 in. from the floor. In contrast to the ceiling coils, however, the copper tube in this wall panel is installed on the room side of the metal lath (Fig. 3) and this wall panel is in a partition having occupied rooms on either side in which the air temperature will normally be approximately the same. This method of construction was used for purposes of comparison with panels where the coils are located on the top side of the metal lath. It is also the intention to determine the rate of heat flow through the partition to the plastered wall on the opposite side of the panel.

Some significant facts came to light during the plastering of the surfaces of this room. The plastering on the ceiling seemed to be normal in every respect, that is, particularly as to length of time required, ease of application, and amount of material used. The plastering of the wall panel was very much slower and apparently required more material than the ceiling panels. The amount of plaster required when the tube coils are on the top or back side of the metal lath is the same as if no tube were installed. On the other hand, when the tube coils are below or on the room side of the metal lath, the scratch coat of plaster must first be applied between the rows of tubes to a thickness slightly greater than the outside diameter of the tube and then the entire surface smoothed and scratched (Fig. 4). This will require at least $\frac{5}{8}$ in. of plaster if $\frac{3}{8}$-in. copper tube is used, which indicates that the scratch coat is considerably heavier than is normally required. This additional thickness of the scratch coat plus the normal thickness of the brown coat and the finish coat will result in a total thickness of plaster of at least 1 in. This means that at least 33-1/3 % more plaster is required for the scratch coat when the copper tube is on the under side or room side of the metal lath. The total thickness of plaster is thus greater in this type of panel construction. Because of the comparatively close spacing of the tubes (4 in. on centers) very short strokes of the plasterer's trowel were necessary as well as much greater care in applying the plaster. The short strokes of the trowel referred to can be plainly seen in the accompanying illustration (Fig. 5) and these are in contrast to the long sweeps of the trowel that were possible when plastering the ceiling panels (Fig 6) or other plastered surfaces.

The relative time required for plastering the wall and ceiling panels was shown very plainly in moving

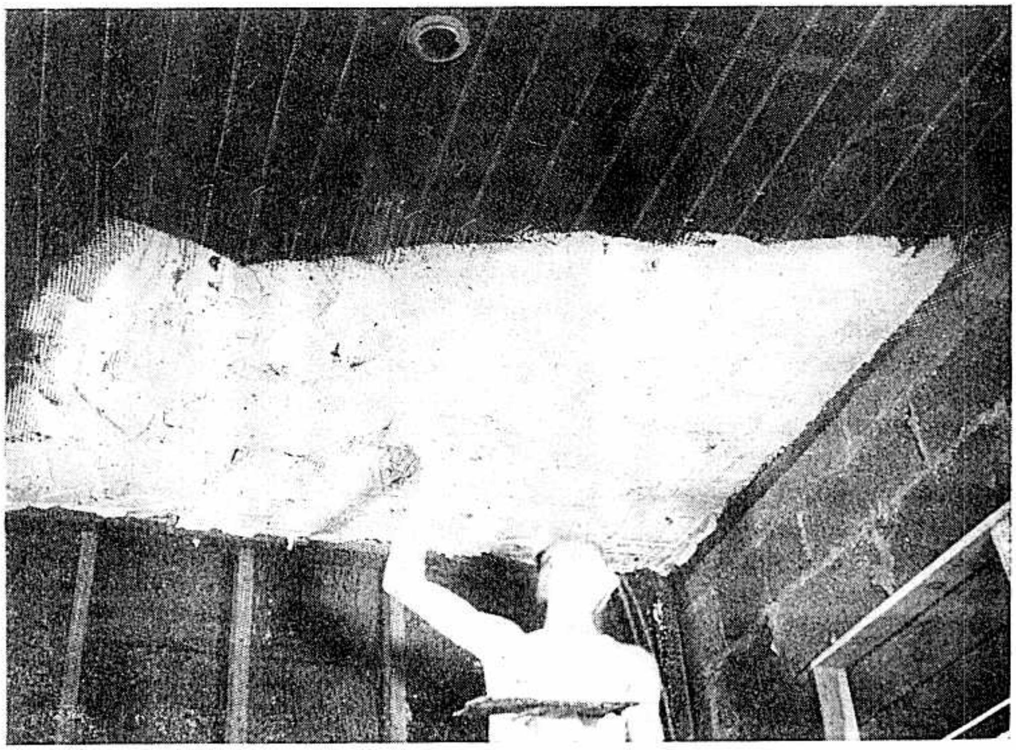

Fig. 6. Applying the scratch coat of plaster with copper tube coil on top side of metal lath.

pictures that were taken in the building during the plastering. Where many panels are concerned or where the panels are comparatively large in area the additional plastering time for coils on the room side of the metal lath might be significant in the total cost of an installation. This additional cost is directly attributable to the method of installing the coils. The actual timing of the plastering was not recorded in this building because of the fact that there was only one wall panel available for comparison with ceiling panels and it was rather small in area. It was the opinion of the plastering contractor that it would take twice as long to apply the scratch coat of plaster when the copper tube is below or on the room side of the metal lath as it would if the tube were on the reverse side of the metal lath.

Floor Coils

A description of the floor coils appeared in the first paper in this series. A 6-in. coarse gravel fill was levelled and tamped as a base. On this was laid 6 in. square reinforcing road mesh (Fig. 7) which was raised from the ground approximately 1 in. while the concrete was being poured. The floor coils were tested for leaks by the same method as used for the ceiling coils.

The tube coils were supported on insulated wire saddles to produce different depths of bury as described in a previous article. The pouring of the concrete over the grid type coils was done first. After the concrete on that half of the floor had set, pouring was resumed over the sinuous coils in alternate sections. A 1-2-4 concrete mix was used for the floor slabs.

Low sectional runways (Fig. 8) were used by the contractors for pouring. The concrete was dumped out of wheelbarrows on the end of the runway and spread with shovels. As the floor coils were to be used for experimental purposes in this case and their spacing and relation to the finished floor surface was important, the contractors were careful not to disturb the tube location when pouring and spreading the concrete. Such precautions would, of course, be unnecessary where slight variations in tube locations are relatively unimportant. Observation of the pouring operation from a low runway will show that there is no possibility of damage to copper tube while pouring concrete over the tube in a floor slab. It was the opinion of the concrete contractor that there should be no greater expense in pouring a concrete floor slab in which radiant heating coils are embedded than for a slab without coils.

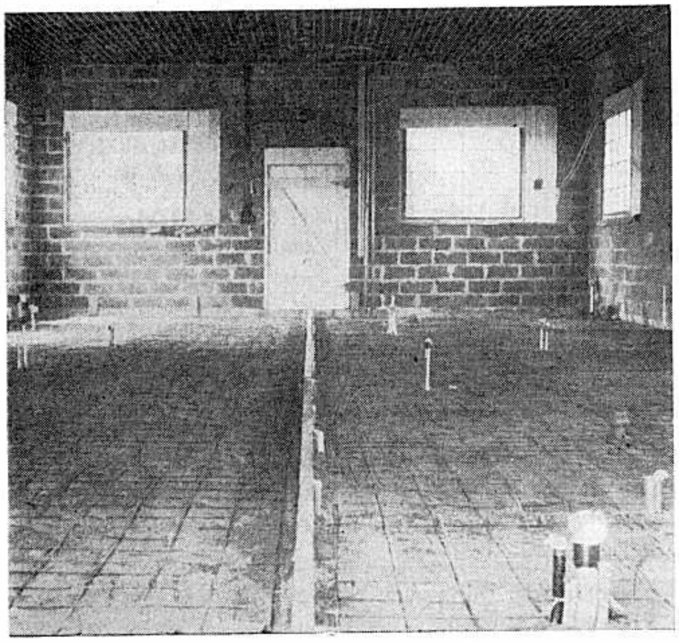

Fig. 7. Gravel fill and reinforcing mesh before installation of coils.

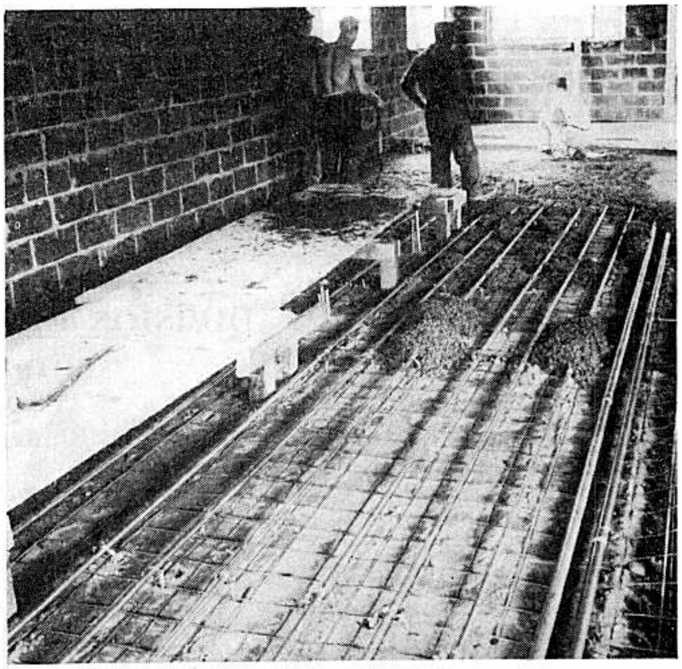

Fig. 8. Sections of runways are removed as pouring progresses.

Both the plastered ceiling panels and the concrete floor slabs were allowed to cure for a period of four weeks before hot water was introduced into the coils. For the first week, the water temperature at the boiler was not allowed to exceed 90F and after that time the water temperature may be increased depending on requirements.

To Be Determined

Subsequent articles covering instrumentation and test results will be published as the work progresses.

In the case of this installation it is too early to arrive at any conclusions as to the relative effectiveness of the two types of panel construction described. The authors are led to the opinion, however, that the embedment of heating coils directly in the plaster may result in streaking on the panel surface and the panel surface temperatures will not be as uniform as though the heating coils were located above or behind the metal lath. This theory is substantiated by reports of experimental studies.