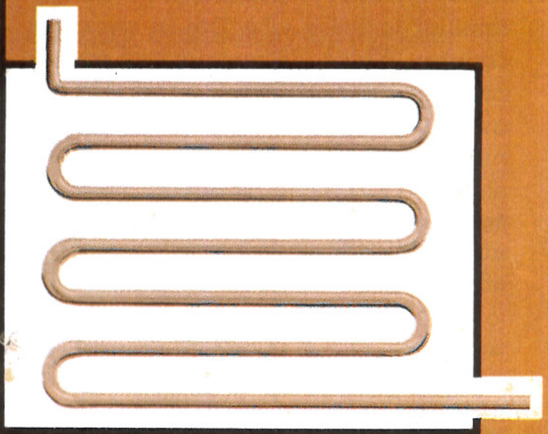
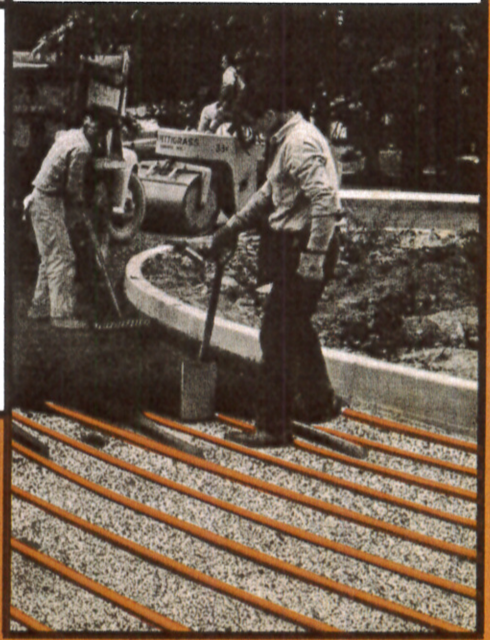
REVERE PUBLICATION NO. ABP-115

copper tube snow-melting systems and their design

—utilizing all the advantages of Revere Copper Water Tube





REVERE

developed by the Revere engineering staff at its Research and Development Center at Rome, New York

the advantages a copper tube snow-melting system makes possible:

The problems that arise with the onset of the snow season are all too familiar to those who live in snow country. Walks, driveways and access areas can become blanketed overnight with heavy, wet snow that makes traffic difficult or brings it to a standstill. On other occasions, these same areas can become covered with a glaze of ice that makes travel across them extremely hazardous. ○ ○ ○ The modern answer to these problems is the installation of a copper tube snow-melting system, hydronically operated. No other method of snow removal can do the job so completely, so efficiently. Scraping the area with a plow may push the snow to one side—but it cannot guarantee the immediate removal of underlying patches of ice which could still make travel hazardous. This is particularly true on steep grades. Pushing the snow aside into high, adjacent banks may require subsequent trucking of the snow—either to regain essential space or to remove an ever-increasing cause of snow drifting down into the cleared area. ○ ○ ○ A hydronic, copper tube snow-melting system takes care of *all* these problems: It melts the snow as fast as it falls, even up to a rate of two inches of snowfall per hour. In addition, it causes the resulting moisture to evaporate as quickly as it forms. It thereby eliminates both high banks of snow and accumulations of ice adjacent to the snow-melting area.

these lasting dividends:

The moderate operating cost of the system is readily justified by the savings it makes possible:

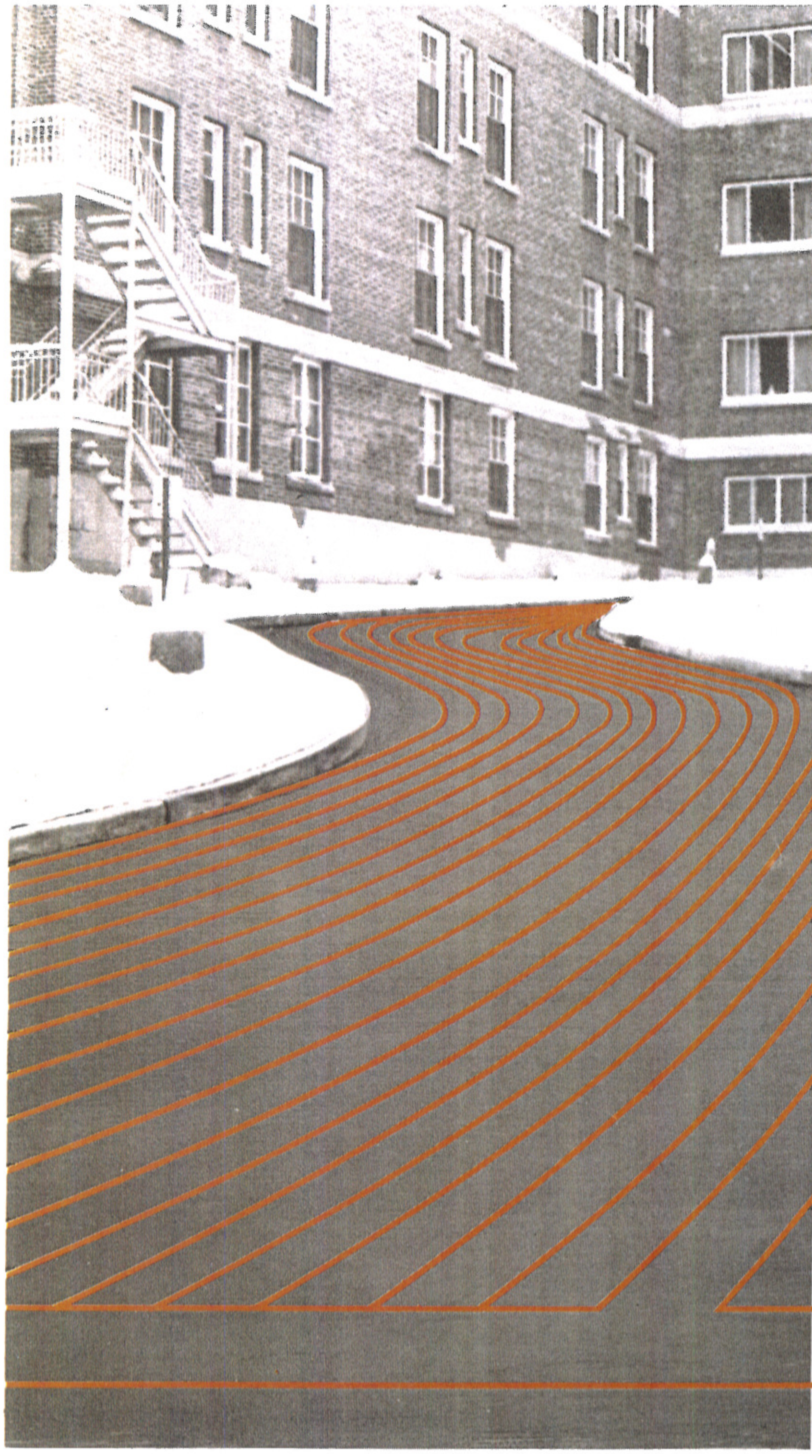
- the elimination of labor costs for physical snow removal
- the reduction of costly maintenance of floors and carpets soiled by tracked-in snow, slush and salt
- the virtual elimination of damage suits resulting from injury to persons slipping on icy walks in front of business establishments, hospitals or public buildings

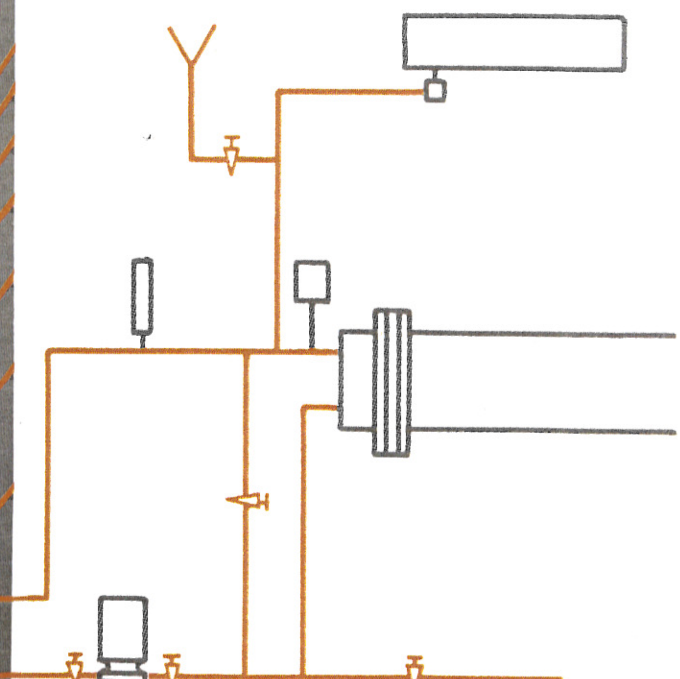
the basic operating concept:

A copper tube snow-melting system, hydronically operated, is basically a designed arrangement of copper water tube coils embedded in concrete or blacktop, approximately 2 inches below the surface. These coils are either supported by steel reinforcing rods, or strapped to a concrete slab, or fastened down to a crushed stone or gravel base. Through these coils—formed in either a grid or sinuous pattern (or combination)—a moderate-temperature solution of water and permanent-type antifreeze is circulated. The heat of this solution is transferred through the copper coils to the concrete or blacktop embedment. This heat not only melts the snow and ice on the surface of the embedment—but causes the resulting moisture to evaporate. ○ ○ ○ The system can be operated either continuously or intermittently. If operated continuously, the system starts melting from the first falling of snow and circulates at a lower fluid temperature than that required by intermittent operation. If operated intermittently, the system is turned on when snowfall is *predicted*—to compensate for the time lag involved in bringing it up to full operation. The source for heating the solution can be either a heat exchanger (operating off a main boiler) or a separate boiler. A circulator, in the line, keeps the solution continually in motion. ○ ○ ○ For the coils, themselves, Revere Copper Water Tube is particularly suited. The primary reason: its unusually high thermal conductivity. Also other inherent characteristics: its long lengths (fewer joints)...its solderability (easier, quicker joining)...and its ease of bending (reduction in number of fittings and joints).

As shown in the phantom illustration at right, most of the system is "hidden" under the pavement. It is for this reason that it is essential that the entire system—from coil design to pressure-temperature gauge—be correctly designed in every detail.

section





1

ever-widening scope of application

Copper tube snow-melting systems are today being designed and specified for the clearing of a wide variety of heavily traveled areas. In most cases, these installations prove themselves virtual necessities: to keep approaches, steps, and all sorts of business areas free from the hazards and interruptions so quickly caused by snow and ice.

two methods of operation

In all these installations, two methods of operating the system are available. The choice, in many cases, depends on the size and location of the area to be cleared and the frequency of snow storms:

- **continuous operation:** The system is switched ON at the first fall of snow and remains continually activated until Spring. If, desired, an outdoor thermostat may be installed to cut off circulation when the air temperature reaches 35 F or higher.
- **intermittent operation:** The system is switched ON each time a snow storm occurs or is predicted. Response is achieved within an hour.

rate of operation

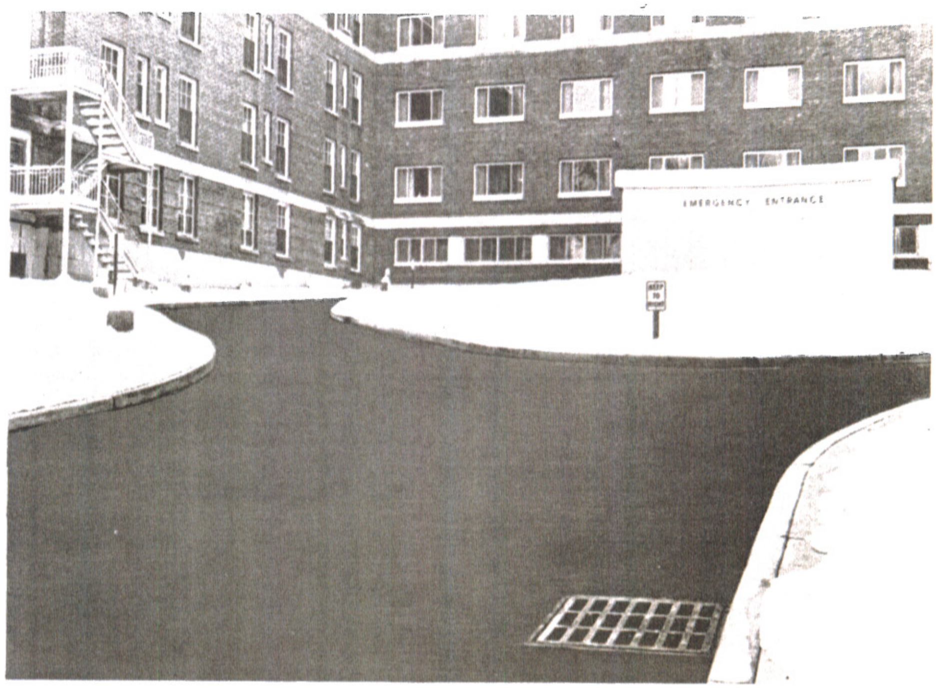
Once in operation, a properly designed system is capable of continually melting snow falling at the rate of from one to two inches per hour—and of causing the resultant moisture within the confines of the snow-melted area to evaporate. To a correctly designed system, even *drifting* snow does not present a problem.

sidewalk areas

in front of stores, office buildings, banks, hospitals, churches, schools, public auditoriums—wherever pedestrian traffic is heavy

driveways

to warehouse entrances, hospital emergency entrances, loading platforms, drive-in teller booths, commercial buildings



parking areas

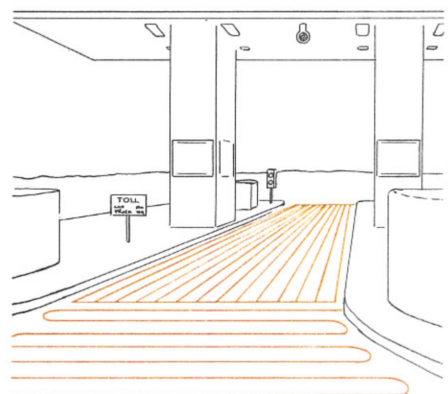
in confined downtown business districts (where snow would have to be trucked away), also in parking facilities for banks, hospitals

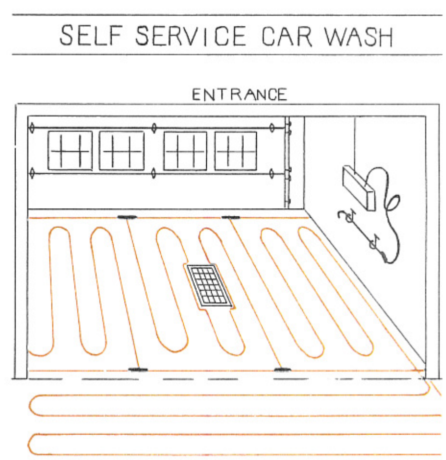
steps, ramps

leading to office buildings, churches, schools, or other places of public assembly—where the safety of pedestrians is critical

other strategic areas

Each year the scope of application broadens. New enterprises can now be designed *without* provision for physical snow removal. For example, plaza toll booths and self-service car-wash establishments are increasingly resorting to this means of removing snow and preventing ice formation. Larger areas—such as airport ramps and shopping malls—are now being considered as desirable applications of this inconspicuous and effective method of snow and ice removal.



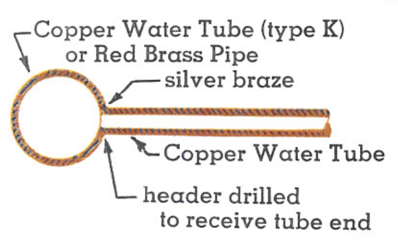


the importance of correct coil design

The efficient, low-cost operation of a hydronic, copper tube system is dependent, primarily, on the arrangement and capacity of the coils. It is therefore important that the pattern of the tube coil passes conform to the contour of the area to be protected and to its traffic conditions.

As shown at right, there are three basic patterns of coil arrangement: grid, grid-sinuous and sinuous. Large, irregular areas generally require a combination of at least two types. In all cases, the tube coil passes are fabricated from Copper Water Tube (either type K or type L) because of its ease of bending and its high heat conductivity.

grid coil headers



The supply and return headers—connecting all tube passes—may be either Copper Water Tube, type K☐, or Red Brass Pipe. Through the wall of the headers, holes—equal to the outside diameter of the tubes that form the passes—are drilled. Then, the ends of the tube passes—cut square, cleaned and fluxed—are so inserted that they are flush with the inside surface of the header. They are then brazed in place.

☐ When Copper Water Tube, type K, is used for the header, a special tool should be used to pull a collar out from the tube wall to provide greater bonding area.

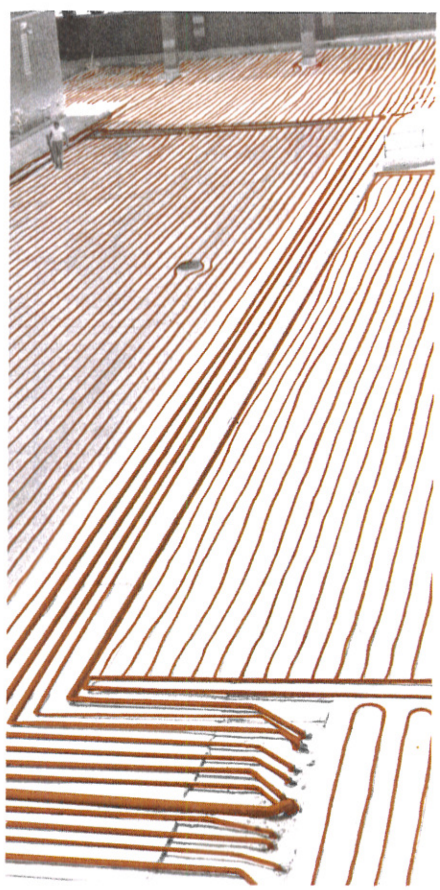
for large rectangular areas

For rectangular areas more than 8 feet in width—such as long driveways, ramps, loading platforms, wide sidewalks—the coils are usually formed either in a plain grid pattern or in a grid pattern with sinuous passes.

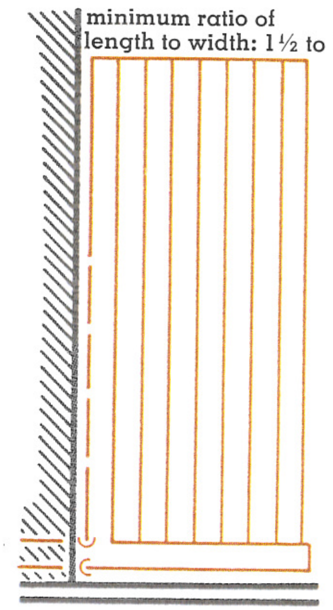
In either arrangement, the resistance to flow is divided among a number of *parallel* circuits. Thus, these systems have certain advantages over systems of a completely sinuous arrangement:

- lower hydraulic resistance
- tubes of smaller diameter
- pumps with lower head capacity

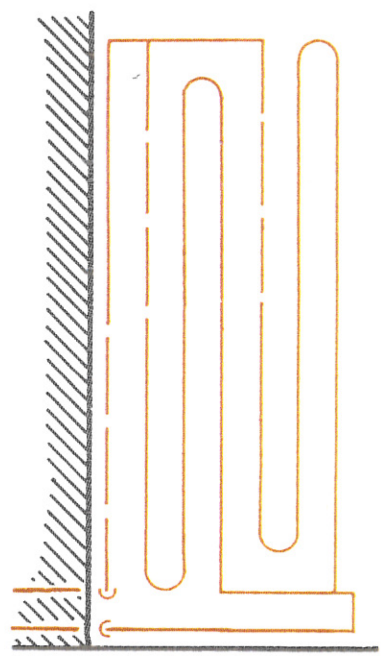
To minimize the possibility of short circuiting of flow through a portion of the coil (either grid or grid-sinuous), the length of tube passes between headers should be at least 1½ times the length of the header.



grid coil system



combination grid and sinuous coil system

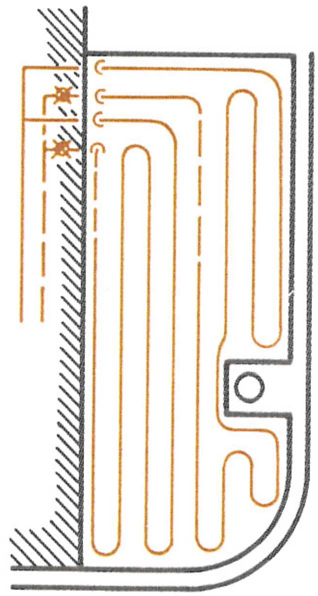


for small or irregular areas

For areas under 8 feet in width or decidedly irregular in contour, the coils are fabricated in a sinuous pattern to fit the area. These coils—each fabricated from a long length of Copper Water Tube and usually available in lengths to 100 feet may be connected to a common supply header. However, if the coils are of unequal length, each coil should have a separate return with its own balancing valve.

Because individual coil lengths in a sinuous system tend to be longer than the tube passes in a grid system, tube size must usually be larger—to compensate for the increased hydraulic resistance. However, a sinuous coil circuit requires fewer header connections.

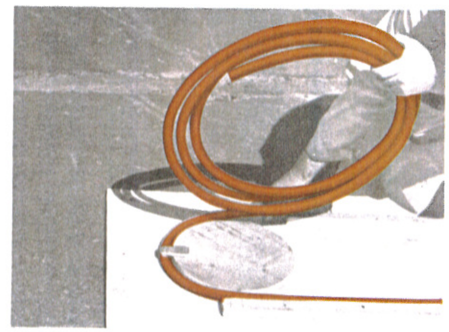
sinuous coil system



bending limitations of Copper Water Tube

Experience has shown that, for the successful bending of Copper Water Tube, certain minimum bending radii must be observed for each size.

To assist in making accurate, smooth bends with soft-temper copper tube to a given radius, wood forming discs are often used. The discs are nailed in place on a suitable wood surface (such as plywood). Around these discs, the tube is bent in 180-degree return bends.



The location of the discs at the proper distance between the return bends permits the tube to be quickly unrolled back and forth in straight lines between the bends—into the pattern required for the coils.

The table below shows the required diameter of discs for bending soft-temper Copper Water Tube, both type K and type L, on 9- and 12-inch spacing:

tube size (nom) in.	spacing of tubes between rows (c to c) in.	diameter of discs required in.
½	9 12	8⅜ 11⅜
¾	9□ 12	8⅛ 11⅛
1■	12	13⅞

□ for type K only

■ 1-inch tube should not be bent around wood discs on less than 15 inches (c to c); extend return bends sufficiently beyond 180 degrees to permit spacing of tube passes on not more than 12 inches (c to c), the maximum recommended spacing. If desired, tube may be bent on 12 inches (c to c) with the use of a portable gear-driven bender.

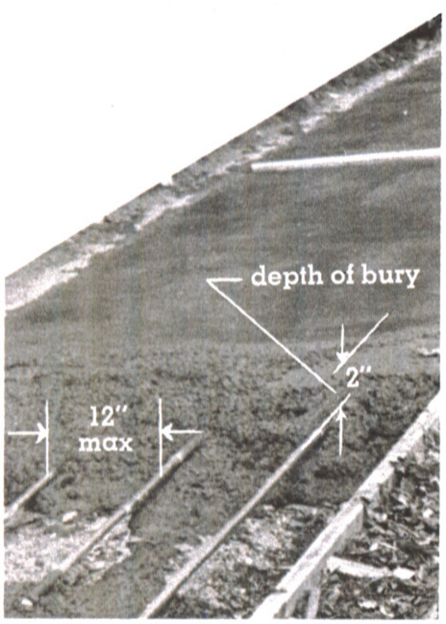
3

the support and embedment of the coils

As shown at right, there are three basic methods of supporting and embedding the coil circuits. The choice is determined, in good part, by the character, size and condition of the area to be protected, also by the materials and labor available.

In all cases, the coils are embedded in either concrete or blacktop. In concrete embedment, the recommended depth of bury of the coils is 2 inches from the top of the tube to the finished surface. In blacktop, the depth varies from 1½ to 2½ inches, depending on the tube spacing.

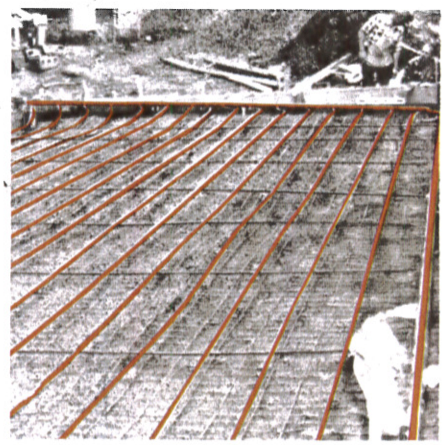
It is recommended that the outermost row of tube be installed 6 inches from the perimeter of the desired snow-melting area. Within the coil area itself, the spacing of the tubes that form the passes should never exceed 12 inches.



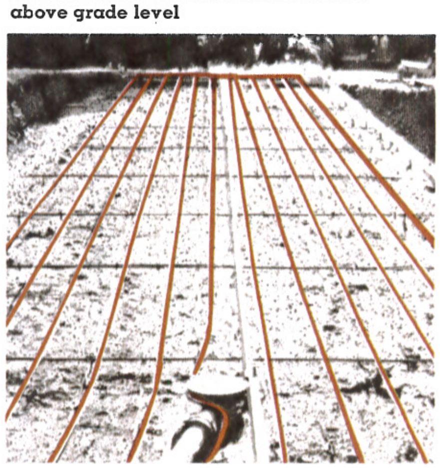
one-pour concrete

In this one-pour concrete operation, the tube passes are wired to transverse steel reinforcing rods preplaced on grade level, at right angle to the tube. These steel rods, usually ½ or ⅝-inch, are spaced 6 to 8 feet apart. To these rods, the tube passes are wired on a 12-inch (center to center) spacing. Then, the transverse rods are elevated above grade level— by wiring them to short vertical rods driven into the ground and spaced 3 to 4 feet apart. The upper surface of the tube passes is thereby raised to a level of 2 inches below that selected for the finished surface of the slab. The concrete is then directed between the rows of tubes to support and embed the tubes in one operation.

coils wired to reinforcing steel transverse rods at grade level



coils wired to transverse rods elevated above grade level



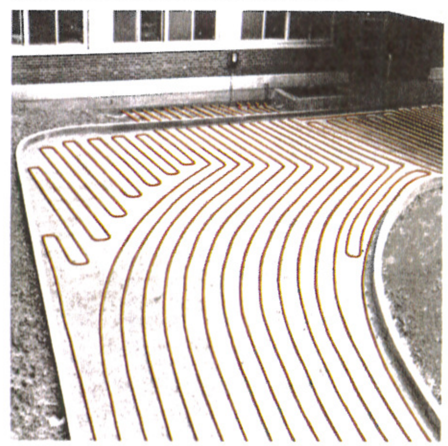
two-pour concrete

or concrete base and blacktop cover

In this method, the base slab of concrete is first poured. After it sets, the rows of tube passes are strapped securely to its surface at intervals of 6 to 8 feet; return bends are given additional securement. This is followed by the second pour—either of concrete to a depth of 2 inches above the top surface of the tubes, or of blacktop compacted to a depth of at least 2 inches over the tubes.

Tubes of larger size, such as headers and mains, can likewise retain this 2-inch depth of bury—by recessing the base slab to accommodate them.

coils strapped to base pour concrete



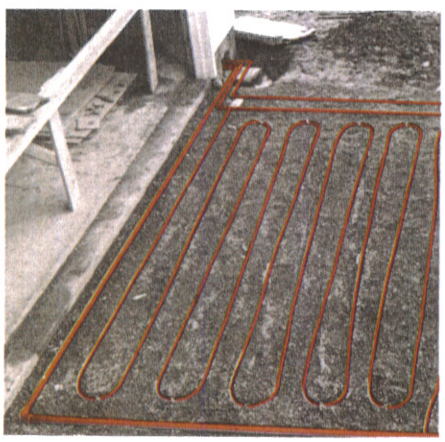
embedment of coils in second pour

blacktop cover on compacted base

In this method, the tube passes are securely fastened down over a base of either fine crushed stone or gravel by J-hooks driven into the ground at intervals of 6 to 8 feet. Return bends are given additional securement. Then, blacktop is compacted over the tubes to a minimum depth determined by the spacing of tubes: 1½-inch depth for 9-inch spacing; 2½-inch depth for 12-inch spacing.

Experimental tests and job experience have demonstrated that, once the tube has been embedded, it does not suffer damage from the weight of either the heavy roller used during compaction or normal vehicular traffic.

coils fastened to base by J-hooks



embedment of coils in blacktop

4

the placement of expansion loops

Under no circumstances should the Copper Water Tube be run directly through a concrete slab expansion joint. Wherever a joint does occur, an expansion loop—either in bent form or made up with fittings—should be dropped in a vertical plane beneath the joint. And it should be wrapped in its entirety with either foamed plastic or flexible rubber tube insulation.

In a one-pour installation, each expansion loop should be completely wrapped *prior* to the pouring of the concrete.

In a two-pour installation—because the coils are not secured in place until after the base pour has set—it is necessary to fabricate, pre-place and wrap the loops prior to the first pour. Not only should each loop be completely wrapped—but each vertical leg should be stubbed sufficiently above the base pour level to permit easy cut-off later, for connection to the coil.

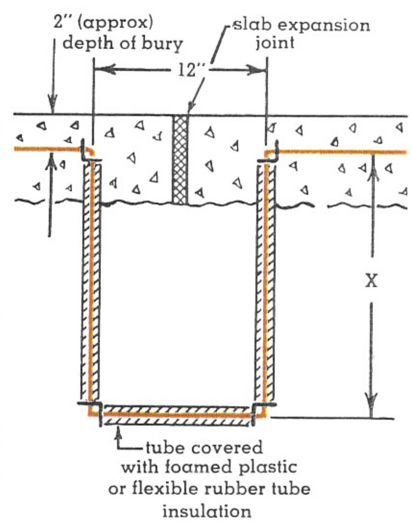
The number of loops is materially reduced by limiting the crossings of construction joints to mains and the few tube passes in long, narrow areas. Grid coils, with their multiple tube passes, should generally be located within areas *not* traversed by construction joints.

Experience has shown that optimum simplicity of installation results when expansion joints in concrete slabs are spaced 40 to 60 feet apart. Layouts, however, can be designed to accommodate lesser spacings, if desired.

If a tube passes from the edge of a concrete slab through an abutting curb or building wall separated from the slab by an expansion joint, the tube should be sheathed with flexible foam insulation. This insulation should be the full thickness of the curb or wall—and should extend within the slab about a foot back from its face.

proper design of expansion loop in concrete expansion joint

using either bent tube or straight tube with fittings



depth of loop recommended

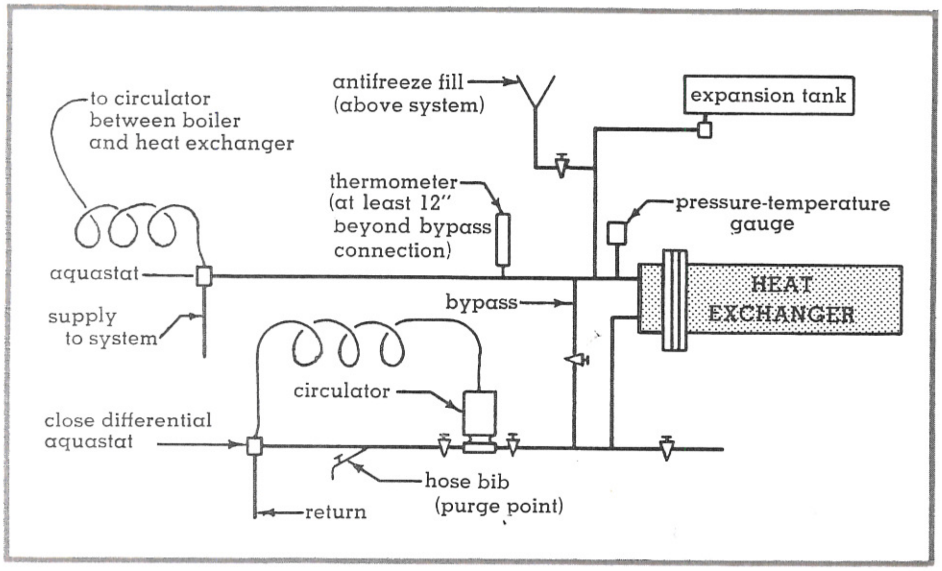
tube size (nom) in.	depth of loop, X in.
¾	12
1	12
1¼	15
1½	18
2	24
3, 4	36

5

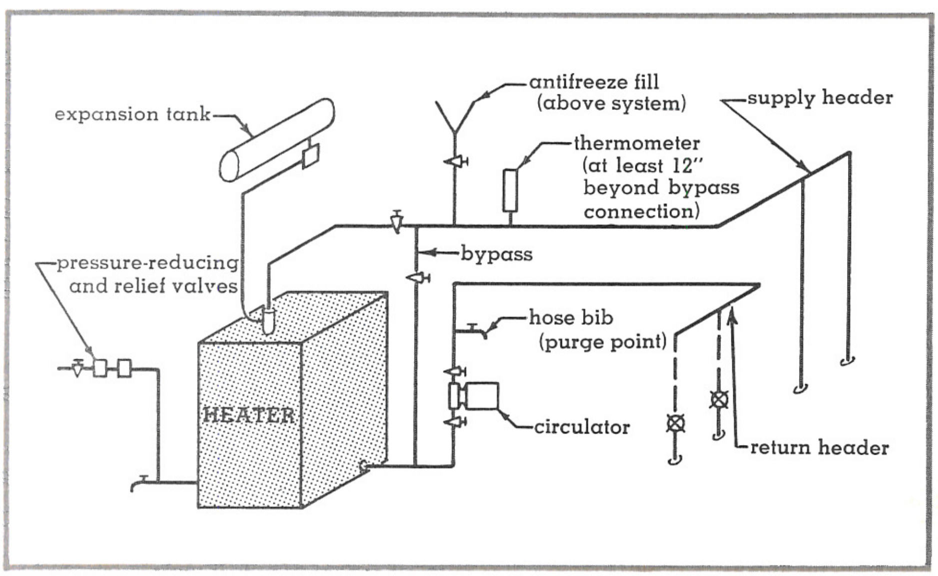
the provision for adequate heat

Two sources for furnishing heat to a hydronic snow-melting system are available. The choice is generally influenced by the size of the installation and the equipment available. Below are schematic details of the connections required by each type of heat source.

from heat exchanger: operated off main boiler in larger commercial buildings where the boiler has sufficient capacity to handle the snow-melting heat load—since heating load is only at partial design level



from separate heater: generally preferable for installations involving residences and smaller buildings, or where the existing boiler on larger buildings lacks the additional capacity necessary to handle the snow-melting load



6

the designing of the complete system

These five steps are intended as a guide in designing a system that is adequate in its capacity and efficient and low-cost in its operation:

1 determine design input:

for large, commercial systems, with continuous or intermittent operation:
recommended: 200 Btu/hr/sq ft

for residential or small commercial systems, with intermittent operation:
recommended: 150 Btu/hr/sq ft
minimum: 100 Btu/hr/sq ft

2 select coil design:

For each area, select type of coil (grid, grid-sinuous or sinuous) most suitable for shape of area. Then, select size of tube—according to length and spacing of passes, design input and type of embedment:

tube size in.	spacing of passes (c to c) in.	length of tube passes max, ft at 100 Btu/hr/sq ft	at 150 Btu/hr/sq ft	at 200 Btu/hr/sq ft
in concrete embedment				
½	12	100	80	60
¾	12	250	180	120
1	12	400	320	240
in blacktop embedment				
½	9	120	100	80
	12	100	80	60
¾	9	280	210	150
	12	250	180	120
1	12	400	320	240

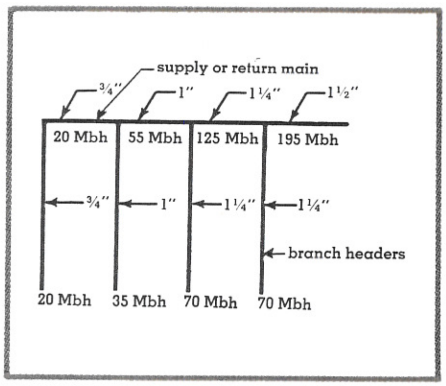
3 locate and size mains, headers:

Size the supply and return mains from the heat source to each snow-melting area, also all branch headers—on the basis of the heating load in Mbh (thousands of Btu per hour) of the area each serves. (The heating load of any area is the number of square feet served by the coil multiplied by the design input per square foot—100, 150 or 200 Btu/hr/sq ft—divided by 1000.)

The size of mains or branch headers required by various heating loads can be easily determined:

heating load Mbh	main or header size, in.
30 or less	¾
30 to 60	1
60 to 130	1¼
130 to 200	1½
200 to 380	2
380 to 630	2½
630 to 1100	3

example of sizing of main (either supply or return) and its branch headers



4 determine size of circulator:

Establish performance requirements of circulator according to required delivery rate (in gallons per minute) and the resistance of the longest circuit (in feet of head). These two values are readily determined:

- gallons per minute = total heating load in (Mbh) divided by 8.3
- feet of head = length of longest circuit (supply main + return main + coil length in feet) multiplied by .035

The resistance is based on hydraulic characteristics of a solution of ethylene glycol and water.

With these two values determined, the proper size of circulator may be selected from performance curves published by the circulator manufacturer.

5 determine size of boiler or heat exchanger:

Net rating of boiler or heat exchanger selected should not be less than the total heat load of the system.

7 the placing of the system in operation

calculate capacity of system:

First, determine the measured length of all sizes and types of tubes in the coils, headers and mains. From these values, calculate their capacities in gallons:

tube capacity

tube size (nom) in.	Copper Water Tube capacity, gal per ft	
	type K	type L
½	.012	.012
¾	.023	.025
1	.040	.043
1¼	.063	.065
1½	.089	.093
2	.156	.161
3	.344	.354
4	.606	.623

To their combined capacity, add the capacity of the heat exchanger or boiler in gallons. This gives the *total* capacity of the system.

fill system with antifreeze solution:

A solution of water and ethylene glycol is recommended (in a concentration of 40 to 50 percent by volume). Care should be exercised that the solution is thoroughly mixed within the system before the onset of cold weather.

adjust temperature of supply fluid:

First, allow the system to operate two or three hours—to reach equilibrium conditions. Then, set the supply fluid temperature according to the method of operation used:

for intermittent operation: usually set to operate at about 120 F...should not exceed 130 F for concrete embedment, nor 140 F for blacktop embedment.

for continuous operation: usually set to operate at 90 F minimum for concrete or blacktop...for severe weather conditions, upward adjustment of supply fluid temperature to 100 F or 110 F often necessary.

8 maintaining the efficiency of the system

It is important that the entire system be kept at high operating efficiency at all times — with continuous, uninterrupted circulation in all circuits and with antifreeze solution at adequate strength. The following two procedures are therefore recommended to check or correct these two sources of possible deficiencies:

to restore circulation:

Should entrapped air cause the circulation in any one circuit to fail, its circulation is easily restored: Simply close the balancing valves in all other circuits of the system. Allow the circulation to occur only through the circuit containing the entrapped air. This forces the entrapped air back into the heater and into the expansion tank. Then, to restore operation of all the other circuits, simply reopen their balancing valves.

to test antifreeze solution:

Each year, prior to setting the system in operation for the snow season, the antifreeze solution should be tested to determine its strength. In order to obtain a representative sample, this testing should take place after the solution has been circulated for a brief period. The degree of protection is determined by the percentage of ethylene glycol in the solution:

solution (by volume):		protection:
ethylene glycol %	water %	freezing point, F
32.5	67.5	0
38.5	61.5	—10
44.0	56.0	—20
49.0	51.0	—30

how Revere works with architects, designers, contractors

To assure the correct designing of hydronic, copper tube snow-melting systems—and their continuous, trouble-free, low-cost operation—the resources and experience of the Revere organization are available to architects, designers and contractors. Consequently, for assistance in developing a system for any type of area, it is recommended that contact be made with the local Revere office while the plans are still on the drawing board. ○ ○ ○ A building products specialist will then analyze the entire project—and, if necessary, enlist the services of the Building Products Advisory Service of the Revere Research and Development Center at Rome, New York. This Service is staffed by technical specialists who not only have pioneered in the development and designing of copper tube snow-melting systems—but who have accumulated many years of experience in their installation and operation. ○ ○ ○ Simply contact the Revere office in your locality....

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New England Region: P.O. box B-975, 24 North Front Street, New Bedford, Mass., 02741	617-999-5601
Northeast Region: P.O. box 151, Rome, N.Y. 13440	315-338-2022
Pacific Coast Region: P.O. box 3246, Terminal Annex, 6500 East Slauson Avenue, Los Angeles, Calif. 90054	213-RA 3-3331
Southeast Region: P.O. box 2075, 1301 Wicomico Street, Baltimore, Md., 21203	301-VE 7-0500

subsidiaries

John I. Paulding, Inc.: P.O. box B952, New Bedford, Mass., 02741	617-995-9541
Revere Aluminum Building Products, Inc.: 2200 North Natchez Ave., Chicago, Ill., 60635	312-637-2600
Revere Extruders, Inc.: P.O. box 731, 3255 Pomona Blvd., Pomona, Calif., 91766	714-595-7403
Revere Foil Containers, Inc.: Industrial Park, Shelbyville, Ky., 40065	502-633-1404
Wells Aluminum Corp.: 400 South Main Street, North Liberty, Ind., 46554	219-656-8111

district sales offices

Albany, N.Y., for mailing address—use Northeast Regional Sales Office address	315-338-2523
Atlanta, Ga., 30325, P.O. box 19835, Station N, 1310 Ellsworth Industrial Drive, N. W.	404-355-9834
Baltimore, Md., 21203, P.O. box 2075, 1301 Wicomico Street	301-VE 7-0500
Boston, Mass., see Chestnut Hill	
Bryn Mawr, Pa., 19010, 14 South Bryn Mawr Avenue	215-GR 7-8326 215-527-2550
Buffalo, N. Y., 14226, 4498 Main Street	716-839-1001
Burlingame, Calif., 94010, 851 Burlway Road	415-347-0751
Cedar Rapids, Iowa, 52406, P.O. box 1268	319-363-3946
Charlotte, N. C., 28202, BSR Building: room 400, 316 East Morehead Street	704-372-2992
Chestnut Hill, Mass., 02167, 220 Boylston Street	617-969-7220
Chicago, Ill., 60635, 2200 North Natchez Avenue	312-637-2600
Cincinnati, Ohio, 45208, P.O. box 8026, 3181 Linwood Road	513-871-1232
Cleveland, Ohio, 44107, P.O. box 2656, Lakewood Br., 14714 Detroit Avenue	216-521-2440
Dallas, Texas, 75247, P.O. box 47087, 8320 Chancellor Row	214-631-4090
Denver, Colo., 80204, 2555 West Eighth Avenue	303-222-4883
Detroit, Mich., 48209, 5851 West Jefferson Avenue	313-VI 1-7350
Evansville, Ind., 47711, P.O. box 4223, Station A, Stringtown Road	812-424-7555
Grand Rapids, Mich., 49502, 236-244 State Street, S.E.	616-459-3301
Houston, Texas, 77027, P.O. box 22033, 3202 Weslayan Street	713-621-0921
Indianapolis, Ind., 46220, P.O. box 20231, 6100 N. Keystone Avenue	317-251-4505
Kansas City, Mo., 64111, 34th Street and Broadway	816-LO 1-8403
Long Island, 99 W. Hawthorne Ave., Valley Stream, N. Y., 11580	516-LO 1-1800
Brooklyn and Queens: call	212-AR 6-3600
Los Angeles, Calif., 90054, P.O. box 3246, Terminal Annex, 6500 E. Slauson Ave.	213-RA 3-3331
Louisville, Ky., 40207, P.O. box 7326, 4820 U.S. Highway 42	502-425-1065
Memphis, Tenn., 38111, Plaza Bldg.: room 318, 3387 Poplar Avenue	901-323-6241
Miami, Fla., 33142, 5750 N. W. 32nd Court	305-635-0406
Milwaukee, Wis., 53216, 4222 West Capitol Drive	414-442-0430
Minneapolis, Minn., 55416, Gamble Center, 5217 Wayzata Boulevard	612-545-2521
New Bedford, Mass., 02741, P.O. box B975, 24 North Front Street	617-999-5601
New Jersey, P.O. box 1010, 99 Washington Street, East Orange, N.J., 07019	201-672-5400
New Orleans, La., 70113, 923 Howard Avenue	504-JA 5-4259
New York City, 1415 Boston Post Road, Larchmont, N. Y., 10538	
Manhattan and Bronx—call	212-687-4111
Westchester, Putnam, N. Y. and Fairfield County, Connecticut—call	914-TE 4-8700
Philadelphia, Pa., see Bryn Mawr, Pa.	
Pittsburgh, Pa., 15228, 666 Washington Road	412-561-8606
Portland, Oregon, 97230, 13019 Northeast Couch Street	503-252-4051
Rochester, N. Y., 14620, 541 Clinton Ave. South	716-325-2820
St. Louis, Mo., 63144, 2510 Brentwood Boulevard	314-WO 8-0600
San Francisco, Calif., see Burlingame, Calif.	
Seattle, Wash., 98109, 314 Fairview Avenue, North	206-MA 2-1401
Syracuse, N. Y., for mailing address—use Northeast Regional Sales Office address	315-338-2523
Tulsa, Oklahoma, 74114, Columbia Building—room 202, 2651 East 21st Street	918-749-3174
West Hartford, Conn., 06107, P.O. box 22, 45 South Main Street	203-521-1190

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