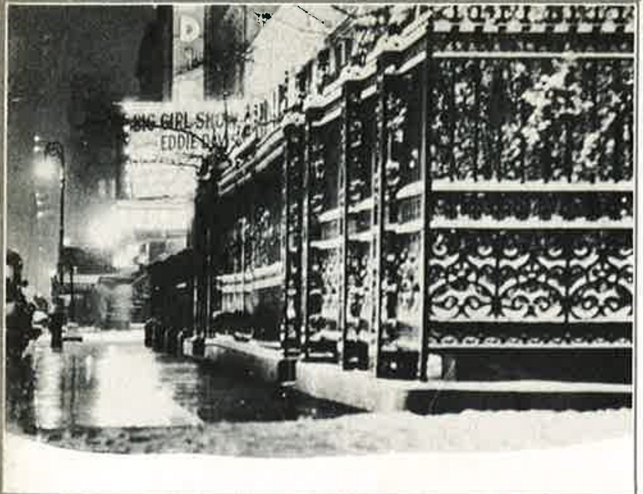
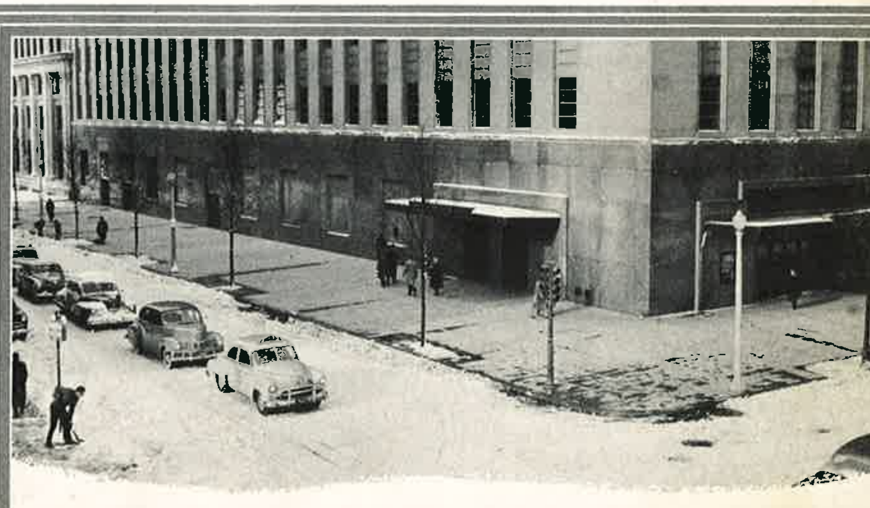


BYERS
WROUGHT IRON
PIPE

FOR
SNOW MELTING SYSTEMS



Front Cover Illustrations

Top Left—Snow melting system permits patrons of New York's famed "21" to enter the Club from snow-free sidewalks.

Top Right—Best & Co. sidewalk after record snowfall in New York City. Described on opposite page.

Lower Left—Despite a record-breaking 30-inch snowfall in November, 1950, the sidewalks of The Union National Bank, Pittsburgh, Pa. remained clear. Seeing the system in operation the President of The Union National Bank said "The use of sidewalk heating is so obvious and practical a solution to the snow and ice problem that I can't imagine anyone erecting a new building without including it." In addition to the safety factor of a clear, clean sidewalk for the benefit of passers-by and customers entering the bank, this method of snow removal contributes to the cleanliness of the bank floor which, incidentally, is radiant heated.

Lower Right—Clear, dry sidewalks were the result when the snow melting system at John Hancock Mutual Life Insurance Company, Boston, Mass., got its first test.

On December 26, 1947 a sidewalk became front page news all over the country.

The sidewalk was on Fifth Avenue, New York in front of the store of Best & Company. It became news by remaining clear when almost every other spot in the city was buried under 26 inches of snow after one of the worst snowfalls in New York's history.

The depth of the snow and the contrast between this sidewalk and those which had to be laboriously cleared by shoveling after the snowfall ended made the incident dramatic, and therefore newsworthy. Essentially, however, it was merely a routine example of the operation of a snow melting system. Such systems, utilizing heating coils embedded beneath the surface to be cleared, have been successfully employed in a wide variety of applications, from the clearing of switches, tracks, drain outlets, etc., to the removal of snow from sidewalks, driveways and working areas. Several hundred installations are known to be in service.

Because Byers wrought iron pipe possesses the high corrosion resistance which is required in snow melting installations, together with the physical and mechanical properties which are necessary, A. M. Byers Company has followed developments in this field very carefully. The Company has pioneered in the preparation and distribution of technical and practical data to engineers, architects, contractors and others interested in snow melting and has accumulated a veritable library of information concerning the design, installation and operation of snow melting systems.

Much of this information will be found on the following pages, and the Engineering Service Department of the Company is always available for further information or for discussion of any problems which may arise concerning specific installations.

Table of Contents

PAGE

What Is Snow Melting?

The idea of snow removal by melting is an old one, and a number of methods have been tried and discarded. The one method which has survived is the introduction of heat beneath the surface to be cleared, usually by circulating hot water or steam through a network of embedded pipes.

Figure 1: Snow and ice removal from the front and side walks of the Omaha National Bank Building, Omaha, Nebraska, is merely a matter of starting the snow melting system.

Since the "accidental" clearance of surface resulting from heated tunnels, basements, steam conduits and the like is so familiar, it is probable that similar devices have been used deliberately in many instances. However, the oldest recorded installation of the sub-surface coil type of snow melting system dates back only to 1925. In that year the Rochester (N. Y.) Gas and Electric Corporation placed 1½" wrought iron steam pipes parallel to and about 14" below the concrete sidewalks on two sides of their new building. The design and installation of the system is not what would be recommended today—but it has kept the sidewalks free of snow.

Effective as this installation was, it did not start any trend toward the general use of snow melting systems. No further progress seems to have been made until more than a decade later when the phenomenal success of radiant heating by embedded heating pipes led engineers to adapt radiant heating techniques to the problem of snow and ice removal.

Wartime restrictions on materials brought further delays, but since 1945, the number of snow melting systems installed has been growing rapidly in both number and variety. These installations have been so successful that private and governmental agencies are planning either test or full scale installations at street crosswalks, in dangerous highway sections, and in aprons and runways of airports. Today there is hardly a type of installation likely to be considered that is not already a matter of engineering record in the files of A. M. Byers Company.

Some Typical Applications

To describe all of the snow melting applications which are in the Byers records would require a full sized book. The installations listed below are typical and may serve to suggest other situations in which such systems provide the best answer to problems of snow and ice removal.

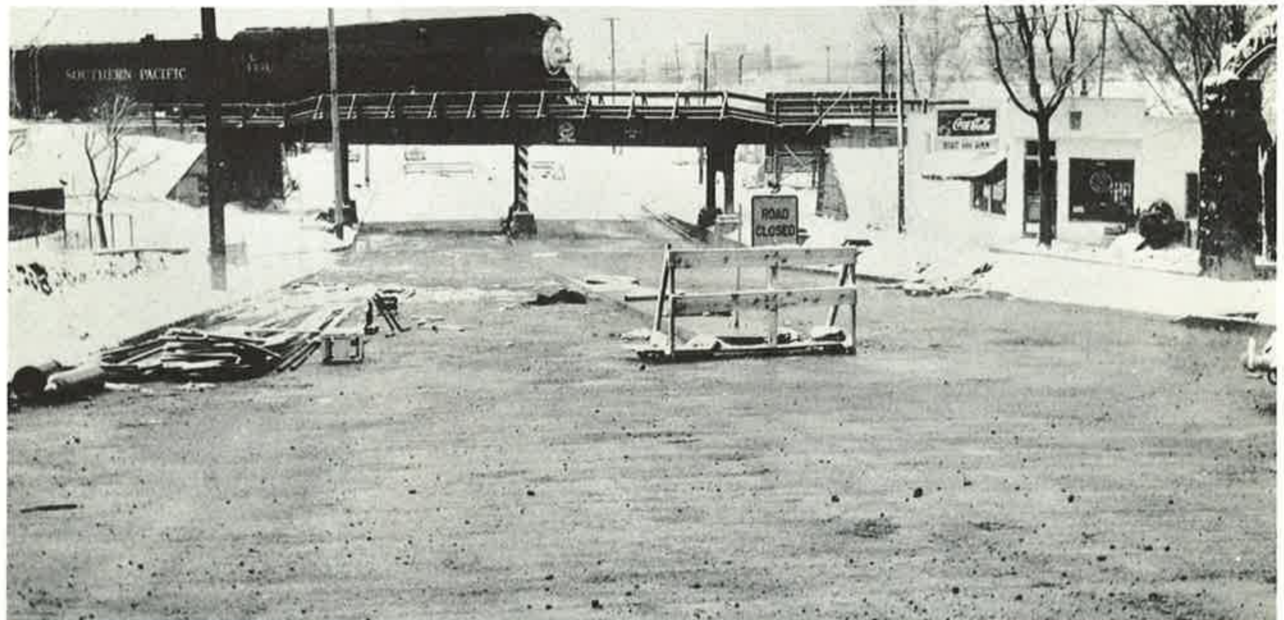


Figure 2: A snow melting system like this one in Klamath Falls, Oregon can promote highway safety in many parts of the country. Grades, particularly when there are piers or other obstacles at the bottom, may be very dangerous when the pavement is icy.

HIGHWAYS: Every motorist knows how snow and ice slow up traffic and add to the danger of travel, particularly on hills. In Oregon the State Highway Commission is trying a new approach to this problem by installing snow melting systems at dangerous spots. The first test installation on a rather steep grade at Klamath Falls, near Salem, is unique in that the heating mixture of water and anti-freeze in the coils is heated to 160°F in a natural hot water spring near the highway.

AIRPORTS: At the time of this writing, the only existing snow melting system embedded in airport runways was found by our armed forces in Germany. Plans for such systems have been drawn up in this country, and in at least one instance where costs have been estimated, the installation cost was computed to be less than that of snow removal equipment. Snow melting systems for runways are attracting the attention of airport operators because they can keep the field completely free of ice and snow at all times, making take-offs and landings safer and avoiding the financial loss resulting when a field is unusable for even a few hours.

Airports also have many other uses for snow melting systems. At the Chicago Municipal Airport, American Airlines has a snow melting system under the doors of its hangar to prevent ice from forming in the door tracks. The Mercury Aircraft Company of Hammondsport, N. Y. uses a grid of wrought iron pipe beneath the ramp approach to the paint shop at its field. Taxi strips, aprons and passenger loading areas are also potential users of snow melting systems, and with the increased commercialization of airport areas, installations in driveways, walkways, parking areas for the public and similar installations can well be considered as a means of combating a decrease in revenue during inclement weather.

Figure 3: Airports are finding many uses for snow melting in driveways, ramps, walkways and similar areas.

Figure 4 (above): Trackways for the heavy doors of the American Airlines hangars at the Chicago Municipal Airport are kept free of snow and ice at all times by a snow melting system utilizing coils of wrought iron pipe buried beneath them.

LOADING AREAS: The need for an ice-free surface on loading docks is obvious, whether the materials are carried, moved by hand truck, or hauled in gasoline or electric powered industrial trucks. The American Cyanamid Company has met this need at its Wallingford, Conn., plant by installing a snow melting system on the loading dock itself.

Where the loading area is above or below grade, a snow melting system is even more of an advantage. The Star Market of Newtonville, Mass. installed such a system in the approach to below-grade loading docks, giving the advantage of year round access to a basement storage area. The entire ground floor may thus be used for sales without double handling of supplies.

Figures 5: Heated platform right at the Wallingford, Conn., plant of American Cyanamid Co. is dry a few hours after a 12 inch snowstorm. Platform at left is unheated.

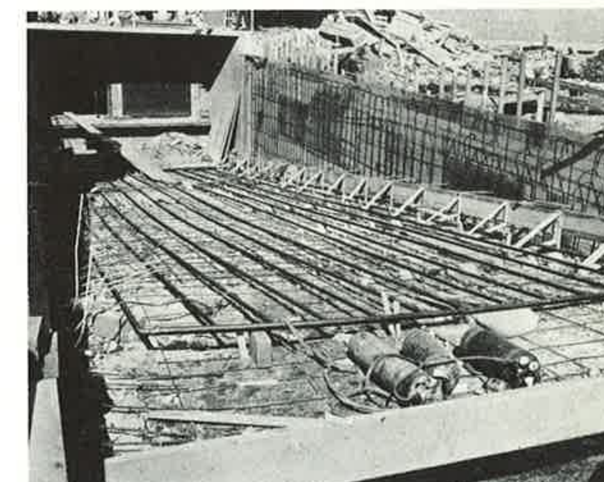
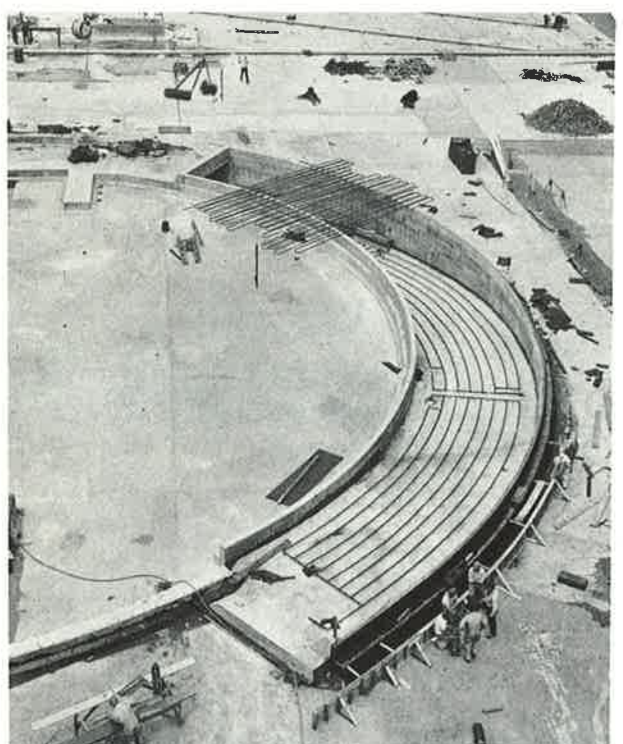


Figure 6 (above): Snow melting installation under driveway to below-grade storage space at Star Market, Newtonville, Mass. *Figure 7 (below):* Snow-free loading space at the plant of The Swiss Chocolate Co., Inc., Fulton, N. Y.

Figure 8: The Dickinson Motor Company, of Carnegie, Pa., and many other garage operators find that snow melting systems in outdoor ramps more than pay their way by saving space and cost of indoor elevators to second floor storage or repair areas.

RAMPS: The outside ramp, to gain access to an off-street entrance or to the upper floors of a garage or other building, is becoming increasingly popular with architects—but presents a considerable hazard when covered with snow or ice. Snow melting systems are solving this problem at the United Nations headquarters in New York City—and for garages all over the country, such as the McCutcheon & Drake Garage in Beckley, W. Va. and the Dickinson Motor Company of Carnegie, Pa.



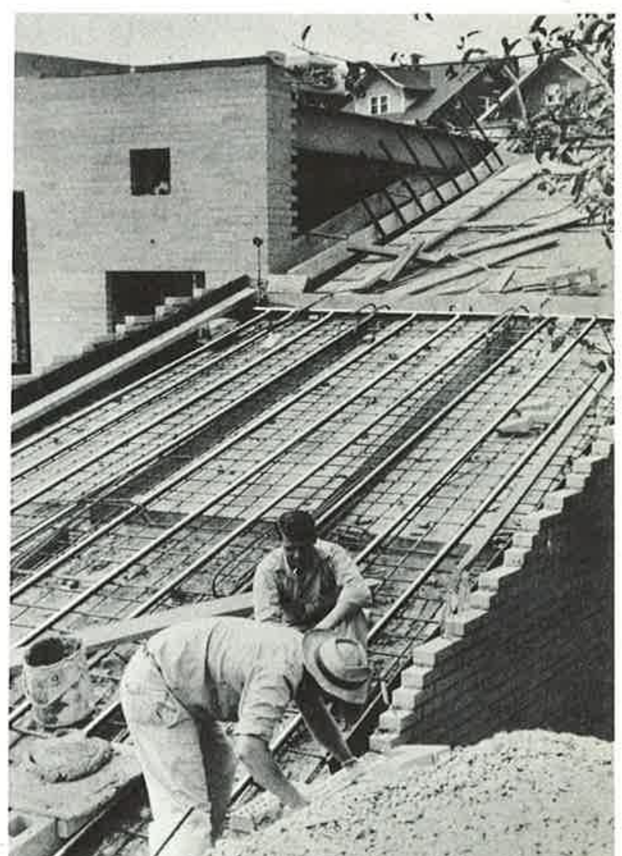


Figure 9 (above): Snow melting system under construction in ramp to parking areas at United Nations Headquarters, New York, *Figure 10 (right)*: Ramp installation at the McCutcheon and Drake Garage, Beckley, W. Va.

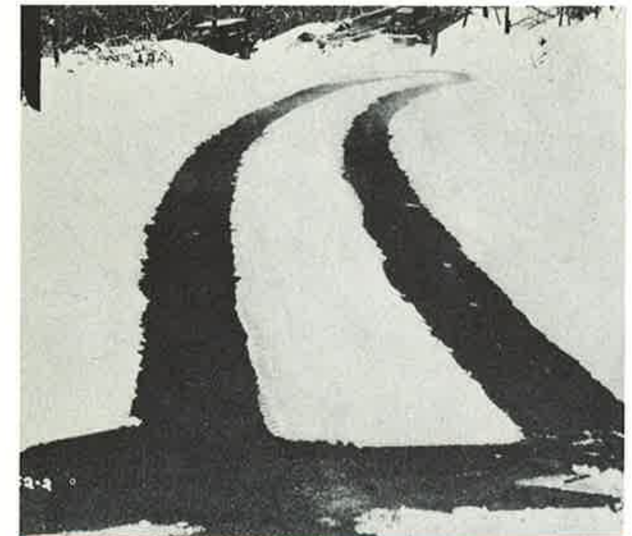


Figure 11: This long, steep and winding road was a winter hazard to residents of the Snake Hill section of Belmont, Mass., until they installed their own snow melting system—with the results shown in this photograph.

DRIVEWAYS: Snow melting systems are perhaps more widely used in driveways than in any other application. Records show such installations for private homes, hospitals, service stations, hotels and industrial plants. In some cases, such as the Snake Hill District of Belmont, Mass., residents of the community have privately financed a snow melting system on the road leading to their section.

On driveways, snow may be melted from the whole area, or the system may be confined to "tracks," providing a snow-free area only where needed to assure proper traction for the car wheels.

Figure 12 (above): Garage of Mr. Frank Ewer, Jamaica Plains, Mass.

Figure 13 (below): Garage at residence of Mr. Thomas L. Stover, Cambridge, Mass. Snow melting installations of this type are becoming increasingly popular because of their effectiveness and economy of operation.

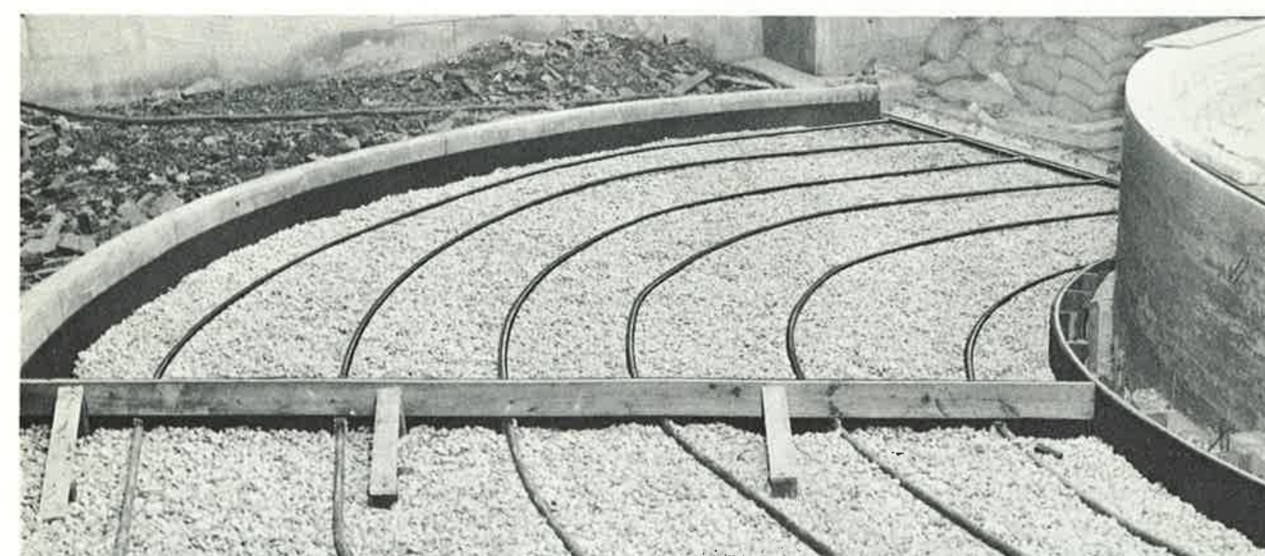


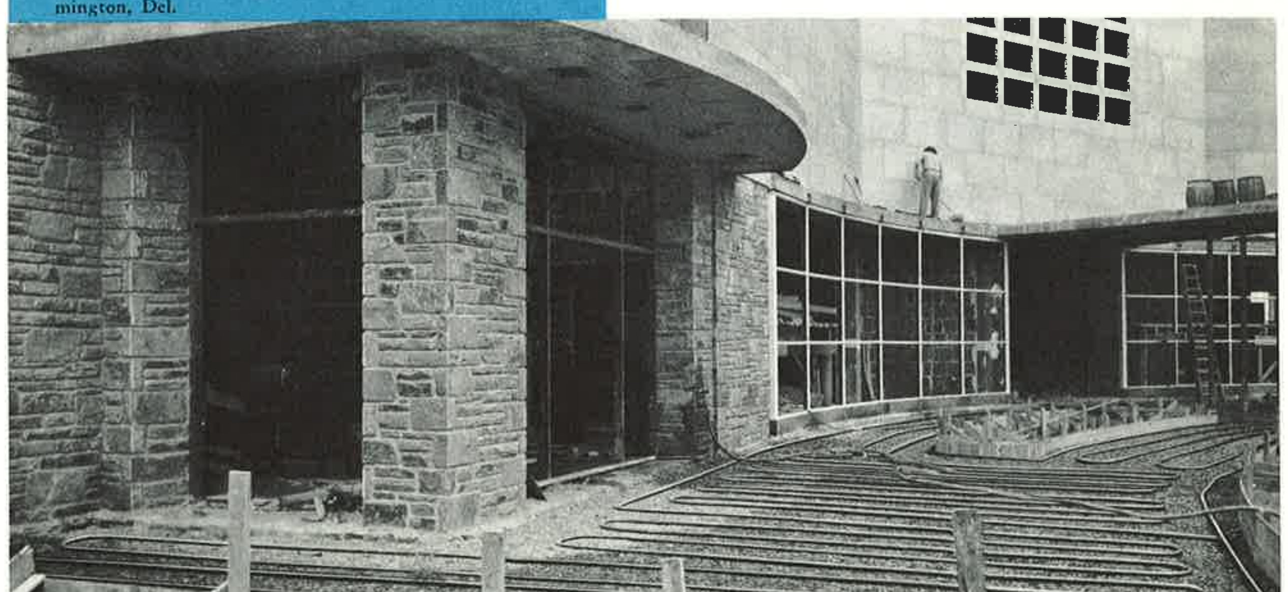
Figure 14: No snow or ice collects on the curved and sloping ambulance entrance to the South Side Hospital, Pittsburgh, Pa. Photograph shows welded grid of wrought iron pipe laid on gravel, which makes a very satisfactory type of installation.

Figure 15: Patrons of the Covedale Theater, Cincinnati, Ohio, appreciate clean sidewalks—and the management appreciates the decreased cost of carpet cleaning.

Figure 16: Excess capacity of the regular oil-fired heating system keeps sidewalks clean and dry even during heavy snows for A. A. Smith Co., Torrington, Conn.

Figure 17 (above): Another typical sidewalk installation is that of Dewey and Almy Chemical Co., Cambridge, Mass. *Figure 18 (below)* shows the extensive installation at the new store of John Wanamaker & Co., at Wilmington, Del.

SIDEWALKS: Commercial establishments find that clear sidewalks earn good will and attract customers—which accounts for the many snow removal systems of this type. That of Best & Company in New York City has already been mentioned; some others are the Dewey & Almy Chemical Company of Cambridge, Mass., the Covedale Theater of Cincinnati, Ohio, the Protane Company of Erie, Pa., The Union National Bank of Pittsburgh, Pa., and the John Wanamaker Department Store of Wilmington, Del.



SPECIAL APPLICATIONS: In addition to these more or less standard uses of snow melting systems, there is a wide variety of special situations in which the basic techniques of snow melting have been employed.

Cold storage plants and freezing tunnels are about the last places on earth one would expect to find snow melting systems—yet such systems are in use, though not for snow removal. Their function is to prevent freezing of the ground underneath, for if the ground freezes, it swells, and causes the buckling of expensive, insulated floors.

The Adams Apple Products Corporation of Aspers, Pa. and Penn Dairies, Inc. of Lancaster, Pa. have found that it is less expensive to install such a system than to use a type of construction which would make it unnecessary.

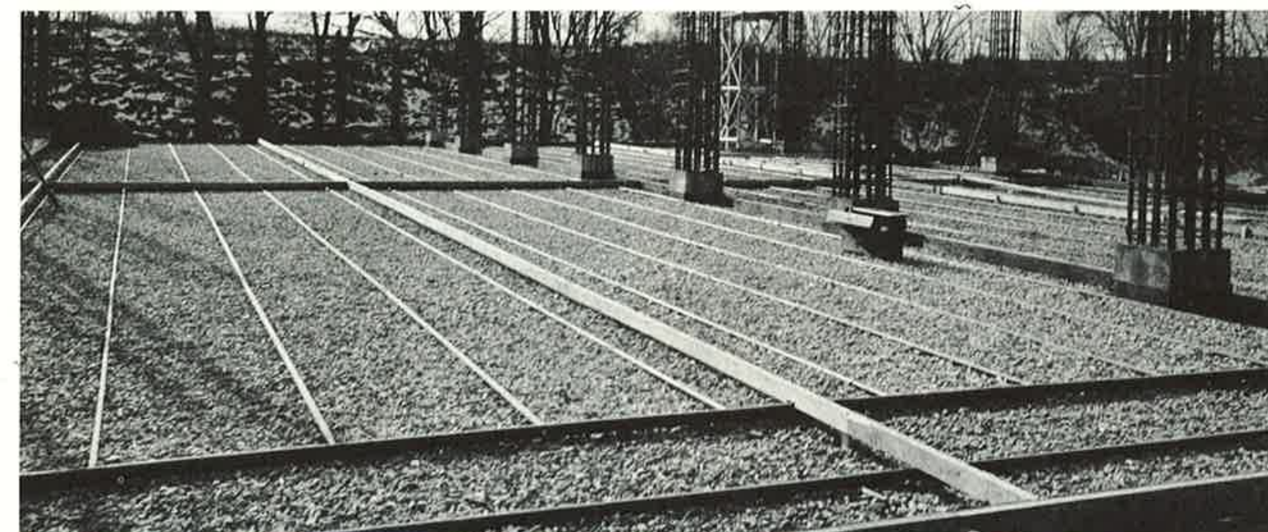


Figure 19: Not for snow removal but for the prevention of damage to expensive, insulated floors in this extensive installation beneath the cold storage plant of Penn Dairies, Inc., Lancaster, Pa. Similar installations have been made in other cold storage plants.

Advantages of Snow Melting

Some of the advantages of snow melting systems have already been mentioned, and others are indicated by the nature of the applications which have been described. The major benefits may be summed up as follows:

1. Snow removal is automatic, requiring no more than the pressing of a switch. There is no labor, no plows or loading machines. No chemicals are used, thus eliminating the danger of damage to surfaces and drainage systems.
2. The system can be operated to melt snow as it falls, thus preventing accumulation at any time and eliminating completely the hazard of snow and ice.
3. Surfaces may be wholly or partially cleared, and partial clearance may be in any desired pattern. The system lends itself particularly to "spot" clearance which would be difficult or impossible with machine equipment. Sliding doors, switches, walkways in hazardous places, etc. are examples of such areas.

Figure 20: The famous 21 Club in New York City has clear sidewalks even while snow is still failing heavily.

4. Surfaces have been kept dry during light rainfall or quickly dried after rain or snow, thus preventing the tracking of moisture and dirt into lobbies, stores, reception areas, etc.

Many other advantages might be listed, but these should be sufficient to show why snow melting systems have gained such wide acceptance during recent years.

Figure 21: Many industrial plants use snow melting systems to keep inter-plant sidewalks clear. Photograph shows walk at the Sarco Manufacturing Co., Bethlehem, Pa.

Figure 24: This is the sidewalk that made the headlines in 1947, in front of Best & Co., Fifth Avenue, New York, N. Y.

Figure 22 (above): Clearly visible water vapor shows rapid drying of sidewalk by snow melting installation in front of Commonwealth Edison Building, Chicago, Ill. *Figure 23 (below):* A. E. Mayer, St. Louis, Mo., advertises his business by having grid of his snow melting system spell out "Radiant Heat" in the snow on his walk during early stages of operation.

The widely varying requirements of snow melting systems make it impossible to give any exact figures as to the cost of installation and operation. Factors which enter into these costs are discussed in detail in another section of this bulletin.

It can be said, however, that the experience of users of these systems indicates that, in general, snow melting is no more expensive than any other method of snow removal. Operating costs are usually well below the cost of hand shoveling. Best & Company, for example, have estimated that the cost of removing 26 inches of snow from 6000 square feet of sidewalk was less than $18.

All costs, including amortization of the investment, are especially low in comparison with the benefits obtained.

Pipe

The most important single component of any snow melting installation is pipe. This pipe must resist corrosion for it is only accessible for repairs at considerable cost and inconvenience and such leaks as might result are frequently difficult to locate with any accuracy.

Pipe for a snow melting system should have considerable strength. It is virtually impossible to avoid some rough handling during the course of fabricating and installing such a system.

The wide temperature range to which pipe is exposed in snow melting systems makes it imperative that the pipe and the material with which it is surrounded have closely matched coefficients of expansion. Unequal expansion will surely destroy either the pipe or the surrounding material unless special provision is made for free expansion of the pipe—and this cannot be provided without increasing installation costs and reducing the rate of heat transfer. (This statement does not apply to expansion joints installed between one section of the installation and another. These expansion joints are essential and can be readily achieved by loosely covering an expansion loop with a suitable material during assembly.)

Still another factor which must be taken into account is ease of fabrication, for this is directly reflected in installation costs. Here again wrought iron is indicated, for wrought iron pipe can be easily bent and welded with standard equipment.

To summarize, wrought iron is not the only piping material which has been used, but it certainly is the best. No other common piping material can equal wrought iron's unique combination of corrosion resistance, rugged strength, compatibility with structural materials over wide temperature ranges and ease of fabrication. It costs so little more (usually a 4-8% increase in contract price) that substitutes are a poor investment.

An installation for the Heekin Can Company (fig. 26) shows the use of welding fittings and cold bends to fabricate a well designed job. Welded joints are usually specified for their greater strength and durability, although installations have been made with threaded joints.

Design

The wide variation in the requirements of snow melting systems and in the conditions of their installation and operation make it virtually impossible to provide any "standard" design. It is possible, however, to set up certain basic principles, derived from a detailed study of the many installations in the records of A. M. Byers Company. When these principles are followed, a reliable, smoothly-functioning snow melting system can be easily designed, installed and operated at reasonable cost.

The first step in designing such a system is to determine the amount of heat which must be delivered to the slab surface. Weather Bureau records of snowfalls show that in nearly 90% of the cases, snowfalls occur at temperatures between 10°F and 35°F. The mean temperature in this range was 26°F, at which temperature the average density of the snow is 6 pounds per cubic foot. Under conditions normally encountered, a melting capacity of one inch per hour is adequate.

Using these figures, the heat required for this rate of melting can be calculated from the formula:

$$H = A\ t.d.F$$

where H = *heat requirements, in Btu*
A = *area in square feet*
t = *thickness of snow in feet*
d = *density of snow in pounds per cubic foot*
F = *latent heat of fusion of snow or ice (144 Btu per pound)*

If we assume a melting rate of 1″ of snow per hour for a surface area of one square foot, we can, by substituting these figures in the formula, find:

$$H = 1 \times 1/12 \times 6 \times 144$$
$$= 72 \text{ Btu per hour per square foot}$$

Since the above figure is net Btus at the slab surface, some allowance must be made for the loss of heat from various sources—i.e., loss from the sides and bottoms of the panel, evaporation, etc. These losses are difficult to determine and will vary with the physical circumstances. Both test work and past experience indicate that an efficiency of about 70% can be expected. This would make the demand per square foot about 100 Btu per hour. Allowance should also be made for piping losses, etc., when determining the total heat requirement, although the low water temperatures involved keep these losses low.

Reports from installations based on the above figures indicate that their performance is usually in excess of their design capacity.

Provision may be made for a higher rate of melting if local weather conditions or some special requirements of the job itself make it desirable, but the same formula applies. For the purposes of this discussion, however, a demand of 100 Btuh per square foot will be assumed where it is not specifically stated as being some other value.

The total heat requirements of the installation are obtained by multiplying the area by the demand in Btuh and adding suitable allowances for piping, pickup, etc. The next step in design is to decide on the pattern of heating and the size of pipe most satisfactory for the particular installation.

Figure 25: Snow melting system is installed in outside steps and parking lot as well as sidewalks in the luxurious Wilmington, Del., store of John Wanamaker & Co. Wrought iron pipe in sinuous coil and grid patterns are used.

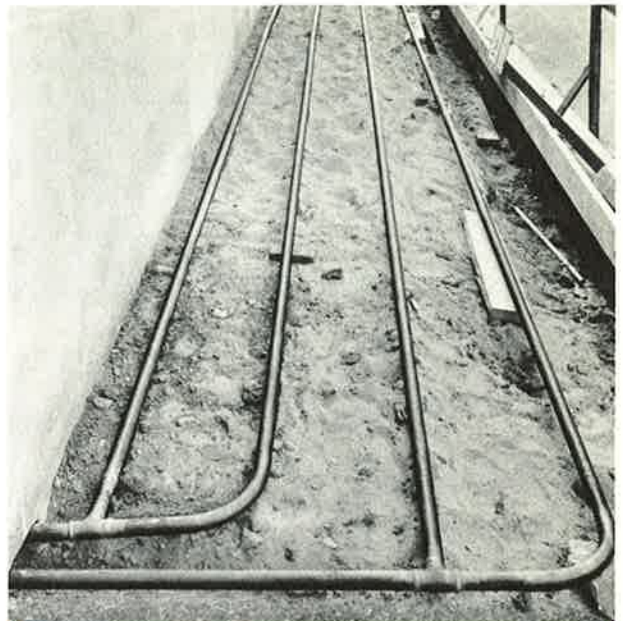


Figure 26: Cold bends and welding tees were used to fabricate this sidewalk installation for The Heekin Can Co., Cincinnati, Ohio. Good coverage is provided very simply by two lines laid in the shape of elongated U's.

Figure 27: Shown here in the course of construction is one of the largest sidewalk snow melting systems in the world—the wrought iron, grid type installation for the John Hancock Mutual Life Insurance Company, Boston, Mass.

Coil and Grid Patterns

The design of the piping layout of a snow melting system must balance two factors. For best heat distribution it would theoretically be desirable to use very small pipe spaced on very close centers to get the best distribution of heat. For lowest installation cost it would be desirable to use large pipe spaced at a considerable distance. For most jobs the best balance between these two factors is achieved by the combination of 1″ Wrought Iron Pipe on 12-15″ centers or 1¼″ wrought iron pipe on 16-18″ centers in concrete. Because of their lower heat transfer rates, 1″ wrought iron pipe on 12″ centers should be used in the various types of bituminous paving.

Three types of flow patterns are used in the design of snow melting systems. These are known as *sinuous coils, grid, and combination grid and continuous coil patterns.*

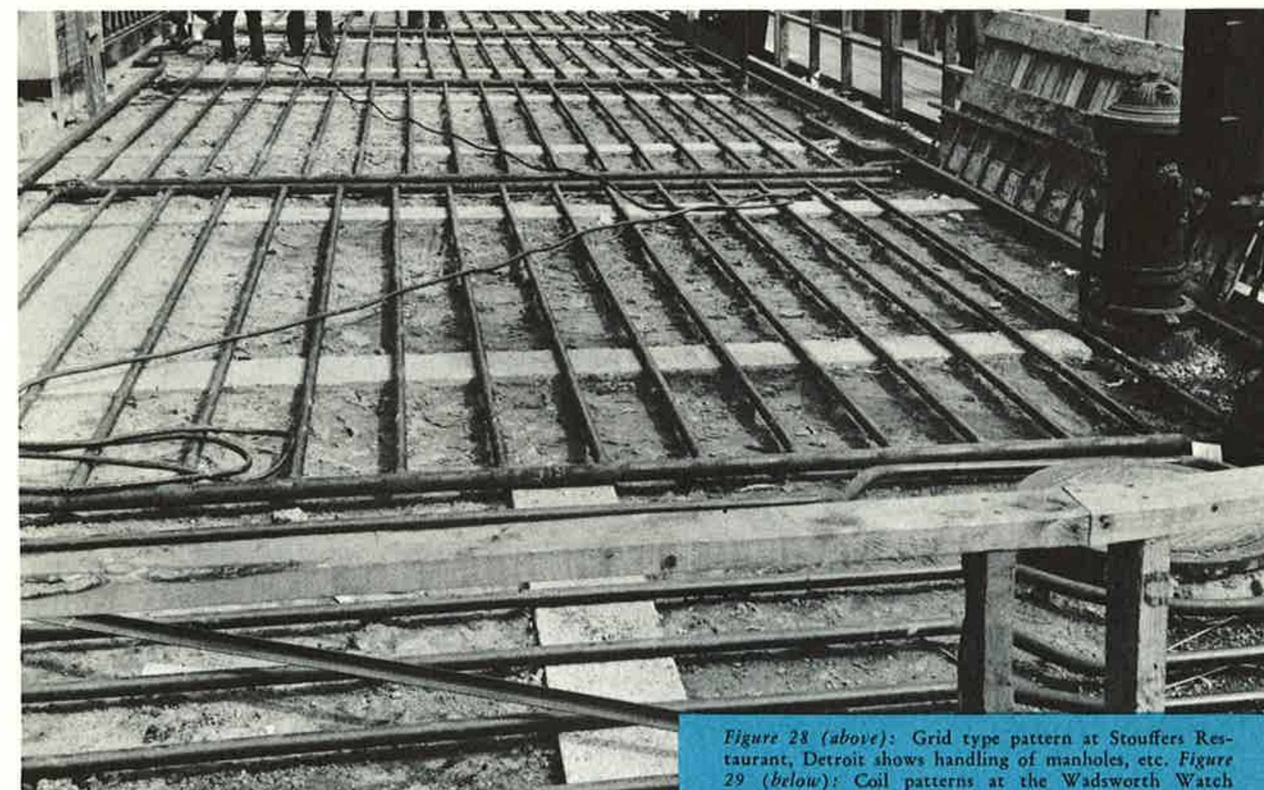
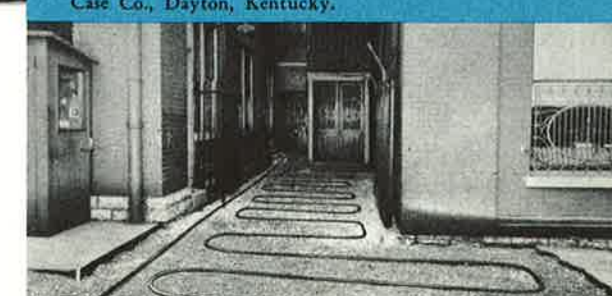


Figure 28 (above): Grid type pattern at Stouffers Restaurant, Detroit shows handling of manholes, etc. *Figure 29 (below):* Coil patterns at the Wadsworth Watch Case Co., Dayton, Kentucky.



A sinuous coil is a long piece of pipe bent so as to cover the area with parallel runs of pipe on the proper centers. Where the space is irregular, the coil may be in any shape which will space the pipe so that a maximum distance of 18″ exists between any two runs.

Such an installation was made for the Wadsworth Watch Case Company of Dayton, Kentucky at their ambulance entrance. Gravel was used as the fill and concrete poured over it. This 75′ x 12′ drive and a 200′ x 11′ snow melting sidewalk were installed at the same time.

A grid consists of a number of parallel runs of pipe, the ends of which are welded into larger pieces of pipe, or headers, placed (usually) at right angles to the runs so that the flow will be into the header, through the parallel runs, and out through the other header. It is necessary that the supply and return line connections to these headers be at diagonally opposite points to obtain an equal flow through all runs.

The snow melting system installed for a Stouffer Restaurant at Detroit, Mich. shows the grids being welded into the supply and return mains. In the foreground, a grid with a curved header which has been built to fit around a manhole is visible, demonstrating that some degree of irregularity can be handled by the grid type of installation.

A combination grid and continuous coil type of installation consists of coils of three or more runs connected into headers. This method is well illustrated by the snow melting system installed in the court of the Student Union Building on the Ohio State University Campus at Columbus, Ohio. The supply header is on one side of the building and the return header on the other. Coils are connected between the headers. On this particular job each coil makes three passes of the area between the headers. Coils for radiant heating are visible on the second floor of the building.

Each type of pipe pattern has certain advantages and disadvantages. Sinuous coils are easy to form, utilize full random lengths, require fewer cuts and welds, and are easily adapted to irregular areas. The chief disadvantage of the coil type layout is that for similar areas pumping heads are higher due to higher frictional resistances and the inability to be positively drained.

Figure 30: Each coil of this combination grid and continuous coil installation in the Student Union at Ohio State University makes three passes between the headers.

Grids have the lowest friction loss, use few bends, and for large installations such as airports runways, subassemblies can be welded automatically. They are the least expensive type of installation for large areas, but may be the most expensive for small ones. Grids have additional advantages in that they can be sloped for more efficient drainage and venting, and require fewer balancing valves for large areas. Their chief disadvantages are the greater amount of welding necessary for the same area, and their inability to make use of full random lengths.

Combination grid and continuous coil systems are intermediate in the advantages they possess, requiring fewer welds than grids and enjoying lower friction losses than coils, but they have higher friction losses than grids and require more welds than coils.

Properly designed and constructed, all three types of installations do a good job. Choice of the type for any particular installation will be determined by considering the installation cost and the most practical layout for the area.

Current practice with all types of snow melting is to install 1″ wrought iron pipe on a maximum of 15″ centers or 1¼″ wrought iron pipe on a maximum of 18″ centers in concrete; 12″ centers in asphalt or other bituminous surfaces. Where it is only desired to clear tracks, the two lines are usually installed on 12-14″ centers which reduce the time necessary to clear the

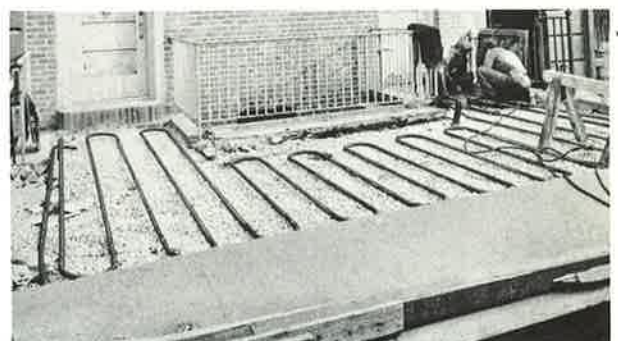


Figure 31: The sinuous coil construction, used here for Al Brown Sons, Inc. apartment building, New York City, is often the simplest and easiest for small and irregular areas.

center of the track.

If, because of local weather conditions or some special requirements of the job itself, it is considered essential to design an installation for a higher rate of snow melting the lines may be placed on somewhat closer centers. The decision as to the desirability of a higher melting rate is usually made on an economic basis. On a small job, a higher melting rate will not increase the cost of the installation nearly as much as on a large job, due to the price of a small heater not being proportional to the heat it delivers, and the generally thinner paving of residential driveways, etc., which allows a more rapid delivery of heat to the surface for the same pipe area.

Designers of systems for relatively small areas with higher melting rate requirements frequently use 1″ wrought iron pipe on 12″ centers. Charlie's Super Service Station of Erie, Pa. has a snow melting system installed which uses this design in the sidewalk and driveway. The lines going left across the driveway in the foreground are for the purpose of draining the system, should that become necessary (figs. 36 and 37).

PERMISSIBLE BENDS IN WROUGHT IRON PIPE

Regardless of the type of installation, some bends will probably be necessary. The following table indicates the minimum diameter to which black wrought iron pipe can be cold bent, if some degree of flattening is permitted.

Size	Minimum Diameter of Bend, center to center
½″	2.8″
¾″	3.5″
1″	4.3″
1¼″	5.5″
1½″	7.0″
2″	11.0″

Temperature Drop

Still another factor which must be considered in designing a snow melting system is the temperature drop through the system. It requires twice as large a flow to supply a given amount of heat at a 10°F drop from supply to return temperature as is required to supply the same amount of heat when the temperature drop in the system is 20°F.

The gallons per minute to be circulated can be calculated from the following formula:

$$\frac{\textit{Total heating load in Btuh}}{\textit{60 x 8.3 x specific gravity x specific heat x temperature drop}} = \textit{gallons per minute to be circulated}$$

For a system utilizing water as the heating medium, the formula resolves itself into:

$$\frac{\textit{Total heating load in Btuh}}{\textit{500 x temperature drop*}} = \textit{gallons per minute to be circulated}$$

For example, assume a total heating load of 100,000 Btuh and a temperature drop of 10°F. The gallons per minute to be circulated would be:

$$\frac{100{,}000}{5{,}000} = 20 \text{ gallons per minute}$$

* For a drop of: 10°F, this denominator becomes 5,000
15°F, this denominator becomes 7,500
20°F, this denominator becomes 10,000
25°F, this denominator becomes 12,500
30°F, this denominator becomes 15,000

By use of this formula, the flow through each section of the system can be determined as well as the flow through the entire system. Knowing the flow required by each section, flow through the supply and return mains can be determined. With this information and the chart on *Friction Heads in Black Iron Pipes for a 20°F Temperature Difference of the Water in The Flow and Return Lines* (Page 16), main sizes and the friction head of the longest run of pipe from the boiler and return can be computed.

As a general rule, main sizes and the length of runs should be chosen to limit the pumping cost to as reasonable a level as is compatible with efficient operation of the system. Pump capacity should, however, be figured to provide a margin of approximately 50% to take care of the fittings, bends and the boiler, etc. (This figure is not inflexible and varies from designer to designer, and also depends in part on the particular installation.)

Figure 32: The grid type of pipe layout is most useful in regular areas having a uniform slope, as in this installation for the Century Tire Co., Portland, Maine. Method of handling grids around the pump island should be noted. Asphalt paving was laid over the pipe.

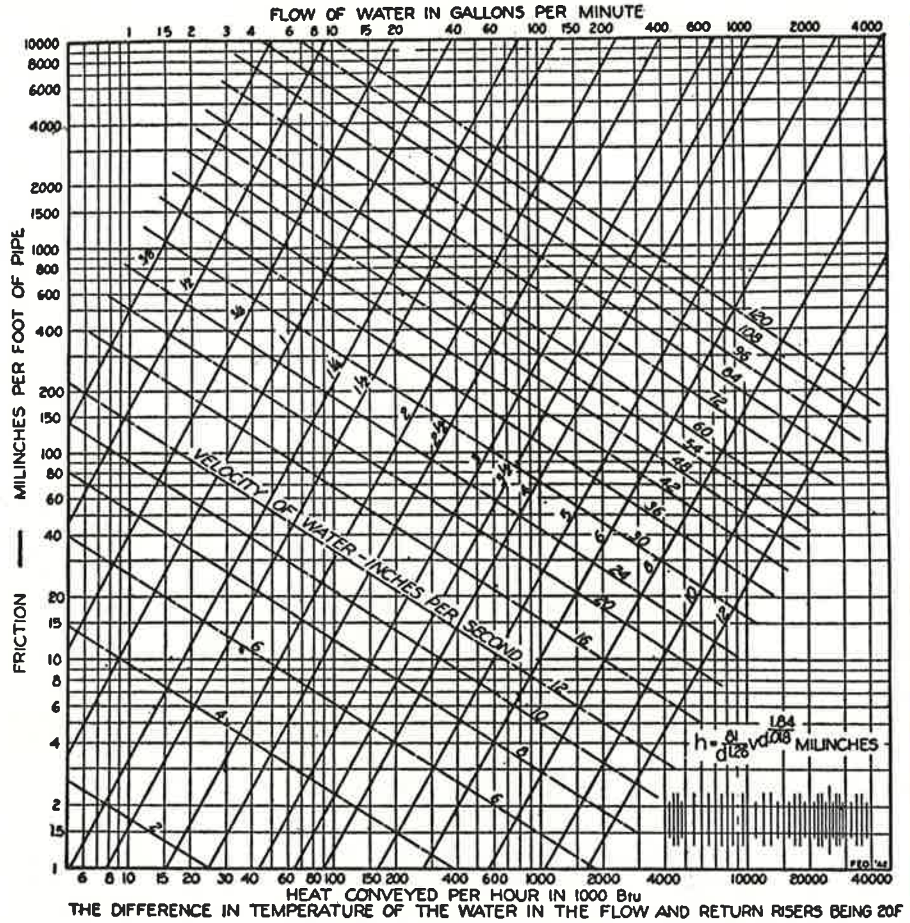


Figure 33: Friction heads in black iron pipe for a 20°F temperature difference between water in the flow and in the return lines.

Effect of the Use of Anti-Freeze Solutions on Design

Mention has already been made of the use of anti-freeze in snow melting systems for protection from damage by freezing. This is necessary in all water filled, intermittently operated systems.

Alcohol has not been found satisfactory in this service, as its use imposes both a fire and a health hazard because of its tendency to "boil out" of solution and form a concentrated vapor when it is heated to temperatures only slightly above those frequently employed in snow melting systems. This creates the possibility of fires or explosions, and also suffocation from alcohol fumes. At least one fire is known to have resulted from the ignition of escaping fumes by an electric spark.

Anti-freezes of the ethylene glycol type (the "permanent type" anti-freezes for use in automobiles) do not entail these hazards. It is usually not necessary to use more than 35 to 40% anti-freeze to secure the necessary protection against freezing.

The correct amount of anti-freeze to be put in the system is dependent upon the liquid capacity of the piping in the system which can be calculated by referring to the following table.

Pipe Size	Capacity Gal. per linear ft.	Pipe Size	Capacity Gal. per linear ft.
½″	.016	2″	.173
¾	.027	2½	.247
1	.044	3	.382
1¼	.077	3½	.511
1½	.105	4	.658

The total fluid in the system can be found by adding the amount of fluid in the piping to the capacity of the boiler or convertor and the expansion tank.

The required percentage of permanent type anti-freeze can then be determined by referring to the table below.

CHARACTERISTICS OF WATER-GLYCOL MIXTURES

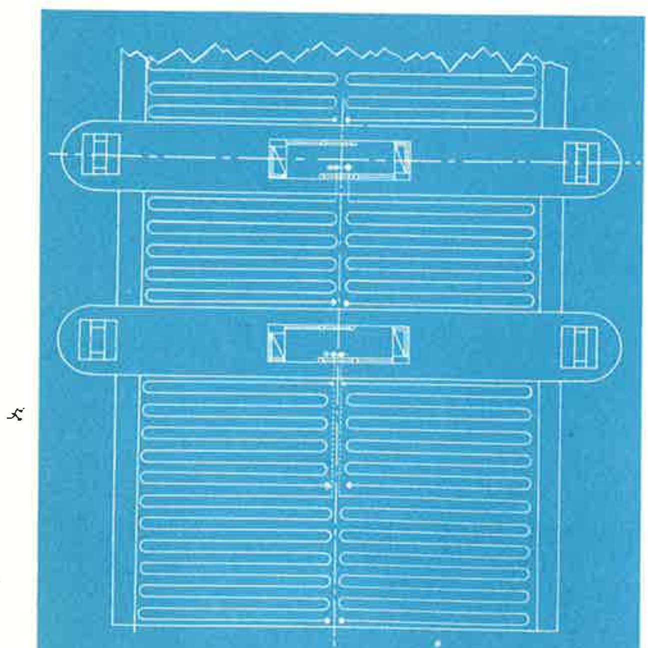
% Glycol by Volume	Freezing Point Deg. F.
12.5	25
17.0	20
25.0	10
32.5	0
38.5	—10
44.0	—20
49.0	—30
52.5	—40

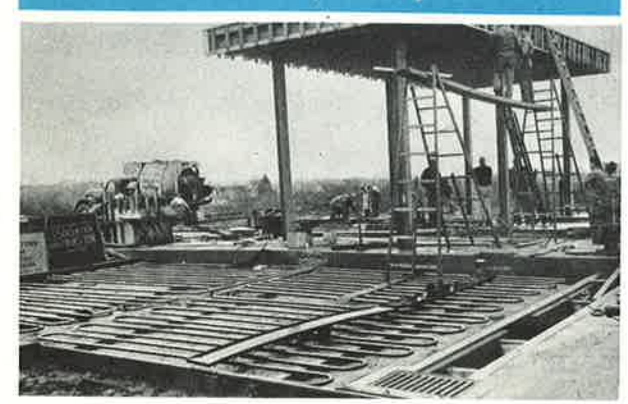
in the water chamber or by the addition of a convertor. Where the capacity is not sufficient, a second source of heat may be installed to help carry peak melting loads. Some installations use their excess space heater capacity to temper or warm up the system when the temperature drops below 35°F., and install another heater in parallel to provide the extra heat required to carry the full melting load.

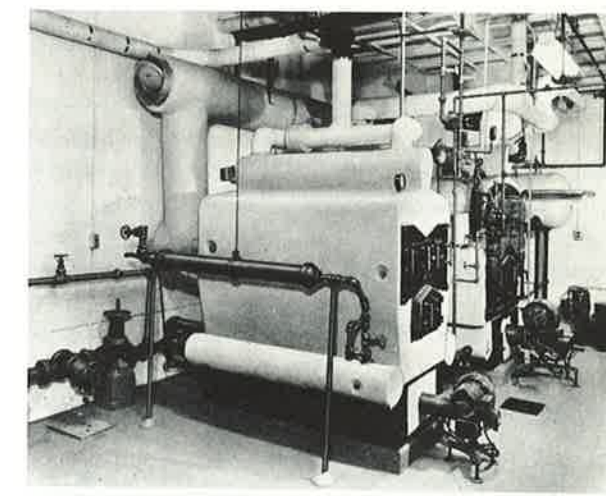
Smaller installations nearly all use direct heat in coal, oil or gas fired heaters. The Protane Corporation uses a 200,000 Btuh Ruud Instantaneous water heater to supply the heat for their 672 square foot snow melting system. An aquastat controls the supply temperature at 130°F. To illustrate how rapidly this system works, a picture of a partially melted 4″ snow fall was taken. Less than 40 minutes later the walk was clear and most of it was dry. This system was installed with 1″ wrought iron pipe on 12″ centers.

Larger systems frequently make use of boilers designed originally for hot water heating systems, as was done by the State of Connecticut at the new Raymond E. Baldwin Bridge over the Connecticut River. Since bridges get treacherous under many conditions which do not affect ordinary roads, the state engineers decided to install a snow melting system for their new toll booth station at this point, using a gun type, oil fired cast iron boiler of 557,000 Btuh to supply the heat. Choice of this type of heating unit was made so that future expansion of the system could be handled simply by adding more sections to the boiler.

In this installation 12 sinuous coils are embedded in the 8″ concrete paving slab and are connected to 3″ supply and return mains. Each 1¼″ wrought iron coil is located 3″ below the surface of the paving, and melts a 10′ x 17′ road panel. The return from each coil is fitted with a square head balancing cock. Each pair of coils is run into a header which comes into a toll booth, where it is vented with an automatic valve. Coils were fabricated on 12″ centers because of the heavy load of "tracked in" snow. Thermometers in the return line of each coil indicate the temperature. The coils are connected to the headers on a "first in-last out" basis. A







Snow melting system at the toll booths of the Raymond E. Baldwin Bridge, over the Connecticut River. *Figure 41 (upper left)* is a diagram of the pipe layout of this installation. *Figure 42 (lower left)* shows the project in the course of construction. Oil-fired boilers *(Figure 43, top)* can be expanded to take care of additional booths by simply adding more sections. *Figure 44 (lower photo, above)* shows cleared area, permitting easy stopping and thus reducing delay at booths.

water-anti-freeze mixture is circulated by means of a 1/3 hp high head, 3″ centrifugal pump.

It has been found that supplying 130° heating fluid is sufficient to exceed by 15% to 20% the designed capacity of 1″ of snow melted per hour even in coldest weather. At the first signs of snow or drizzle in cold weather, the system is started by throwing a switch. A boiler aquastat maintains the boiler at a maximum temperature of 130°F., the pump continues to run until shut off manually. This type of operation is fairly common.

Heat Exchangers

Where steam is the potential source of heat, it is generally advisable to use a heat exchanger to heat a water-anti-freeze mixture for circulation as the heating medium. This method is preferred because of the danger of condensate freezing in the pipes between periods of use or in starting the system, with the possibility of a ruptured pipe necessitating expensive repairs. Then, too, the direct use of steam demands that the system drain from supply to return, a qualification not essential for other heating mediums and one which frequently complicates the design.

The use of a heat exchanger permits the use of process steam which would otherwise be unusable by virtue of the load of dissolved or suspended contaminants it contains. Any corrosion or deposits which might occur are thereby confined to an accessible area. The use of special alloy heat exchangers makes it possible to employ virtually any hot vapor or liquid medium as a source of heat. Power plants and many processing and manufacturing plants have to dissipate vast quantities of low grade heat which is available as a "no cost" source of heat and is entirely suitable for melting ice and snow through the use of a heat exchanger.

A system of this type is employed at the Bridgeville plant of the American Cyanamid Company, where exhaust steam is used in a heat exchanger to heat a mix-

Figure 45: Waste heat keeps this road clear of snow at the Bridgeville, Pa., plant of American Cyanamid Co.

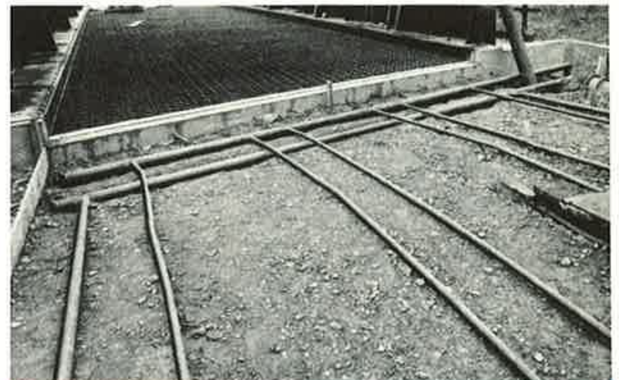


Figure 46: Four supply and four return lines are connected to headers at the plant end of the road.

ture of water and anti-freeze to a temperature of 165°F. This mixture is circulated at a rate of 50 gpm against a 17′ head by an electrically driven centrifugal pump.

The area heated by this snow melting installation is a 600 foot driveway from the state highway. This driveway is constructed of an 8″ reinforced concrete slab resting on graded earth. Eight runs of black wrought iron pipe were laid on the 24′ wide road bed and positioned in such a manner as to provide 2 runs 18″ apart between each of four wheel tracks. On the outside of each lane a 2″ supply main carries the hot water anti-freeze mixture to a 4″ header at the top of the roadway, from which it returns through 3 runs of 1¼″ wrought iron pipe to a 4″ return header at the bridge. Vents were installed at the highway or upper end headers.

The system was designed to melt 1″ of snow or 0.1″ of ice per hour, which was calculated to require a boiler output of 100 Btuh per square foot of surface to be cleared. Although the primary objective was to provide four wheel tracks of 2′ to 3′ width each, the first winter's operation, on the basis of the constant circulation of 140°F water, proved the installation adequate for quick clearance of the entire roadway with snowfalls of up to 13″ in depth. During the 13″ snowfall the road stayed not only clear but dry.

As was previously mentioned the same company has installed a snow melting system operating on waste heat in the loading dock at their Wallingford, Conn. plant. This system is installed over a reinforced concrete slab sub-floor. The piping system consists of 3000 feet of wrought iron pipe most of which is 1″ in size. Pipe is laid the length of the 246′ x 13′ area on 18″ centers, under that part of the approximately 20′ wide platform which is not covered by an eave.

As the illustration of the end of the grid construction shows, there is a row of valves for balancing the flow through the grid and thus distributing the heat to the platform evenly. Access to the platform was maintained in pouring the concrete.

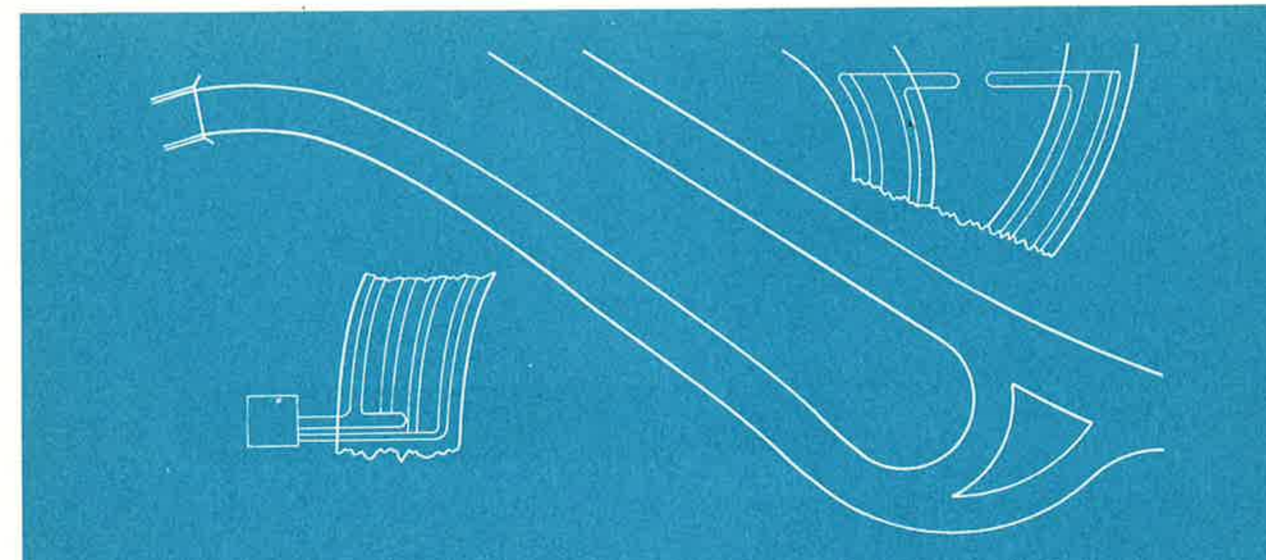


Figure 47: Diagram of pipe and road layout at American Cyanamid Co., Bridgeville, Pa.

In this installation the system is filled with a light petroleum fuel oil instead of the more common water-anti-freeze mixture. Heat is supplied by a heat exchanger which utilizes low pressure process steam to heat the oil to 140°F. The oil is circulated at the rate of 60 gpm. Return line temperature is approximately 100°F.

Where steam is used as a source of heat, most designers prefer to keep the heat exchanger and pump located as near the scene of operation as possible. The small size of most of these installations and the ease with which they can be mounted on a wall has the advantages of leaving valuable floor space free, and making installation possible in almost any location. The manner of installation used at Bigelow-Sanford Carpet Company of Amsterdam, N. Y. shows how little useful space is consumed by the heating, circulating and control portion of a snow melting system which keeps the driveway clear and permits access to their below grade shipping platform.

The system, having a designed melting capacity of 2″ of snow an hour, is fabricated of 1¼″ wrought iron pipe in the form of a grid, spaced on 13½″ centers. The driveway is 85′ long, 9′ wide, has a bend with radius of curvature of approximately 40′ and 10% grade. The water-anti-freeze mixture is heated by a "Whitlock" type R exchanger utilizing plant steam. The grids are installed in a 6″ concrete slab overlaying an 8″ crushed rock fill. Catch basins are installed at the top and bottom of the drive, with the grids passing through the basin to prevent its clogging with snow and ice. Sleeves are used over the grids where they are exposed in the basins, thus controlling the emission of heat and giving the pipe added protection.

The snow melting system installed at the Stouffer Restaurant in Detroit, Michigan, which has been referred to previously, illustrates another method of handling the heating, circulating and control equipment for the system. The contractor on this installation assembled the equipment on a rack, reducing the on-the-job assembly to merely setting the rack into position and welding the joints. Pipe for the job was cold bent, flame cut and electrically welded. To obtain a high melting rate, and thus avoid having dirt tracked into the restaurant, 1″ pipe on 12″ centers was used. Where the 1½″ supply lines came close to the building, they were insulated to prevent cracking the carrara glass of the building front.

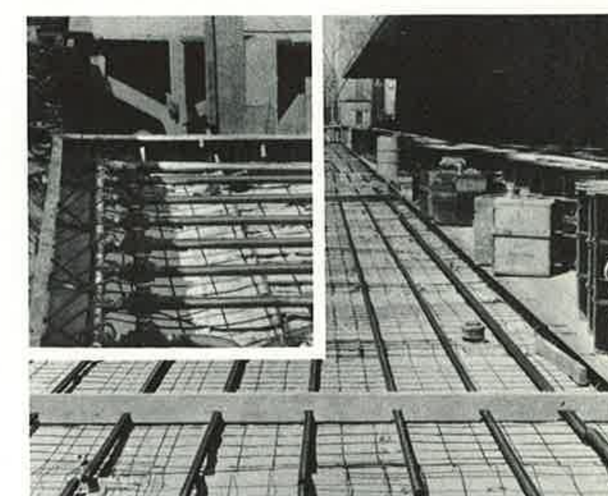


Figure 48: Snow melting system being installed in loading dock at Wallingford, Conn., plant of American Cyanamid. System is operated by waste heat. *Figure 49 (inset):* Balancing cocks at headers were added because of long run.

Figure 50: The 10% grade in this drive at The Bigelow-Sanford Carpet Co., Amsterdam, N. Y. would make it unusable after snow—except for the snow melting system.

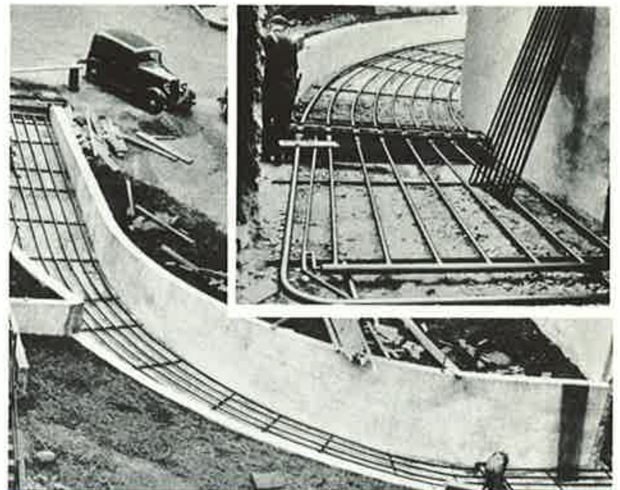


Figure 51: A long, curved grid at Bigelow-Sanford provides quick melting. *Figure 52 (inset):* Grids go through catch basins, keeping them open in all weather and assuring good drainage.

Boiler Accessories

All fluid heating systems must provide room for expansion of the heating medium, and snow melting systems are no exception. Expansion tanks of both the elevated-open type and the closed low pressure type have been used. Standard practice with hot water heating systems may be followed here, remembering that the temperature of that part of the water in the pipe will be at a considerably lower temperature than is common in hot water heating systems; consequently, more room must be provided for expansion.

In some systems, means have been provided for adding the anti-freeze solution through the expansion tank. Larger systems, such as the Toll Booth snow melting system previously described, may make special provision for adding the anti-freeze through a reservoir fitted with a valve at the top and coupled into the system so the flow can be run through it or by-passed around it as desired. Closed expansion tanks are frequently fitted with a sight glass, and with a manual valve for venting.

Vents for the removal of air from the system are installed at all high points of the system or where the plane of the piping changes. They may be automatic or merely a manual valve.

Wherever possible drains are provided at the low point of the system; otherwise provision is made for blowing out the lines with compressed air. Annual draining is not recommended.

Systems involving long runs or complicated layouts usually employ balancing cocks to equalize the flow through all parts of the system, although offices have been used for this purpose.

Figure 53: Grids of the installation at Stouffers Restaurant, Detroit, Michigan, curve around obstacles. Lines near glass facing at base of building are insulated to protect glass.

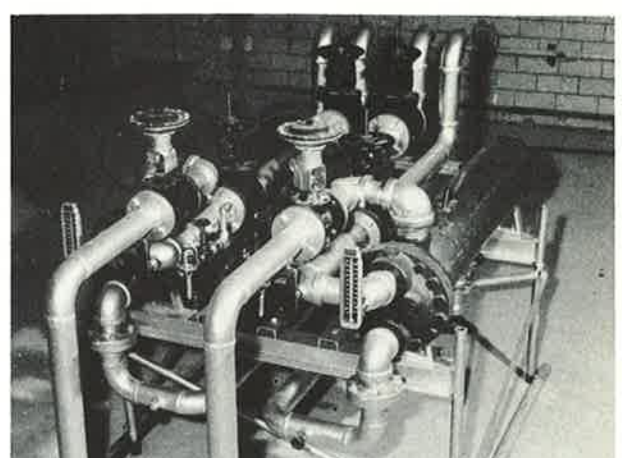


Figure 54: All elements of the heating system for the Stouffer snow melting installation are mounted on one small rack, saving space and installation time.

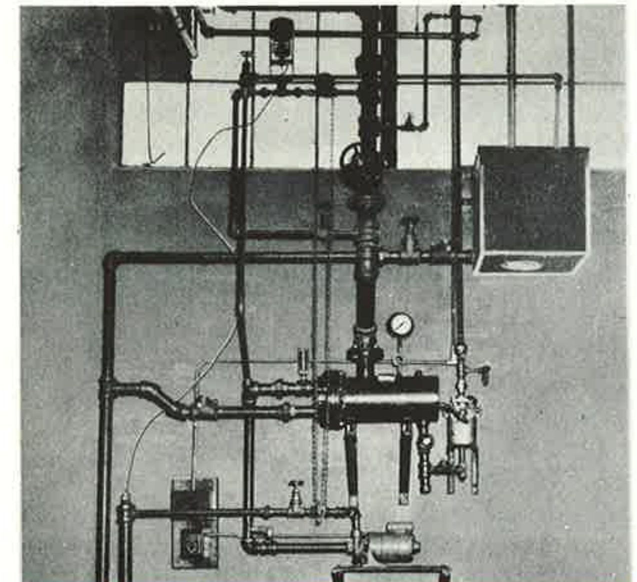


Figure 55: Wall mounting of pump, heat exchanger and controls saves valuable floor space for Bigelow-Sanford.

Provision for filling the system with water may be either a temporary or a permanent installation. If, as is virtually always the case, the system is to be protected from freezing by the addition of a permanent type anti-freeze, any permanent installation should include a check valve as well as filling valves and the line should be opened or a union broken between the system and the water supply line. Ethylene glycol, the base of the permanent type anti-freeze, is poisonous when taken internally; therefore, allowing any chance for it to get into the water supply would be extremely negligent.

The designer should take every reasonable precaution to avoid any possible back syphoning of the water—ethylene glycol solution into the potable water supply, as well as the entry of water through the automatic fill-up valves. In the event that part of the solution would escape through air vents, valve stem leaks, pump gland, etc., the automatic fill-up feature may gradually dilute the anti-freeze to a dangerously low concentration with a resultant potentiality of the medium freezing during periods of inoperation.

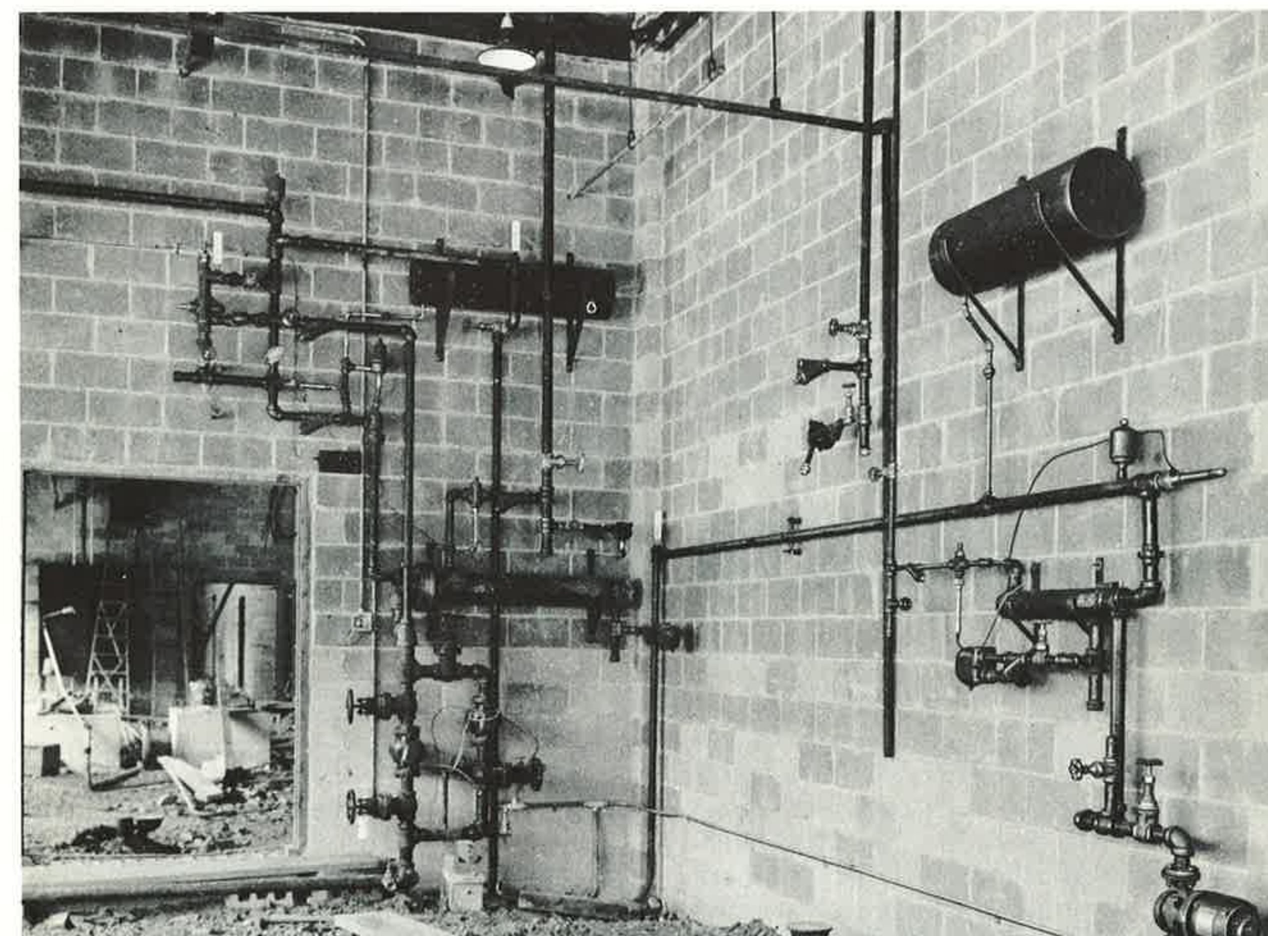


Figure 56: This picture shows all the equipment necessary to circulate No. 2 fuel oil at 45°F in grids under the freezing tunnels and cold storage rooms (*right wall*), and to provide radiant heat (*back wall*) for Adams Apple Products Co., Aspers, Pa.

Controls

For smaller systems such as are frequently installed in private homes, the only controls usually incorporated are an on-off switch, and an aquastat to prevent overheating. Since it is not usually essential to have complete melting of the snow from the start of the fall and it is usually desirable to operate at as low a cost as possible, these systems rely on their relatively short warm-up period and a somewhat higher melting rate, rather than anticipation of the fall of snow.

In larger systems, or those with thicker paving and consequent slower heating, more complicated systems of control frequently are considered advisable. Such systems may incorporate an aquastat to control the fuel valve and/or the circulating pump. When the heat is supplied by a coil in an existing boiler, the proper temperature of the heating fluid in the snow melting system is obtained by a proportioning valve which by-passes enough of the cold fluid around the heater to bring the resulting mixture to the proper temperature. The output temperature of most systems may be varied somewhat according to the demand of the snow melting system.

Where it is desired to keep an installation free of snow at all times, controls are available which will start a system in operation at any time that the air or ground temperature falls to a predetermined point, usually 35°F.

A limited amount of success has been obtained with photo-electric devices designed to turn on a system when or shortly after a fall of snow has started, but these are still largely in the experimental stage. Much better results have been obtained with a weighing device which starts the system in operation when a predetermined amount of snow has collected on a perforated pan. This system must be shut off manually.

Automatic controls exist which have the ability to regulate the heat supply in accordance with the outside temperature, but at present no automatic device has been perfected to regulate the heat supply in accordance with the amount of snow falling.

There are also many other types of controls available which can be readily adapted to snow melting systems in which special needs exist.

Paving Design and Fill

Fill under snow melting systems should be crushed stone, washed gravel or similar materials. Acidic materials should not be used. Cinders, some types of slag and other sulphur bearing fills are corrosive to all piping materials, both ferrous and non-ferrous, and should be be avoided. Even some types of brick have been known to cause corrosion.

Since the temperatures involved are less than those caused by the summer sun, snow melting systems operating at normal temperatures (130° to 160°F) have shown no tendency to soften bituminous surfaces, and have had no other detrimental effect provided the piping is covered with a minimum of 2″ of surfacing. For installations where heavy loads are anticipated, it is usual to cover the pipe with at least 3″ of surfacing. With this much cover, unless very unusual loading conditions exist, failure of the pipe by crushing need not be considered.

The cover necessary with concrete construction has generally been regarded to be a minimum of 2½″, although it has not been established that this is the absolute minimum. Good concrete practice normally calls for a minimum slab thickness of 4″ in sidewalks, 5″ in residential driveways and light loading areas, and 6″ to 8″ or more in loading areas, highways, etc. The piping should be fully embedded in concrete with a minimum of 1″ between the bottom of the pipe and the gravel fill. Short pieces of ¾″ pipe, angles or bars can be used to raise the piping above the fill before pouring the concrete.

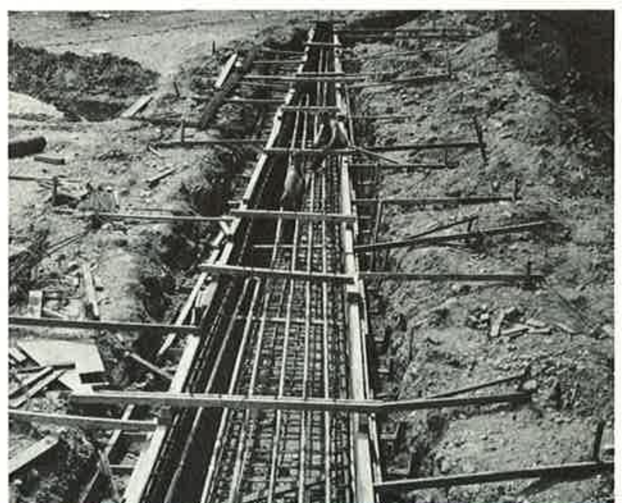


Figure 57: Coils were cast into the reinforced concrete trackway for the American Airlines hangar doors at the Chicago Municipal Airport.

It is a common practice to add calcium chloride to concrete poured during weather when freezing temperatures exist or are expected. This admixture is not used as an anti-freeze agent, but rather to accelerate hardening of the concrete or to produce higher than normal strengths at early periods. The "Specifications for Cold Weather Concreting" prepared by the Structural Bureau of Portland Cement Association limits the calcium chloride to 2 pounds per sack of cement.

Because calcium chloride is a corrosive substance, it it undesirable to embed heating pipes in concrete that contains even small percentages of calcium chloride.

Consequently, it is suggested that a high early strength concrete be obtained by other means.

As a substitute for calcium chloride as an accelerator, the Portland Cement Association suggests the use of "high early strength" concrete. For protection against low temperatures, the Association recommends that shelter and heating facilities be adequate to maintain normal concrete at 70° for 3 days or 50° for 5 days, or to maintain high early strength concrete at 70° for 2 days or 50° for 3 days.

The snow melting system itself can be used to maintain the concrete at the proper temperature. Since the piping is always pressure tested before the pouring of the concrete, it would entail very little extra work to set the boiler and put the system in operation. Portland Cement Association's specifications call for a maximum concrete temperature of 80°. It is advisable to adjust the boiler aquastat or to provide a set of accurate controls to limit the supply water to an 80°F maximum. The system can then be operated until the desired concrete strength is obtained. A concrete temperature above 80°F may result in flash curing and/or a lower strength concrete.

Standard practices for protection and wetting of the concrete should then be followed.

Where installation of a snow melting system is to be made in a concrete structure, it is usually not necessary to change the design of the structure. The presence of the pipe may act as reinforcing, but this possibility has not yet been completely substantiated. If the design of the system calls for the use of reinforcing, it may be installed either above or below the piping. Reinforcing installed above the piping (or below, but to a lesser degree) helps to distribute the heat more evenly over the surface of the installation. Since the temperature of the concrete does not get any higher while a snow melting system employing normal temperatures (130°F to 160°F) is operating than it would during an ordinary summer day. Provision for expansion is normally the same as would be provided for similar construction without a snow melting system.

Figure 58: Pacific oil-fired boilers provide heat for the snow melting system protecting the concrete walk and driveway of Bennett Motor Co., Salt Lake City, Utah.

Figure 59: Coils buried in the steps and walk remove snow and prevent ice from forming. Installation is at the home of T. Napier Adlam, West Orange, N. J.

Fabrication and Installation

A snow melting system is virtually all pipe. Fabrication of these systems will demand a knowledge of the best techniques for bending, cutting and welding wrought iron, for wrought iron is recognized as the most desirable piping material for these systems.

Wrought iron differs substantially from steel in some respects, little in others. Virtually any operation which can be performed on steel can be duplicated on wrought iron, although the conditions under which it can best be done may vary. Wrought iron is characterized by the presence of very tiny threads of a special type of slag distributed throughout the metal, and lying parallel to the direction of rolling. It is in large part due to these tiny threads of slag (between 200,000 and 250,000 per square inch) that wrought iron owes its excellent properties, and it is because of them that some slight changes must be made in certain types of fabrication.

The bending of wrought iron to form sinuous coils is an operation frequently performed, both in the shop and on the job. To get a satisfactory cold bend with wrought iron it is necessary, as with other piping material, to do the bending steadily and evenly, and in such a manner that the bending force is applied to the unbent portion rather than to the part which is already bent.

Figure 60: Photomicrograph of wrought iron, showing glass-like threads of silicate which act as barriers to corrosion.

Hand methods of bending have been used with complete success and are considerably faster on 1¼″ and smaller pipe. A portable hydraulic or electric bender saves time on larger sizes and gives assurance of uniform bends. The illustration below shows a hydraulic bender being used to form the coils of the sidewalk snow melting system installed for The Union National Bank of Pittsburgh, Pa.

Wrought Iron pipe may be fusion welded either with gas or the electric arc method. With gas welds a neutral flame and enough heat to get good fusion, coupled with minimum rubbing or agitation, give the best welds. Because of the silicate slag in the wrought iron, the surface to be welded takes on a greasy appearance at temperatures below those necessary to fuse the iron. Care should be taken not to mistake this condition for actual fusion, but to continue to heat until it is obvious that the iron is melting. Ordinarily just enough of the parent metal should be melted to provide a sound bond with the filler material.

Figure 61: Portable pipe bending equipment makes uniform bends and saves time for The Union National Bank, Pittsburgh, Pa. snow melting installation.

A few of the suitable rods are listed in the following table:

Type of Rod for Gas Welding. Avoid rods containing high carbon or alloys intended only to increase strength of deposited metal. Use any high quality, low carbon rod suitable for welding steel, such as:

TYPE	MANUFACTURER
Airco No. 4 or No. 7	Air Reductions Sales Co.
Oxweld High Test No. 1	Linde Air Products Co.
Page "C" Gas Wire	Page Steel and Wire Div. American Chain & Cable Co.

Any make of rod of *similar type and quality* should produce good results. The rods listed are merely some of those with which we have had first-hand experience. In general, rods meeting requirements of AWS Designation A-251 grades GA 60 and CB60 are suitable.

For welding, it is generally desirable that the composition of the deposited metal have as nearly as possible the same composition as the pipe. Thus the rod used should contain enough of those elements which normally burn out to take care of the oxidation losses. The table lists some of the rods which have been found to give satisfactory welds on wrought iron. Technique is similar to that suitable for soft steel, with the exception that the arc voltages and amperages should be slightly lower and welding should proceed at a slightly reduced rate.

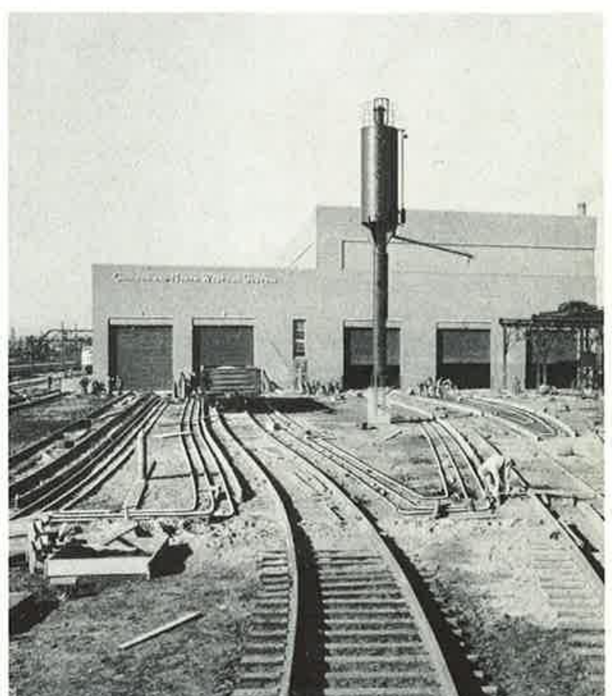


Figure 62: Grids for the snow melting system beneath platforms of the diesel locomotive shop in the Chicago yards of the Chicago and North Western railroad. Keeping these platforms free of snow and ice enables employees to inspect and work on locomotives more easily and safely.

Type of Rod for Arc Welding

Use any high quality coated rod suitable for welding soft steel, such as those below. Rod types are listed according to use and AWS specification numbers.

Manufacturer	All Position Rev. Polarity D.C.	Poor Fit Up All Position	All Position A.C. or D.C. Universal
	E6010	E6012	E6011 on A.C. E6010 on D.C.
Air Reduction Sales Co.	78E 79E	87	230
Champion Rivet Co.	Blue Devil	Gray Devil	Bluedac
General Elec. Co.	W-22	W-20 & W-30	W-26
Harnischfeger Corp.	AP	PF & FW	AC 1
Hollup Corp.	Sureweld B	Sureweld N	Sureweld C
Lincoln Elec. Co.	Fleetwood No. 5	Fleetwood No. 7	Fleetwood No. 35
Metal & Thermit Corp.	Vertex	Genex	Type A
Page Steel & Wire Co.	C	F	—
A. O. Smith Corp.	SW 10	SW 11	SW 15
Westinghouse Elec. & Mfg. Co.	Flexarc AP	Flexarc FP	Flexarc ACP

Any make of rod of similar type and quality should produce good results. In general, rods meeting requirements of AWS Designation A-233, classification numbers E6010, E6011, E6012, E6013, E6020, and E6030 are suitable.

Since sloppy welding can partially or completely plug a line and result in faulty or unsatisfactory operation, close attention should be paid to securing proper clearance before welding and to obtaining neat, sound welds.

Figure 63: Gas welding a sinuous coil for sidewalk installation for The Union National Bank, Pittsburgh, Pa.

While it is not frequently done, snow melting systems have been completed with threaded joints in areas where welders were not available.

Wrought iron's characteristic structure makes the threading of Byers Pipe easy. The same iron silicate fibre inclusion which gives Byers Pipe its well-known corrosion and vibration fracture resisting properties also is responsible for its exceptional threading quality. Less resistance is offered the progress of die-chasers through wrought iron than other piping materials. Good threads are cut quickly and with minimum effort.

Flame cutting of wrought iron can be readily accomplished by reducing the oxygen and gas pressure to nearly half of the pressures normally used on the same thickness of soft steel, and also reducing the speed of the cut. These measures are necessary because the slag in wrought iron acts as an insulator, requiring a longer time for the heat to build up to the point where cutting can occur. Four hole cutting tips usually work better than three hole tips on wrought iron.

Figure 64: Electric welding grids for snow melting system installed for John W. Gnagey & Son, Somerset, Pa.

The Service Bulletins "The Bending and Flanging of Wrought Iron Pipe," "The Welding and Flame Cutting of Wrought Iron" and "The Threading of Wrought Iron Pipe" are available upon request to the Engineering Service Department or any of the division offices listed on the back page of this bulletin.

Most contractors find it desirable to do as much of the fabricating as possible in their shops, because of the convenience of having at hand all the tools they are likely to need and because of the ability to work comfortably during inclement weather. This means that, because of differing means of transportation, no set method of fabricating will apply. One method of handling coils has been found useful. By springing the adjacent coil loops together (not enough to bend them permanently) and wiring in the sprung condition to a suitable support it is possible to handle larger shop assemblies, with less labor necessary on the job.

After the assembly of the system has been completed it is essential to test the installation for leaks. The system is filled with water, all air vented out and hydraulic pressure is applied for a minimum of several hours. The recommended range of pressure for the test is between 125 pounds and 200 pounds. If leaks are found, they should be sealed and the system retested until the installation will hold pressure for at least 4 hours. Many contractors leave the test on overnight during warm weather. Once the system is leak-free, the job is ready to bring to final grade and to install the paving.

During winter weather considerable care should be exercised during hydraulic testing of the piping system. If temporary heat to maintain the area at above freezing temperatures is not available, it is suggested that the testing solution consist of a permanent type anti-freeze and water. A sufficient amount* of anti-freeze should be added to prevent damage to the piping by solid ice freezing.

There have been several instances where vent line piping has frozen due to inadequate draining of a system after testing. In these instances, the water was blown out of the system by air under pressure and the vent lines were neglected. Accidental freeze ups of this type can be eliminated if, after the system has been tested and found tight, the system is filled with a water-ethylene glycol solution of the proper strength.

* The manufacturer of the anti-freeze should be consulted to determine the proper percentage.

Figure 65: Use of a jig during fabrication of grids saves time and assures proper positioning of pipe.

Installation and Operating Costs

While the cost of installing a snow melting system will vary with the requirements placed upon the installation, there are certain easily determined material and equipment costs which can be readily fixed in each case. The major variable which has made it difficult to estimate installation costs during the early stages of the development of snow melting is the experience of the fabricator and/or the contractor. Since snow melting piping is relatively inaccessible, specifications almost always call for welded joints. At the same time, to minimize material and labor costs, all coil loops and other changes in pipe direction are normally formed by cold bending, a fabricating technique that the average plumbing and heating contractor does not follow extensively except in radiant heating work. The skill and efficiency of contractors in handling these essential installation practices varies widely and is usually responsible for the range of cost figures on similar installations.

However, the tremendous popularity of both radiant heating and snow melting during the past five years has created a demand for these systems at a reasonable cost. The result has been that recent installations (1947-1949) have been completed at unit costs which are quite consistent. For the average driveway, sidewalk, or loading zone, installation costs of snow melting systems have ranged from $1.00 to $1.80 per square foot of area to be melted. For large roadways, parking areas, and similar spaces, costs as low as $.75 per square foot of area

Figure 66 (left): Track melting installation in driveway of J. C. Keaney, Mt. Lebanon, Pa.

Figure 67 (right): Instantaneous hot water heater furnishes heat for this installation.

to be cleared have been reported. One company has reported an estimated cost of less than $.40 a square foot for a fairly extensive but uncomplicated system installed by company employees. On the other hand, small complicated piping assemblies for irregular areas have in some cases cost over $3.00 per square foot. In these latter cases, the lack of a low-cost heating unit to do a small, but critical, melting job was partly responsible for the high unit costs.

No actual cost figures are available which are directly applicable to such large snow melting installations as airport runways, or similar areas. Systems of this magnitude permit tremendous economies in the automatic welding of large pipe grid sections, and estimates for airport runway systems considered over the past five years have ranged from $.30 to $.60 per square foot of runway area. Test installations consisting of small sections of several runways are currently being studied, and additional data on systems of the runway type and size will be available in the near future.

All installation costs given above are based on the complete clearance of the area, and a snowfall rate of 1″ per hour. Obviously no general unit costs can be given for irregular melting patterns or rates, but some specific installations may be cited.

For example, a track installation made at the residence of Joseph Keaney, a ceramic engineer of Mt.

Figure 68: A combination of grid and sinuous coil is used at the Swearingen Motor Co., Portland, Maine.

Lebanon, Pa., cost approximately $500 for 110 square feet of surface. In this installation, the old concrete tracks were torn up and 2 runs of 1¼″ wrought iron pipe connected at the sidewalk were laid on a gravel fill in each bed. Thus, a supply and return line in each track, installed on 8″ centers, provides the necessary heat to melt the snow or ice which accumulates on the new asphalt paved drive. A Ruud instantaneous water heater was used to supply the heat. On one occasion this system melted ½″ of ice in 20 minutes from a cold

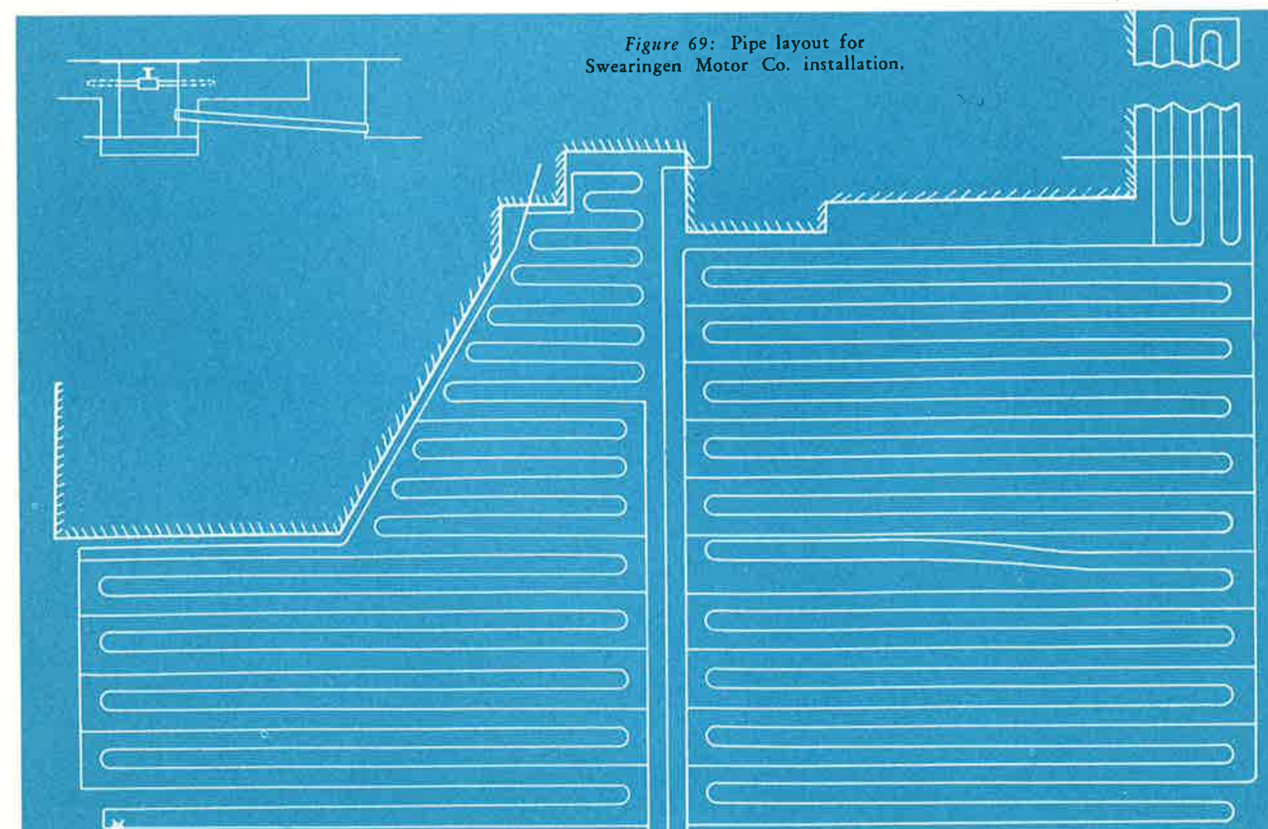


Figure 69: Pipe layout for Swearingen Motor Co. installation.

start, and at another time removed 15″ of snow in 2 hours at a fuel cost of 60c.

Many factors are involved in the cost of operating a snow melting system such as type of fuel, efficiency of the heater, rate of melting, etc. Figures for all installations for which data are available indicate that, in spite of this, the maximum operational cost spread for systems operated only during snowfall is not much more than 100%. The least expensive operation reports a cost of 5 to 7 cents per 1000 square feet per inch of snow melted. The most accurate data obtained, on metered steam purchases from a central heating station, indicated an operating cost of 11.5 cents per thousand square feet per inch of snow melted.

Operational Practices

Snow melting practices may be classified into two general categories, intermittent and continuous operating. For many installations complete freedom from snow or ice, however desirable, is not necessary. In such cases, no attempt is made to keep the surface clear as the snow falls but rather to remove accumulated snow within a reasonable time, usually by providing for a faster melting rate. This type of operation is known as intermittent operation.

On the other hand, where an area is in service all or most of the day, or where the extent of the installation and its heat capacity make the design of the system for rapid warm-up too expensive, the system may be kept continually just above freezing. This type of operation is called continuous, even though such systems usually cease to operate at temperatures above about 35°F.

Intermittent heating is widely employed. Residences usually have this type of operation. Garages, loading docks, sidewalk installations for small businesses, theaters, and similar types of areas, which are out of service for at least a part of each day, find it entirely satisfactory.

Many of the installations to which reference has been previously made are of the continuously operated type. The highway installation near Salem, Oregon, the Toll Booth installation in Connecticut and the roadway installation at the Bridgeville plant of the American Cyanamid Company all use this method. Clubs, large stores, banks, and a variety of institutions located in districts of considerable commercialization have also made use of this method of operation.

Most continuous systems which are not employing "waste" heat find it advisable to employ a two heat level type of operation. During periods when the temperature is near or below freezing, these systems operate at a reduced level. One common method of accomplishing this is by establishing control by means of an aquastat located in one of the mains of the system, usually near the return main or a bulb located in the paving itself. Another method utilizes a timing device similar to that used by domestic stokers to operate the system for a pre-set length of time at half-hourly or hourly intervals. With the onset of snow either method assures that the system will be already above the freezing point, so that snow cannot collect or ice form.

Since the use of controls established in the paving slab or in mains adjust the system to changes in temperature conditions, the first method is usually the more satisfactory.

With either type of operation a number of variations are possible. Pumping for example can be continuous, but with a throttling type of heat control it need not be, provided control of the pump is tied to the heat requirements of the system by using the paving slab or main temperature to control circulation. It is more usual, however, to control the operation of the heater on the basis of the temperature of the return main and to circulate continuously.

Calculations made by Jas. E. Saunders & Associates on the snow melting system of the Swearingen Motor Company showed that the operating cost for the season of this 8400 square foot installation was $216. The season included 26 storms during which a total of 80″ of snow fell, making season cost $25.72 per 1000 square feet. This system is oil fired, and is tied in with the operation of the radiant heating system. A timer operates the pump seven minutes out of every half hour. The same boiler is used for their radiant heating installation.

Because this system is operated to keep the area continuously above 32°F throughout the winter, the cost per thousand square feet per inch of snow melted ($.32) is extremely high. Most continuous systems operate on waste heat, hence no accurate data are available.

Figure 70: Snow melting installation at the Brusco Funeral Home cleared walks quickly after Pittsburgh's record 30-inch snowfall in November 1950.

Examples of Complete Installations

Frozen track switches often cause a great deal of trouble for railroads and street railway companies, but the engineers of the Cleveland Railways Company, Cleveland, Ohio, believe they have found an economical solution that will prevent winter-time traffic delays resulting from non-functioning switches.

Essentially, the de-icer consists of a 600 volt, 2000 watt electrical heating element encased in a 8′-10″ piece of 1½″ wrought iron pipe. A suitable junction box for making the wiring connections is provided at one end, and the opposite end of the pipe is capped and fitted with a terminal for grounding the heating device to the rail. Control is manual and the de-icer is left on continuously during cold weather. The 2000 watt heating elements are larger than are necessary but were used because 1000 watt elements were not available at the time the heaters were made.

A new use was made of a snow melting system when the Peoples Savings Bank of Providence, R.I., was built. In the sidewalks on both ends of the building 6 runs of 1¼″ wrought iron pipe were installed in both 4″ marquee roof slabs to melt the snow accumulating on the marquee and to prevent water, snow or icicles from falling on pedestrians. For the same purpose six runs of 1¼″ pipe were installed in the roof slab on each of the two edges of the building which face the street.

Figure 71: Snow melting system in marquee eliminated danger from falling ice and snow at this Providence bank.

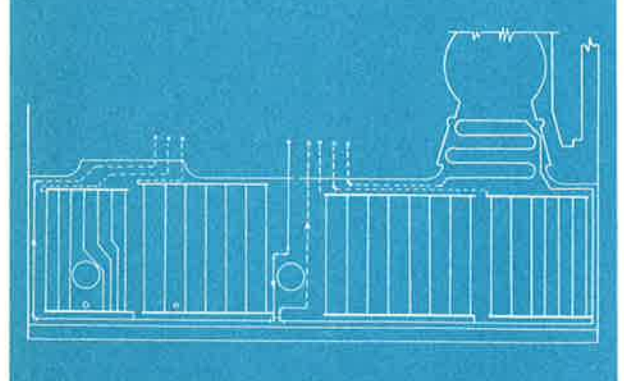


Figure 72: Pipe layout for sidewalk installation at Peoples Savings Bank, Providence, R. I.

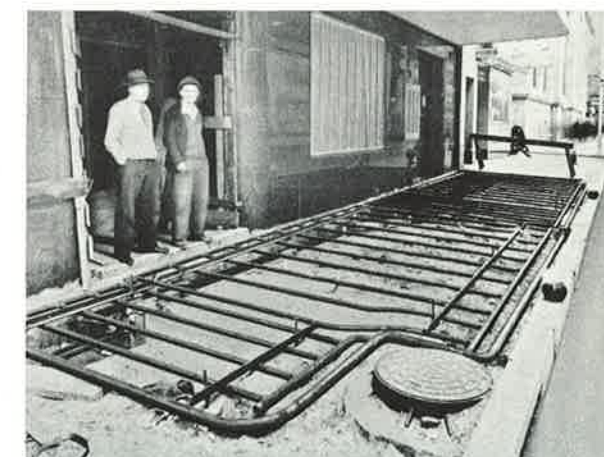


Figure 74: Construction photograph shows grid pattern used in sidewalk installation at Peoples Savings Bank. The sidewalk extends along two sides of the building.

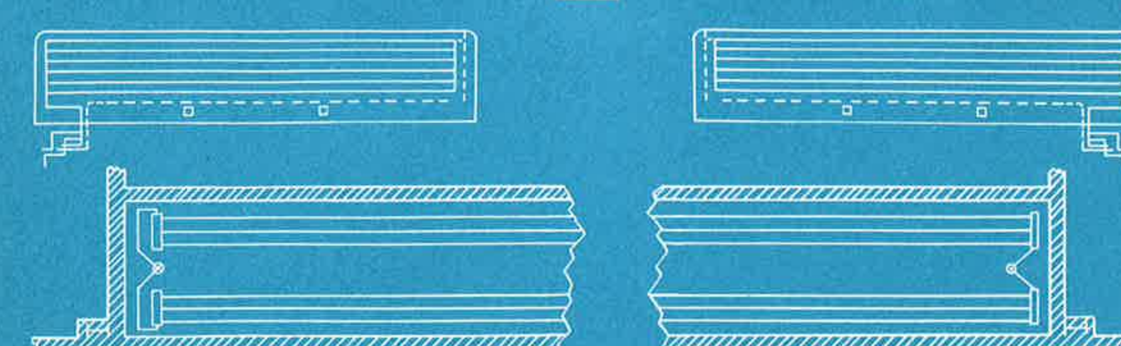


Figure 73: Upper diagrams show pipe layout of marquee installation, lower diagrams of roof installation, at Peoples Savings Bank.

Freddie's Doughnut Shop of Buffalo, N. Y. installed a snow melting system in its parking lot to make it easier to get in and out of their "drive in" and thus to stimulate sales in bad weather. Sinuous coils of 1¼″ wrought iron pipe on 2′ centers were laid over a 5400 square foot surface. The coils were installed over wire mesh reinforcing (6″ x 6″ 10/10) laid on a 4½″ crushed rock fill. A 7½″ concrete slab was poured, covering the coils to a depth of 2″. Pipe expansion joints between sections of the concrete were wrapped with burlap which was wired in place. The capacity of the system, including heater, is 465 gallons of water-anti-freeze mixture, which is circulated by a 3 hp pump at the rate of 116 gpm.

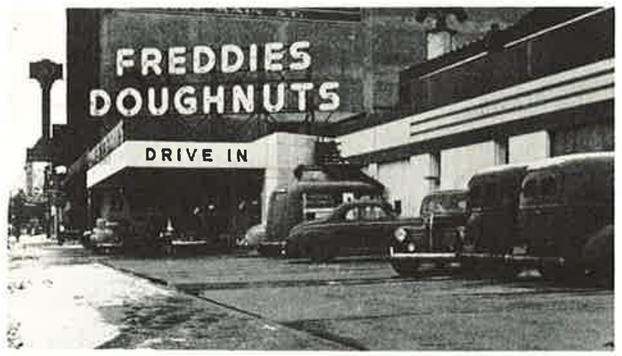
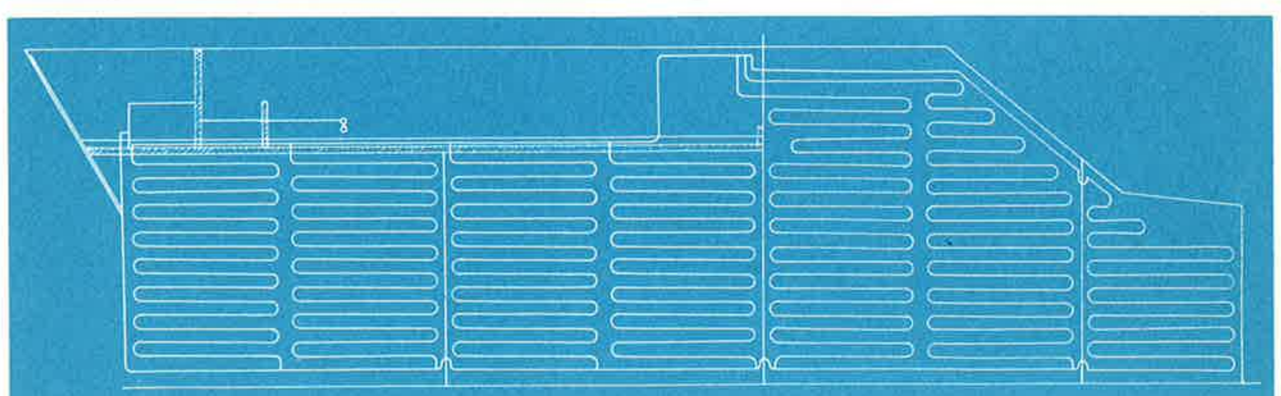


Figure 75 (top): Snow melting means more drive-in patronage, greater convenience for delivery trucks, at Freddie's Doughnut Shop, Buffalo, N. Y. *Figure 76 (center)* shows sinuous coil pattern used in this installation. *Figure 77 (below)* is a diagram of the pipe layout.



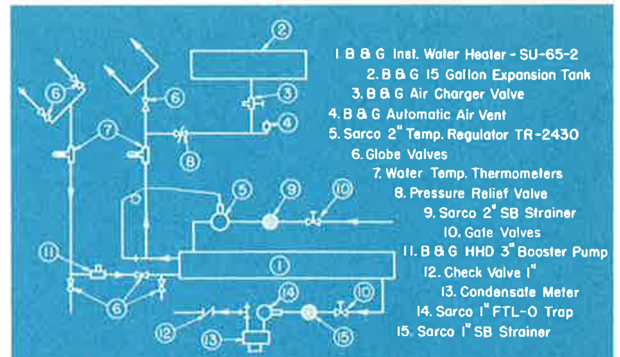


Figure 78: Schematic drawing of heaters, controls and accessories for sidewalk installation at the Duquesne Club, Pittsburgh, Pa. Purchased steam is heat source.

Where it is desired to install a snow melting system in a walk which overlays a basement, construction is complicated by the necessity for supporting the sidewalk from the edges and of preventing the leakage of moisture and heat into the basement. Such an installation was made at the Duquesne Club of Pittsburgh, Pa. The old walk and supporting structure were torn out and a self supporting, reinforced concrete slab was cast into place. After sufficient curing, a 2″ layer of FOAM GLAS block insulation was laid. Next the sub-assembled grid of 1″ wrought iron pipe on 12″ centers was brought to the site and assembly completed. After positioning the grids and connecting the supply and return mains, a mixture of sand and gravel was spread over the whole installation and leveled with the top of the pipes. Light reinforcing mesh was next laid and the 3″ paving slab was poured in five sections. Hot tar was used to seal the installation against the leakage of moisture and to provide for expansion of the paving.

This 1300 square foot installation required 1500 feet of 1″ pipe, 300 feet of 2″ pipe and 200 feet of 2½″ pipe for the completion of the job. A 40% anti-freeze solution at 130°F is circulated by a 3″ pump. Purchased steam at 15 pound gauge is used as the source of heat. A flow diagram with auxiliary parts indicated is shown on this page (fig. 78).

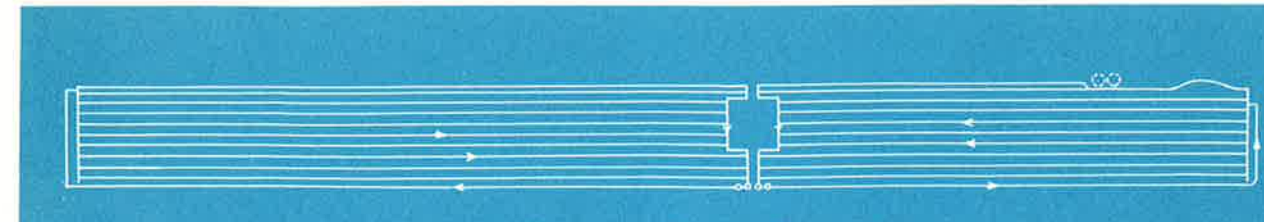
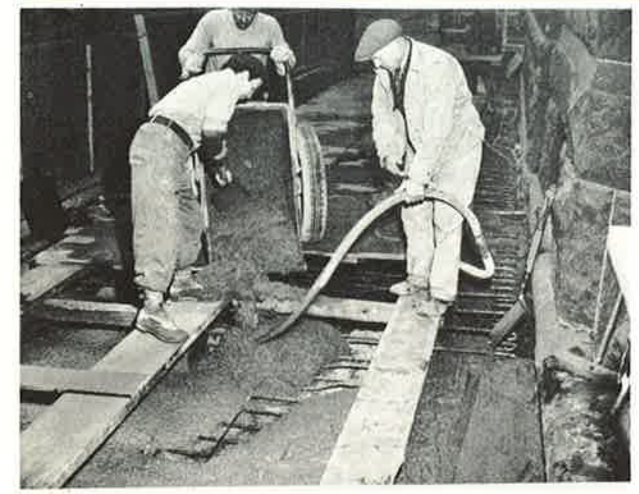
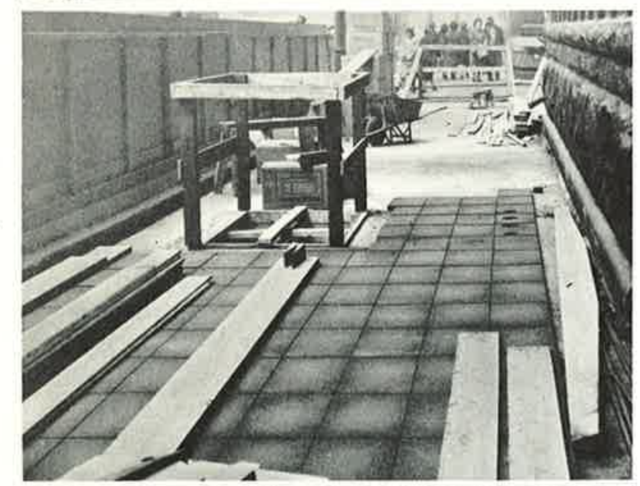
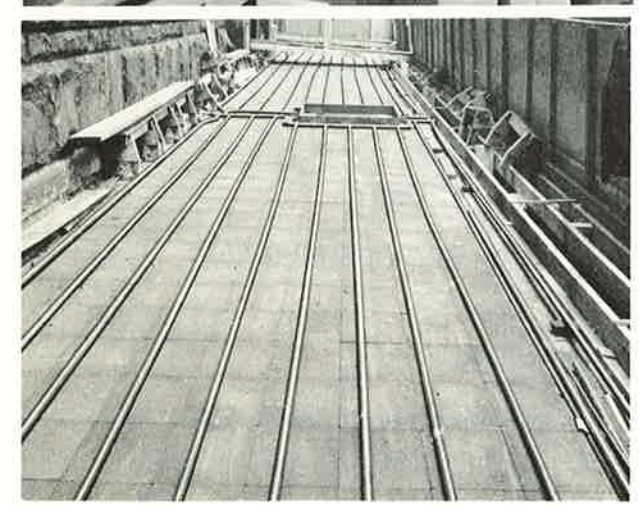


Figure 79: Pipe layout for Duquesne Club installation.







Progressive photographs of sidewalk installation at the Duquesne Club, Pittsburgh, Pa. *Figure 80 (left, top):* Pouring of the self-supported reinforced concrete slab foundation. *Figure 81 (left center):* Placing FOAMGLAS insulation to conserve heat. *Figure 82 (left, bottom):* Grids in place over insulation, ready for hydrostatic testing. *Figure 83 (right, top):* Leveling sand and gravel fill over wrought iron grids, in preparation for pouring 3-inch concrete slab. *Figure 84 (right, bottom):* Sidewalk after record 30-inch snowstorm.

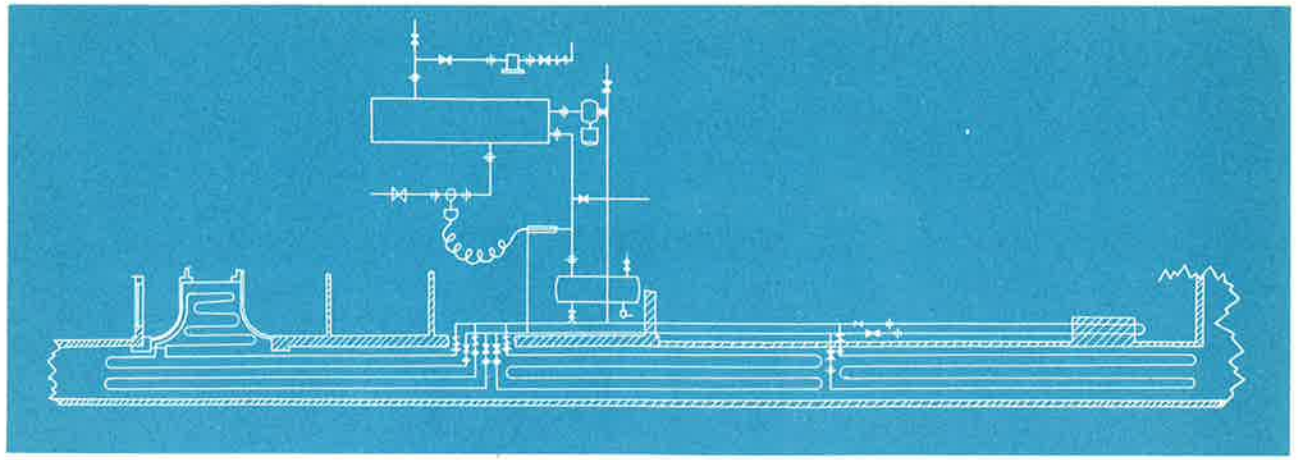


Figure 85: Pipe layout and schematic drawing of heating equipment for the installation at Dewey and Almy Chemical Company, Cambridge, Mass.

The snow melting system installed in the sidewalk of the Dewey and Almy Chemical Company, Cambridge, Mass., also includes the steps and a landing at the entrance to the building. Long sinuous coils of 1″ wrought iron pipe on 11″ centers are used. A water-anti-freeze mixture is circulated at 160°F and returns at 135°F. A flow plan of the system is shown, including heater circulator and auxiliaries.

Frost Prevention Systems

One of the most unusual types of jobs that snow melting systems are performing is that of preventing the formation of ice in the ground beneath cold storage rooms and freezing tunnels. The temperature of these rooms varies between 0°F and —30°F. The most economical type of construction is to pour the concrete sub floor on the ground, install 8″ of cork insulation for those rooms which will have a temperature of near zero and 10″ to 12″ of cork insulation where the temperatures are lower. The concrete floor is then poured. Generally speaking, 6″ of cork insulation reduces heat transfer to an economical level even in the freezing tunnels. The extra cork is included to prevent the ground beneath the sub-floor from freezing and thus buckling the floor. With such an expensive floor, it is doubly desirable to prevent its destruction by the formation of ice under it, but since even doubling the insulation merely delays the formation of ice some other method of protection is necessary.

Three possible methods were considered:

1. Raising the floor off the ground to allow natural or forced connection to remove moisture and temper the bottom of the slab.
2. Heating beneath the floor electrically.
3. Installing a snow melting system.

The first method would have required a considerably greater construction cost, and the operating cost of an electrical heating system was such as to rule this out as a possible solution. The operating cost of heating electrically makes this method disadvantageous.

The third method has been employed with success by at least two organizations—The Adams Apple Products Corporation of Aspers, Pa. and Penn Dairies, Inc. of Lancaster, Pa. Both circulate No. 2 fuel oil at 45°F through a system of grids under the floor. Adams Apple Products Corp. uses ¾″ wrought iron pipe on 3′ centers in the grids under their cold rooms and freezing tunnels while Penn Dairies use 1″ wrought iron pipe on 3′6″ centers. The use of such wide centers in the grids is permissible because the transfer of heat from the ground to the cold rooms is a very slow process.

The necessary heat for systems of this type can be easily obtained from the compressor cooling water or from the compressed ammonia gas. In fact it may be necessary to by-pass part of the flow around the heat exchanger to temper the total flow to 45°F.

Thermocouples installed at several points below the sub-floor of Adams Apple Products showed the following temperature changes:

Time	Earth Temperatures
July (refrigeration started)	60°F
August	50°F
September	40°F
October (heating started)	
December	42°F

Figure 19 shows the wrought iron pipe grids installed below the sub-floor of the Penn Dairies plant during its construction.

Summary

Although snow melting is still in its infancy, it has thoroughly proved its value and these definite statements can be made:

1. Complete and rapid removal of snow and ice from sidewalks, driveways and service areas means increased safety and efficiency for industrial plants, greater good will and increased business for commercial establishments, and some combination of these advantages for homes, hospitals, highways and other places where snow and ice are inconvenient or hazardous.
2. Snow melting systems provide the most rapid and effective method of snow or ice removal, at installation and operating costs which are entirely reasonable in proportion to the benefits derived. In most cases, operating cost will be considerably less than the cost of mechanical or manual snow removal.
3. A properly designed, well constructed snow melting system, using Byers Wrought Iron Pipe, will assure a maximum service life. Systems can be designed for virtually any conceivable solution.
4. The techniques of snow melting can be applied in a number of related situations where prevention of freezing is the objective.

Experience records acquired by A. M. Byers Co., in their close study of a majority of the snow melting systems installed, are available to you without charge or obligation.

Snow melting systems using Byers Wrought Iron pipe are now installed to service the following types of structures: residences, banks, loading platforms, gas stations, driveways (business, apartments, etc.), airplane hangar aprons, stores, office buildings (insurance, etc.), clubs (Duquesne, "21", etc.), department stores, funeral homes, toll booths, theaters, highways, etc.

The list continues to grow as the merits of this type of snow removal become more widely known.

Sales Offices

ATLANTA, GA.	704 Mortgage Guarantee Building
BOSTON, MASS.	2410 John Hancock Building
CHICAGO, ILL.	625 Field Building
HOUSTON, TEXAS	1502 Mellie Esperson Building
NEW YORK, N. Y.	30 Rockefeller Plaza
PHILADELPHIA, PA.	1409 Girard Trust Co. Building
PITTSBURGH, PA.	1501 Clark Building
ST. LOUIS, MO.	1080 Arcade Building
SAN FRANCISCO, CALIF.	225 Bush Street
WASHINGTON, D. C.	935 Munsey Building

A. M. BYERS COMPANY

Back Cover Illustrations

Top Left—Driveways at the Swearingen Motor Company, Portland, Maine remain free from ice or snow, enabling motorists to obtain much-needed winter service.

Top Right—Peoples Natural Gas Company, Johnstown, Pa. has no snow removal problems, as this clear sidewalk illustrates.

Lower Left—The snow melting system keeps snow or ice from forming on the driveways or sidewalks of the Stratfield Hotel, Bridgeport, Conn. and makes for easier access to lobby.

Lower Right—Residents of the Snake Hill section of Belmont, Mass. can rely on their snow melting system to keep this road clear, thus preventing their community from becoming snow-bound.

WHY WROUGHT IRON LASTS

This notch-fracture test specimen illustrates the unusual fibrous structure of wrought Iron . . . which is responsible for the unusual corrosion resistance of the material. Tiny threads of glass-like silicate slag, distributed through the body of high-purity iron, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

A. M. BYERS COMPANY

PLANTS

Pittsburgh, Pennsylvania—6th & Bingham Sts.
Ambridge, Beaver County, Pennsylvania

OFFICES

Atlanta, Ga.
Boston, Mass.
Chicago, Ill.
Houston, Texas
New York, N.Y.
Philadelphia, Pa.
Pittsburgh, Pa.
St. Louis, Mo.
San Francisco, Calif.
Washington, D. C.

LITHO. IN U.S.A.