Feb. 6, 1951 R. S. TICE 2,540,465

ELECTRIC HEATING SYSTEM

Filed Jan. 28, 1947 2 Sheets-Sheet 1

Fig. 1.

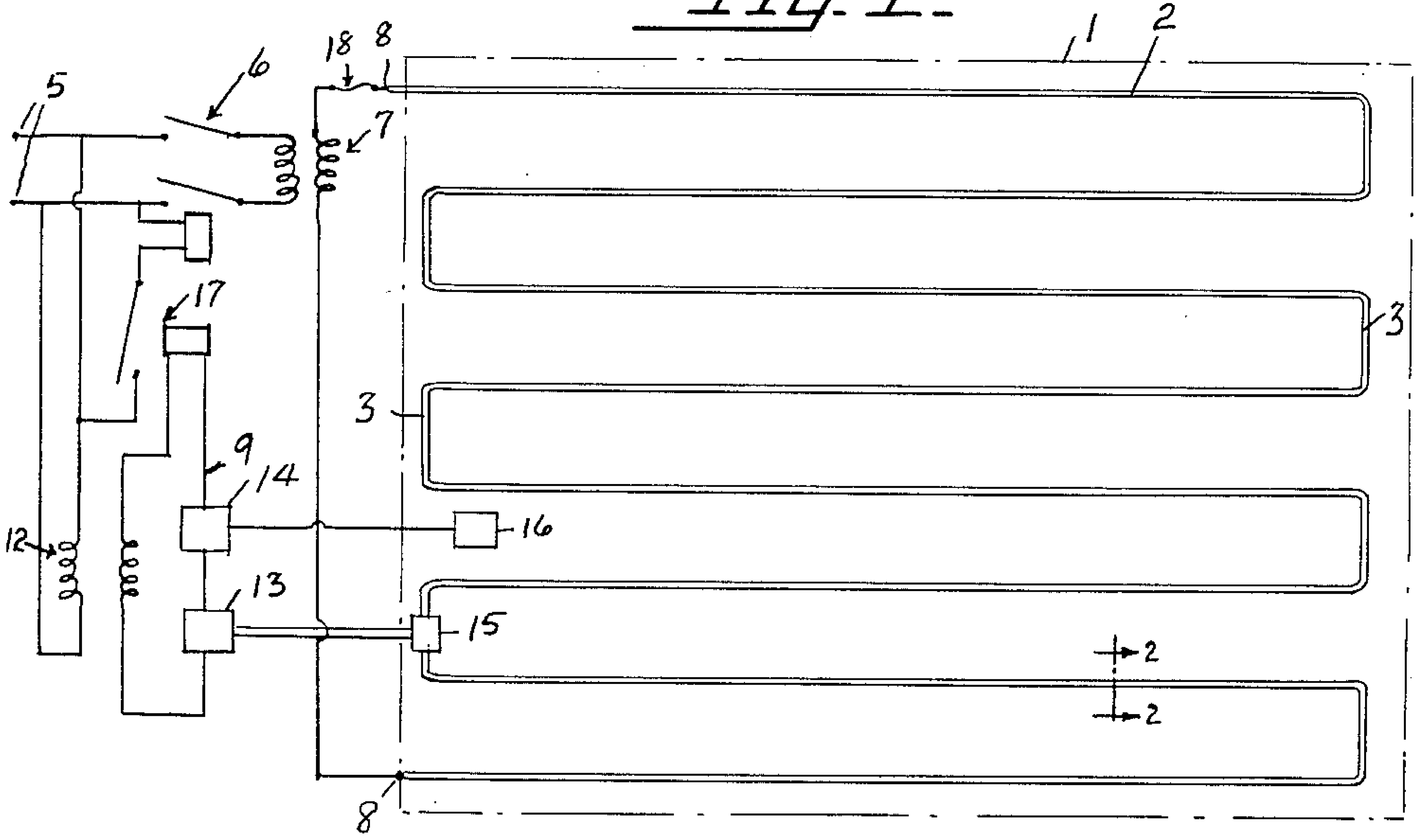

Fig. 2.

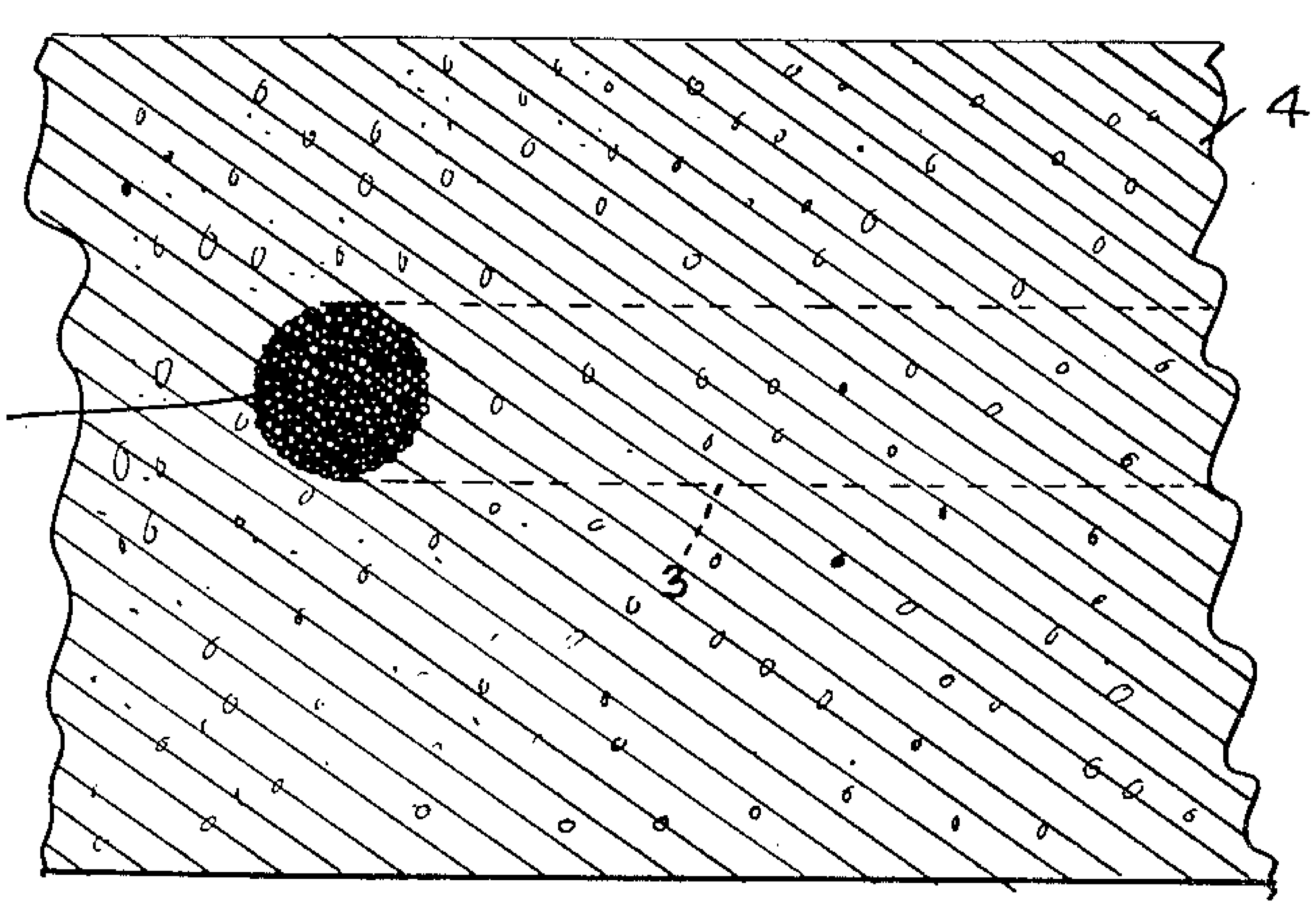

Fig. 3.

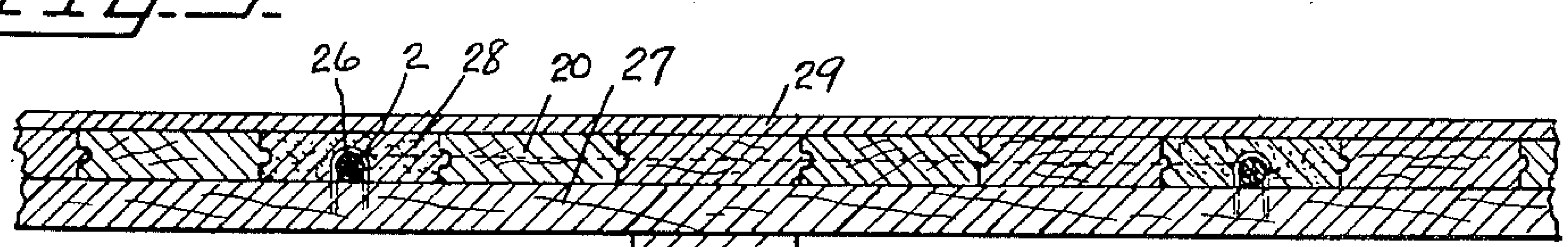

Fig. 4.

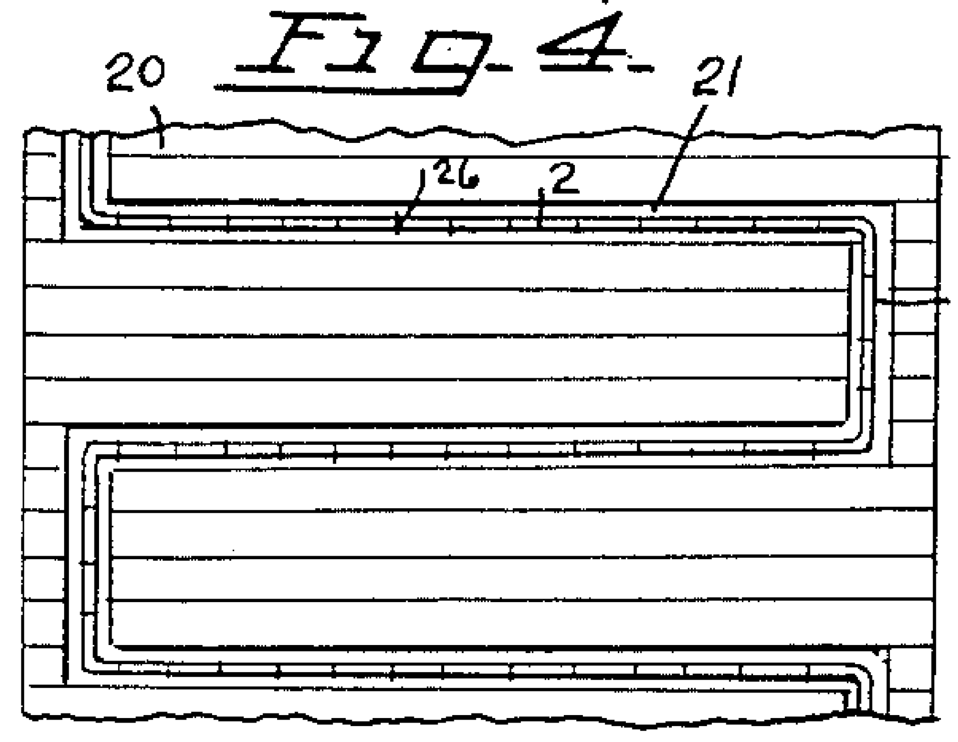

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Fig. 5.

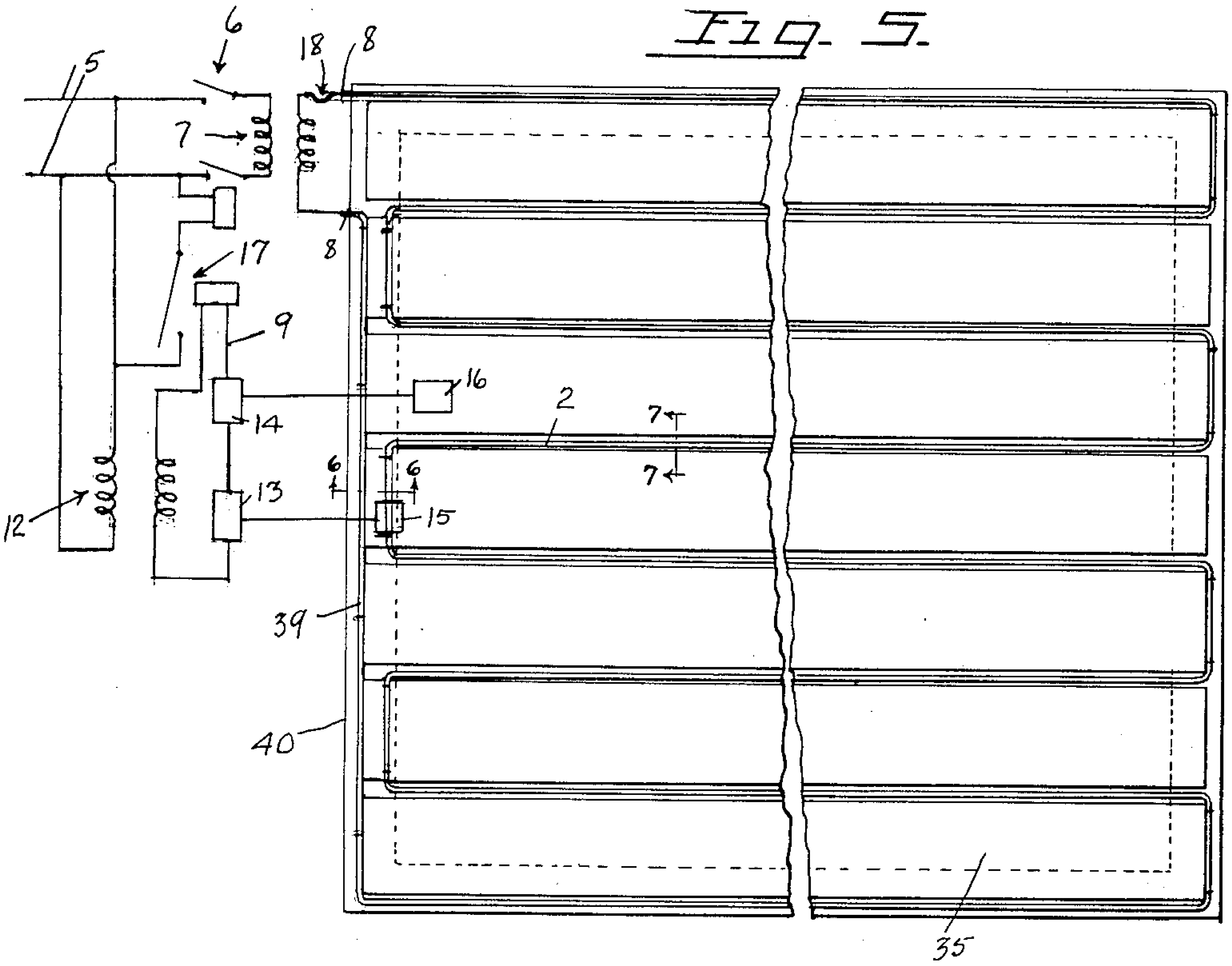


Fig. 6.

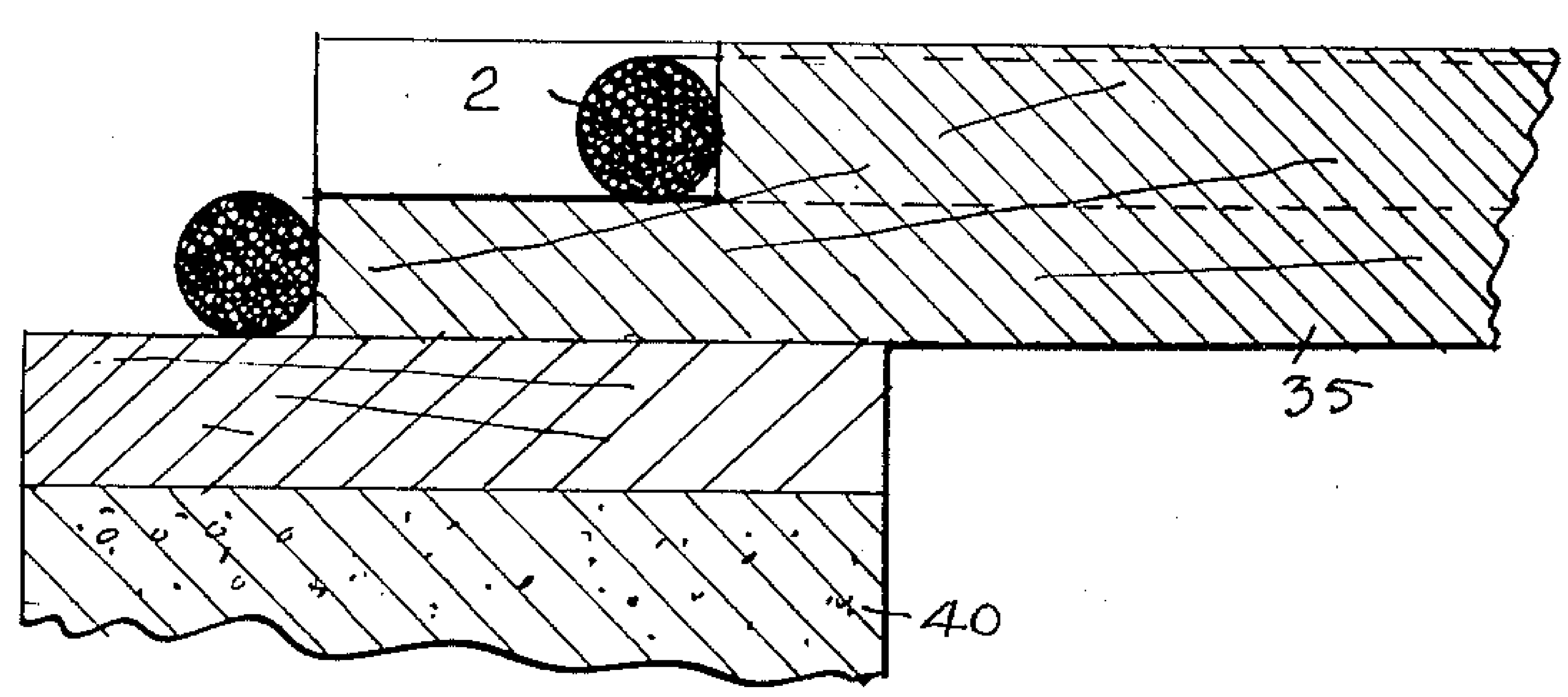
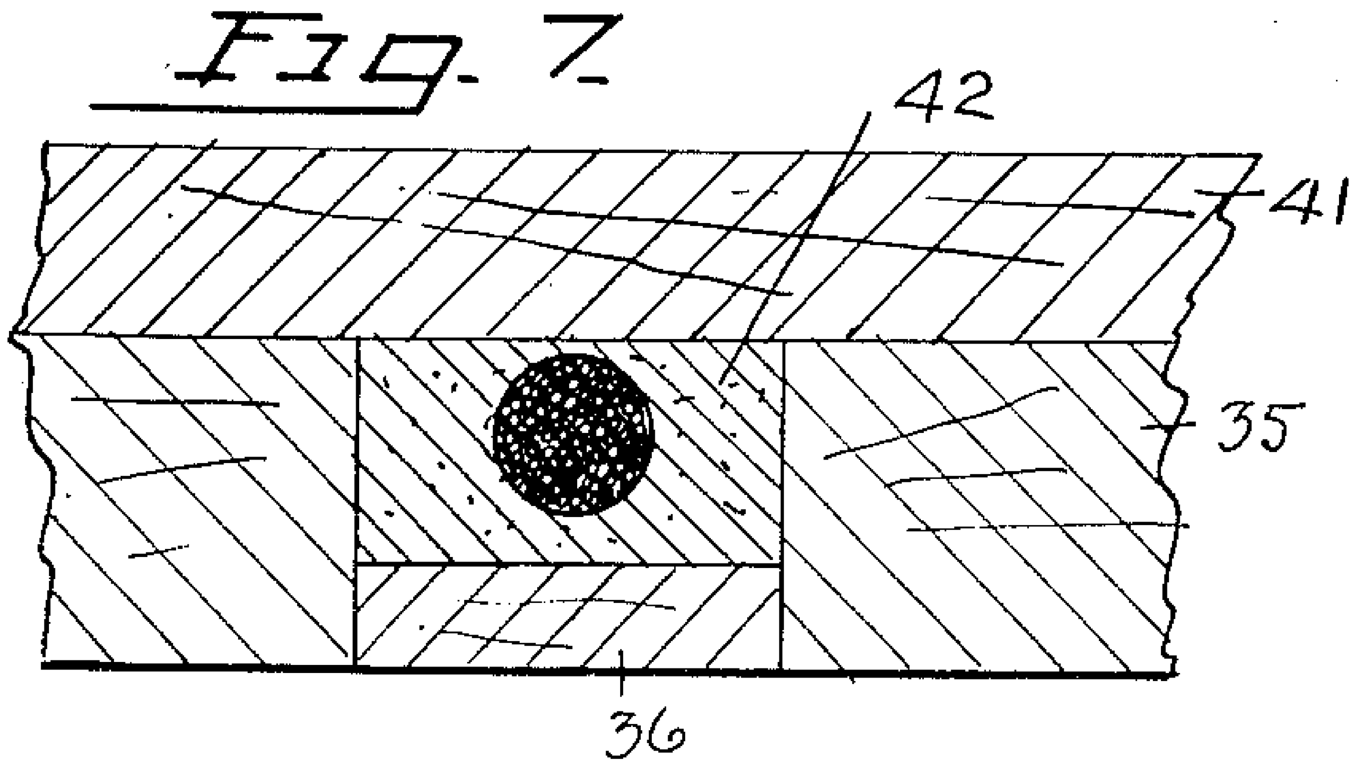


Fig. 7.



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ELECTRIC HEATING SYSTEM

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Application January 28, 1947, Serial No. 724,824

6 Claims. (Cl. 219—19)

1

This invention relates to a heating system, particularly for floors of rooms, although equally applicable to walls and ceilings.

One of the main objects of the invention is the provision of a relatively inexpensive and highly efficient heating system that is easier to install than heretofore, and that is indestructible from use and free from noise.

Heretofore, it has been the practice in floor or panel type heating to employ relatively high resistance conductors operating at temperatures of from 500° F. to 700° F. or more. This type of heating usually employs about a No. 19 "Nichrome" wire, and at the above temperature the concrete disintegrates when such wire is imbedded in concrete, forming an insulated shield around the wire which slows up the heating action and eventually burns out the wire.

There are instances, particularly for soil heating, where asbestos, paper or lead insulated cables of relatively low cross-sectional areas have been employed and in which the operating temperature is less than the above, but such installations are quite expensive and the cost is as prohibitive as where any electrically insulated cables, wires in rods are used. However, such installations as have heretofore been disclosed, require such insulation to prevent the generation of stray currents that would be detrimental to the power system serving the particular job to be heated, and which currents could be dangerous, if not fatal, to the occupants of the building under certain circumstances.

It is one of the objects of the present invention to provide an electrical heating system that is isolated from the source of power against the generation of detrimental stray currents.

Another object of the invention is the provision of a noiseless, safe, efficient and easily laid heating system in a building having a wooden floor and subflooring.

Other object and advantages will appear in the drawings and in the description.

In the drawings:

Fig. 1 is a diagrammatic plan view of a floor in a room in which the heating system is installed, and which view includes the electrical control system between the room heating means and the main source of electrical power.

Fig. 2 is an enlarged sectional view taken through a portion of a completely laid floor of concrete and through the cable or wire rope that constitutes the conductor for generating the desired heat. This view is through the conductor as would be seen in a laid floor from line **2—2** of Fig. 1.

2

Fig. 3 is a cross-sectional view taken through a wooden floor and subfloor showing the heating means therein.

Fig. 4 is a reduced size plan view of a wooden floor showing the heating means secured therein ready for enclosing the latter in cementitious material.

Fig. 5 is a semi-diagrammatic plan view of a wooden subfloor showing a preferred method and structure for installing the heating system, the top flooring being omitted.

Fig. 6 is an enlarged sectional view taken along line **6—6** of Fig. 5.

Fig. 7 is an enlarged sectional view taken along line **7—7** of Fig. 5 with the top floor indicated in position over the cable.

The dot-dash lines **1** seen in Fig. 1 may represent the outline of the floor of the room to be heated, and in which floor a continuous wire rope or cable **2** is arranged in parallel runs with the opposite ends of adjacent pairs of said runs connected by return bends **3**.

The floor itself may be of concrete **4** (Fig. 2) with the cable nearer the top surface of the floor than the bottom. For instance, in a concrete floor that is six inches in thickness the cable would preferably be about two inches from the upper surface.

The amount of heating, the dimensions of the conductor cable and the electrical voltage and currents applied are all related.

The preferred cable employed in this invention is what may be termed a wire rope, but in the trade it is referred to as ½ inch 6 x 37 sash cord type cable and is galvanized and of soft iron. The cross-sectional area, due to voids between the wire, is essentially ⅝ of an inch, but the circular mill area is approximately that of ½ inch solid rod, or 250,000 C. M. This sash-cord type of wire rope is found to be the most satisfactory for accomplishing the desired results.

In my co-pending application, Serial No. 686,-995, filed July 29, 1946, now Patent # 2,503,601, issued April 11, 1950, I showed the use of a solid conductor having an arrangement similar to the cable shown herein. This solid steel on iron conductor is perfectly suited to types of buildings, mostly industrial buildings, where steel reinforcing material is required, but has the objectionable feature of producing a slightly audible reactance hum or magnetic sound at 60 cycles when used in a concrete floor. This hum is not objectionable and usually is not even noticeable to workers in a building, but would not be as desirable in a quiet library as were it absent.

The employment of the soft iron sash-cord type cable eliminates this objectionable hum without reducing the efficiency of the conductor for heating. Furthermore, the cable is more easily bent than a solid rod to follow any desired path.

While voltages up to 50 volts and higher may quite easily be used with the cable, the preferred voltage for many installations is about 34 volts or between 30 to 35 volts. In a properly installed concrete slab voltages may be up to 100 volts at 100 amperes or 10 kilowatts. The basic equation actually used is about 10 watts per square foot of total surface to be heated, which result may be secured with higher or lower voltages or amperes. If wattages are higher than 10 watts per square foot the result is that the current is on for a shorter length of time, and if wattages are less, the current is on for a longer time.

Using 30 to 35 volts, an example may readily be given showing the values required for heating a certain room volume. Assuming it requires the expenditure of 2500 watts electrical energy to heat a given room volume and that 30 volts current is to be applied to the cable, it is necessary to know the length of cable required. If I equals current in amperes, W equals power in watts, and E equals voltage in volts, the current required is formed by the formula:

$$I=\frac{W}{E}=\frac{2500}{30}=83.3 \text{ amperes}$$

The total resistance R in ohms of the conductor may be formed by the formula:

$$R=\frac{E}{I}=\frac{30}{83.3}=.360 \text{ ohms}$$

Since it is known that the ½″ cable has a resistance R, of approximately .0009 ohm per foot, the length can be formed by the following formula, where L equals the total length in feet:

$$L=\frac{R}{V}=\frac{.360}{.0009}=400 \text{ feet}$$

Thus it is seen for the specifications adapted, the application of 83.3 amperes at 30 volts to 373 feet of ½″ 6 x 37 galvanized sash-cord type cable will supply heating of approximately 2500 watts. The current and length of the conductor are inversely proportional to one another and either may be reduced by increasing the other. This example is for illustrative purposes only, and other values may be adapted to suit particular needs, but it is found that the values chosen give adequate heating for the normal home where the runs are spaced about one foot apart without raising the temperature to where it is dangerous or causes cracking.

In the circuit illustrated, line voltage is supplied at terminals 5, which in the usual case, is 220 volts, 60 cycles, and is applied to the double pole relay switch 6 for applying the wire voltage to the primary of a transformer 7, the secondary of which transformer is connected to the terminals 8 of the cable. When switch 6 is closed current at about 30 or 34 volts, as reduced by the transformer 7, is supplied to the cable.

By the above it will be seen that the transformer 7 acts as an isolating transformer so that stray currents cannot be generated that would be detrimental to the power system servicing the particular job to be heated, nor could there be any danger to the occupants of the building being so heated due to stray currents that might be generated in the absence of the transformer. This is quite an important feature.

The line voltage is also applied to the primary of a transformer 12 whose secondary is conducted in a low voltage (24 volts) control circuit 9. In series with the secondary winding of transformer 12 are two conventional thermostats, a cable thermostat 13, preferably of the bulb type and a room thermostat 14. Said thermostats each includes the usual switch in the 24 volt circuit 9. The temperature sensitive element 15 of the cable thermostat 13 is connected directly to cable 2 and the temperature sensitive element 16 of the room thermostat 14 is positioned within the room to be heated. Both thermostats are connected in series in circuit 9 and are so arranged that if and when the temperature in the room or of the cable should rise above a certain predetermined degree respectively, the control circuit is broken. The ordinary cable thermostat may be permanently set at approximately 85° F. or 80° F. to 90° F., which is considerably below the maximum temperature that the concrete will withstand without danger thereto. The room thermostat is preferably adjustable for actuation of the switch in circuit 9 when the temperature in the room rises above, say 65° F. or 70° F. or whatever the occupants of the room desire.

A relay switch 17 in circuit 9 is in series in said circuit and is arranged so that the switch of the relay will be opened whenever the control circuit 9 is broken by operation of either the room or the cable thermostat. The switch of relay 17 is connected in series with the coil of relay switch 6, which coil is included in the circuit fed from terminals 5. This latter circuit is so arranged that as long as relay 17 is closed, the relay 6 will be closed to permit voltage to be applied to transformer 7, but when the circuit 9 is broken, the switch 6 will be opened and no current will flow in the cable 2.

The operation is clear that both of the thermostats in the low voltage control circuit must be closed in order that relays 6, 17 will be closed. Opening of either of the thermostatic switches caused by an excessive rise in the temperature of the air in the room or by an excessive temperature in the cable will open the relays 6, 17 and cut off the current supplied to the transformer 7 and the cable 2.

Line voltage thermostats can be used where available, thus eliminating the necessity for the auxiliary relays, but where such thermostats are not available the circuit as shown is satisfactory.

A conventional fuse 18 of fusible metal is preferably introduced into the cable circuit as an added safety precaution, which fuse will melt and break the cable circuit at a predetermined temperature below that where danger may follow a higher temperature.

The use of cable lends itself particularly to the installation of a floor heating system in a room having the conventional wood sub-floor and the usual wooden floor.

As seen in Fig. 4, certain boards of the top floor 20 may be removed or a space left between boards, to provide parallel spaced channels 21. Opposite ends of adjacent pairs of channels 21 may be connected by channels 22 routed out of the top floor, or as seen in Figs. 5, 6, the cable may extend around the ends of boards.

In the continuous channel so formed the cable 2 may be laid in substantially the manner as seen in Fig. 1. This cable may then be directly stapled by staples 26 to the subfloor 27 and the channel then filled with cementitious material 28 (Fig. 3). If desired, a linoleum or other floor covering 29 may be placed over the floor 20 and the cementitious material 28. The same control circuit shown in Fig. 1 is employed.

In Fig. 6 the same electrical circuit is shown as in Fig. 1, and the numbers are the same; also the same cable 2 is used. The main advantage in this disclosure is the simple and economical method of enclosing the cable in a floor structure.

A desirable spacing of the runs of cable 2 is substantially twelve inches; therefore in laying the floor the subflooring 35 may be of twelve inch lumber (width) spaced to permit easy laying of the cable in the spaces between said lumber with strips 36 of lesser thickness than the pieces 35 to provide a base for the cable. The corresponding ends of alternate pieces 35 may be cut away, as indicated at 38, to space the return bends at one of the ends of the parallel runs from the length 39 of cable 2 that extends past said ends on foundation 40 to a point where the opposite end of the cable terminates, thus facilitating the positioning of the transformer, etc., adjacent the terminating ends of the cable.

The crack in which the cable is positioned may be filled with any suitable filler 42 to provide a conductor for the heat, and then the conventional hardwood floor 41 may be nailed in place over the subflooring.

If desired, the strip 36 may be of fibrous heat insulation material suitable to prevent downward conduction of the heat so that such heat will be conducted upwardly through the filler 42 to floor 41 for heating the latter. In some instances, the cable may directly contact floor 41, but it is not desirable that the cable be insulated by an air space around the same.

By the above system, the runs of cable are automatically properly spaced and insulated from each other by the boards 35 and are held in such spaced relationship. Said boards also provide forms, across the ends of which the cable is formed to provide the return bends.

I claim:

1. A floor heating system comprising a bare continuous wire cable of relatively soft iron arranged in parallel spaced runs and enclosed in the floor of a room in direct thermal contact with the material of said floor, an electrical circuit having a pair of thermally actuated switches normally closed therein, a first thermostat connecting one of said switches with said cable for opening of the switch associated therewith upon a predetermined elevated temperature of said cable above about 60° F., a second thermostat connecting the other of said switches with the air in said room for opening of said other switch upon a predetermined elevated temperature of the air in said room above about 60° F., a relatively high voltage source of power, a step-down transformer between said source and the ends of said cable for inducing the flow of a relatively low voltage current in said cable for heating the latter and a step-down transformer between said circuit and said source for inducing the flow of a low voltage current in said circuit, a relay in said circuit actuated by flow of current therein for connecting said source with the said transformer that is in said circuit and a second relay actuated by the flow of current in said source to said last mentioned transformer for connecting said source with the transformer that is between said source and said cable whereby said circuit and said cable are isolated from said source against the generation of detrimental stray currents in said cable and circuit.

2. In a floor structure having a wooden subfloor and a wooden top floor respectively, a plurality of pairs of parallel channels formed in said top floor and other channels formed in said top floor connecting the opposite ends of the adjacent pairs of parallel channels for forming a continuous channel, a continuous soft iron cable arranged in parallel runs with return bends at the opposite ends of adjacent pairs thereof disposed in said parallel and said other channels, means securing said cable to said subfloor and cementitious material in said channels filling them and enclosing said cable in direct heat transfer relationship, terminals at the opposite ends of said cable, a relatively high voltage source of electricity and a step-down transformer between said terminals and source for energizing said cable with a 30 to 35 volt current whereby said cable will be isolated from said source against generation of detrimental stray currents between said cable and said source.

3. In a floor structure having a wooden subfloor and a wooden top floor respectively, a plurality of pairs of parallel channels formed in said top floor and other channels formed in said top floor connecting the opposite ends of the adjacent pairs of parallel channels for forming a continuous channel, a continuous soft iron cable arranged in parallel runs with return bends at the opposite ends of adjacent pairs thereof disposed in said parallel and said other channels, means securing said cable to said subfloor and cementitious material in said channels filling them and enclosing said cable in direct heat transfer relationship, terminals at the opposite ends of said cable, a relatively high voltage source of electricity and a step-down transformer between said terminals and source for energizing said cable with a 30 to 35 volt current whereby said cable will be isolated from said source against generation of detrimental stray currents between said cable and said source, and a floor covering extending over said top floor and over said cementitious material.

4. In a floor structure having a wooden subfloor and a wooden top floor respectively, a plurality of pairs of parallel channels formed in said top floor and other channels formed in said top floor connecting the opposite ends of the adjacent pairs of parallel channels for forming a continuous channel, a continuous soft iron cable arranged in parallel runs with return bends at the opposite ends of adjacent pairs thereof disposed in said parallel and said other channels, means securing said cable to said subfloor and cementitious material in said channels filling them and enclosing said cable in direct heat transfer relationship, terminals at the opposite ends of said cable, a relatively high voltage source of electricity and a step-down transformer between said terminals and source for energizing said cable with a relatively low current below 110 to 125 volts whereby said cable will be isolated from said source against generation of detrimental stray currents between said cable and said source, said top floor being coplanar parallel strips of uniform width and said channels being parallel with said strips and of a width equal to the width of said strips and spaced a part a distance equal to exact multiples of the width of said strips whereby the removal of spaced strips in a solid

floor of said strips will provide said parallel channels.

5. A floor structure comprising a row of substantially uniformly spaced, uniform width, parallel coplanar boards in side by side relationship, means supporting said boards in said relationship, a flexible electrical conductor in the plane of said boards having parallel spaced runs respectively positioned in the spaces between said boards and with return bends at the ends of said runs extending across the ends of said boards whereby said boards provide a form for uniformly spacing the said runs and for aligning said return bends at corresponding ends of said boards, a step-down transformer connecting said conduit with an electrical circuit for providing a relatively low voltage high current electrical heating means for said conductor, a floor secured over said boards and said conductor and a filler surrounding said conductor and in heat transfer relation with said floor.

6. A floor structure comprising a row of substantially uniformly spaced, uniform width, parallel coplanar boards in side by side relationship, means supporting said boards in said relationship, a flexible electrical conductor in the plane of said boards having parallel spaced runs respectively positioned in the spaces between said boards and with return bends at the ends of said runs extending across the ends of said boards whereby said boards provide a form for uniformly spacing the said runs and for aligning said return bends at corresponding ends of said boards, a step-down transformer connecting said conduit with an electrical circuit for providing a relatively low voltage high current electrical heating means for said conductor, a floor secured over said boards and said conductor and a filler surrounding said conductor and in heat transfer relation with said floor, said conductor having a circular mill area of substantially 250,000 C. M.

REUBEN S. TICE.

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